91-99-0120

行政院及所屬各機關出國報告
(出國類別:研究)

參加「機場系統規劃及設計」研習會暨溫哥華、西雅圖、舊金山國際機場參訪報告

服務機關:交通部運輸研究所
出國人 職　　稱:副研究員
姓　　名:呂蕙美

出國地區:美國、加拿大
出國期間:91年8月11日至27日
報告日期:91年11月4日

參加「機場系統規劃及設計」研習會
暨溫哥華、西雅圖、舊金山國際機場參訪報告

著　　者：呂蕙美
出版機關：交通部運輸研究所
地　　址：台北市敦化北路 240 號
網　　址：www.iot.gov.tw
電　　話：(02)23496789
出版年月：中華民國九十一年十一月
印 刷 者：承亞興企業有限公司
版(刷)次冊數：初版一刷 130 冊
本書同時登載於交通部運輸研究所網站
定　　價：200 元
展 售 處：
交通部運輸研究所運輸資訊組・電話：(02)23496880
三民書局重南店：台北市重慶南路一段 61 號 4 樓•電話：(02)23617511
三民書局復北店：台北市復興北路 386 號 4 樓•電話：(02)25006600
國家書坊台視總店：台北市八德路三段 10 號 B1•電話：(02)25787542
五南文化廣場：台中市中山路 2 號 B1•電話：(04)22260330
新進圖書廣場：彰化市光復路 177 號•電話：(04)7252792
青年書局：高雄市青年一路 141 號 3 樓•電話：(07)3324910

GPN：1009104144

系統識別號：C09200167

行 政 院 及 所 屬 各 機 關 出 國 報 告 提 要

頁數：136 含附件： 含

報告名稱：參加「機場系統規劃及設計」研習暨溫哥華、西雅圖、舊金山國際機場參訪報告

主辦機關：交通部運輸研究所

出國計畫主辦機關/聯絡人/電話：

交通部運輸研究所/葉專員佐油/02-23496788

出國人員姓名/服務機關/單位/職稱/電話：

呂蕙美/交通部運輸研究所/運輸計畫組/副研究員/(02)2349-6813

出國類別：□1.考察□2.進修☑3.研究□4.實習□5.其他

出國期間：九十年八月十一日至八月二十七日

出國地區：美國、加拿大

報告日期：九十一年十一月四日

分類號/目：HO／綜合類（交通類）　　HO／綜合類（交通類）

關 鍵 詞：機場系統、規劃、設計

內容摘要：

本次行程主要在參加加州大學柏克萊分校「機場系統規劃與設計」（Airport Systems Planning and Design）研習會，研習課程內容包括：「機場系統規劃」、「空運需求預測」、「機場主計畫」、「機場佈設之規劃與設計」、「空域與機場容量」、「機場財務分析」、「機場聯外交通」、「客運航站規劃」、「陸側模擬技術」、「環境規劃及管理」、「機場噪音管理」、「航空公司營運及經濟性」及「機場規劃、設計與建設之急要課題」等項，本報告謹摘錄課程內容與心得，期供相關單位或人士參考。

另外，本次行程包含參訪溫哥華、西雅圖、舊金山三大國際機場。溫哥華國際機場爲亞洲通往北美洲各都市之客、貨運主要門戶之一；西雅圖國際機場爲東華盛頓州客貨運關鍵節點，亦爲華盛頓州及美國西北部之重要空運中心；舊金山國際機場爲美國西岸客運第二大機場及轉運中心，三者在北美洲及全球空運中均有其重要之地位。本行程除瞭解前述各機場之空側與陸側設施配置與最新之主計畫外，對於機場之組織架構、管理方式及機場經營目標與願景，亦有深一層之認識，期盼藉由本報告之呈現，作爲國內未來進行機場相關規劃之參考。

本文電子檔已上傳至出國報告資訊網

目　　錄

圖　目　錄

圖 目 錄(續)

圖　目　錄(續)

前　言

本次赴美國、加拿大行程共計十七天，主要在參加美國加州大學柏克萊分校第三十一屆「機場系統規劃及設計」（Airport Systems Planning and Design）研習會，並參訪溫哥華、西雅圖、舊金山三大國際機場，其行程簡述如下：

8 月 11 日(週日)	自台北搭機前往加拿大溫哥華
8 月 12 日(週一)	參訪溫哥華國際機場
8 月 13 日(週二)	參觀溫哥華國際機場聯外運輸
8 月 14 日(週三)	自溫哥華搭乘大眾運輸前往美國西雅圖
8 月 15 日(週四)	參訪西雅圖國際機場
8 月 16 日(週五)	自西雅圖搭機前往舊金山
8 月 17~18 日(週六~日)	至舊金山加州大學柏克萊分校圖書館蒐集資料/整理參訪資料
8 月 19~22 日(週一~四)	參加加州大學柏克萊分校「機場系統規劃與設計」（Airport Systems Planning and Design）研習會
8 月 23 日(週五)	參訪舊金山國際機場
8 月 24 日(週六)	參觀舊金山國際機場聯外運輸
8 月 25 日(週日)	搭機返回西雅圖 自西雅圖搭乘大眾運輸返回加拿大溫哥華
8 月 26~27 日(週一~二)	自溫哥華搭機返回台北

加州大學柏克萊分校「機場系統規劃與設計」（Airport Systems Planning and Design）研習會，研習課程內容包括：「機場系統規劃」、「空運需求預測」、「機場主計畫」、「機場佈設之規劃與設計」、「空域與機場容量」、「機場財務分析」、「機場聯外交通」、「客運航站規劃」、「陸側模擬技術」、「環境規劃及管理」、「機場噪音管理」、「航空公司營運及經濟

性」及「機場規劃、設計與建設之急要課題」等項，內容涵蓋廣泛且豐富，師資包含學術與實務界資深人士，參加研習者多為機場管理階層、機場或顧問公司資深規劃師與工程師，實為一相當寶貴之學習機會。本報告茲摘錄課程內容與心得於后，期供相關單位或人士參考。

另外，本次行程包含參訪溫哥華、西雅圖、舊金山三大國際機場。溫哥華國際機場為亞洲通往北美洲各都市之客、貨運主要門戶之一；西雅圖國際機場為東華盛頓州客貨運關鍵節點，亦為華盛頓州及美國西北部之重要空運中心；舊金山國際機場為美國西岸客運第二大機場及轉運中心，三者在北美洲及全球空運中均有其重要之地位。本行程除瞭解前述各機場之空側與陸側設施配置與最新之主計畫外，對於機場之組織架構、管理方式及機場經營目標與願景，亦有深一層之認識，期盼藉由本報告之呈現，作為國內未來進行機場主計畫之參考。

研習會內容紀要

壹、「機場系統規劃及設計」研習會內容紀要

一、機場系統規劃（Airport System Planning）

（一）講師(職稱)：Geoffrey D. Gosling (Aviation System Planning Consultant)

（二）單位：Institute of Transportation Studies, U.C. Berkeley, California

（三）時數：1.5 小時

（四）課程內容：

本課程主要在對機場系統規劃各主題提出一概念性之輪廓，其重要內容如下：

1. 世界與美國民航發展趨勢

（1）航空費率逐年遞減，至 1995 年航空費率每人公里平均僅 0.08 美元，約為 1950 年之 40%（詳如圖 1-1）。

（2）過去幾十年中全球航空運量不斷成長，預估至 2015 年將達每年七兆人次，其成長趨勢驚人（詳如圖 1-2）。

（3）美國航空費率逐年遞減，自 2001 年 911 攻擊事件後，費率降幅更大（詳如圖 1-3）。

（4）美國航空運量原不斷成長，但自 911 攻擊事件後，空運量明顯下滑（詳如圖 1-4）。

2.簡介

（1）機場規劃時應考慮之背景因素

a. 機場未來擴建時之限制

b. 環境影響因素(愈來愈重要)

c. 市場之不完全性

d. 經濟因素

e. 技術之更新

f. 機場安全(近期規劃之焦點)

（2）空運系統規劃之角色

a. 策略規劃

b. 以系統眼光規劃機場未來發展

c. 整合同一地區內各機場之發展

d. 滿足機場未來基礎建設及服務之需求

e. 以宏觀之運輸角度考量空運問題

f. 確認所需籌措之資金及計畫發展所需經費

（3）機場規劃之目標

a、設施及服務需滿足未來需求

b、機場營運收支平衡

c、提高各設施使用效率

d、促進地區經濟發展並滿足社會之運輸需求

e、使負面之環境衝擊達到最小

（4）系統規劃之範圍(不同範圍之計畫間關係詳如圖1-5)

a、 地區性

b、 州

c、 國際性

3.系統規劃之目的

（1）確認機場發展之未來需要

a、以系統角度預測

- 機場間市場之改變
- 需保持一致之假設

b、預期新技術之衝擊

- 新型航機型式
- 新型航管與飛行技術
- 地面運具之改變

（2）提供資源合理分配之判斷

a、決定資金之未來需求

b、決定未來發展之優先次序

c、使收支平衡

（3）與其他系統或相關規劃之整合

a、與地面運具整合

b、與經濟發展整合

4.規劃面臨之挑戰

（1）對未來需求之正確預測

（2）不確定因素之掌握

（3）系統績效之預測與評估

（4）計畫方案之評估

5.系統規劃作業所包含之內容(空運規劃之程序詳如圖 1-6)

（1）資料蒐集與調查

（2）未來需求預測

（3）容量分析

（4）設施需求

（5）方案評估分析（包括系統績效、噪音與空氣污染等衝擊、其他環境保護問題）

（6）較佳方案之擇定

（7）財務分析及設備更新計畫

（8）經濟衝擊分析

6.系統規劃程序中應包含之項目

（1）重要課題之界定

（2）資料蒐集與整理

（3）方法論之選用

（4）機場規劃參與者應涵蓋各相關團體

a、州及地方代表

b、機場營運者

c、機場鄰近社區

d、航空公司及航太產業

e、其他利益團體

（5）執行面之考量

7.規畫作業之重要課題

（1）與現今政策結合

（2）系統規劃程序

（3）資料整理及模式之選用

8.計畫方案之分析程序

（1）各方案之界定

（2）各方案之評估

（3）最適方案之擇定

（4）分析方法之選用

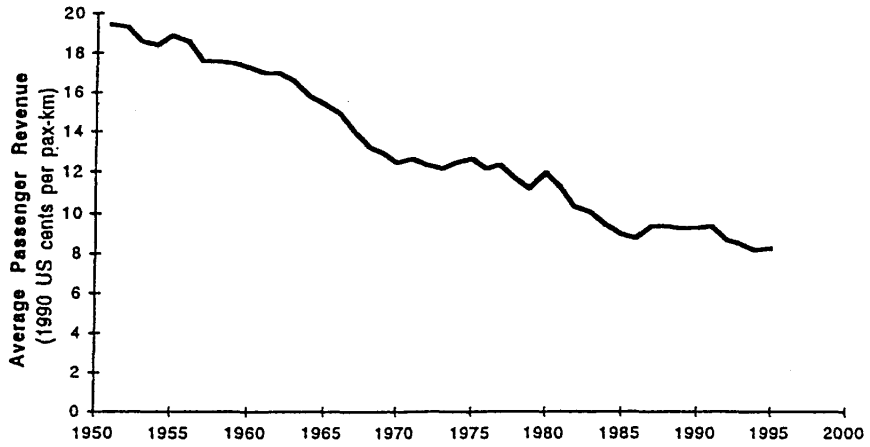
9. 持續之規畫作業要求

（1）在不斷變動的世界環境之下，規畫作業之課題亦需隨時調整，以因應需要。

（2）持續進行相關研究。

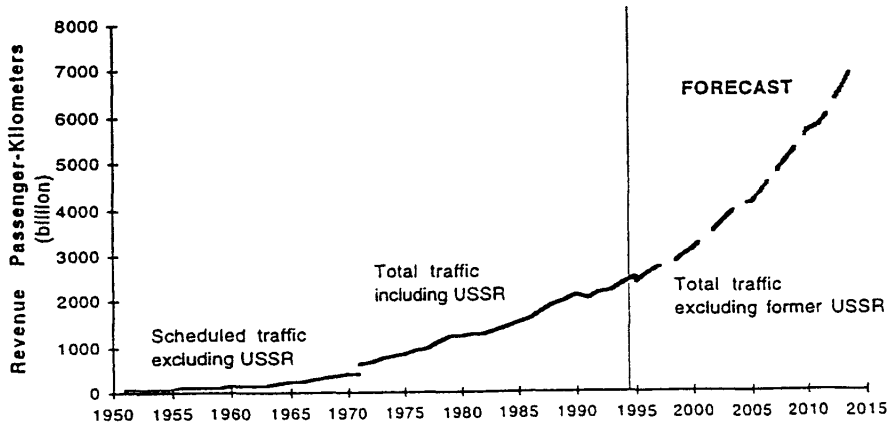
（3）規畫過程應由下而上加以研究，以釐清問題。

（4）持續不斷的資料蒐集，並注意空運系統發展。



Source: *International Civil Aviation Organisation, ICAO Bulletin; Civil Aviation Statistics of the World, various annual issues.*

圖 1-1　歷年全球航空費率變化情形



Sources: *International Civil Aviation Organisation, ICAO Bulletin; Civil Aviation Statistics of the World, various annual issues.*
Douglas Aircraft Company, 1996.

圖 1-2　全球航空客運成長趨勢

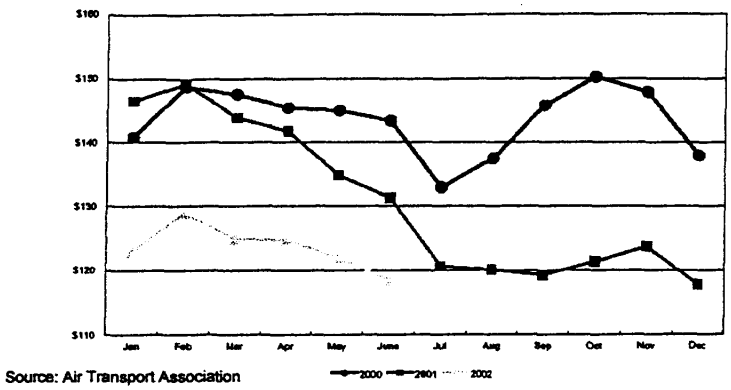


圖 1-3　近年來美國國內航空費率變化情形

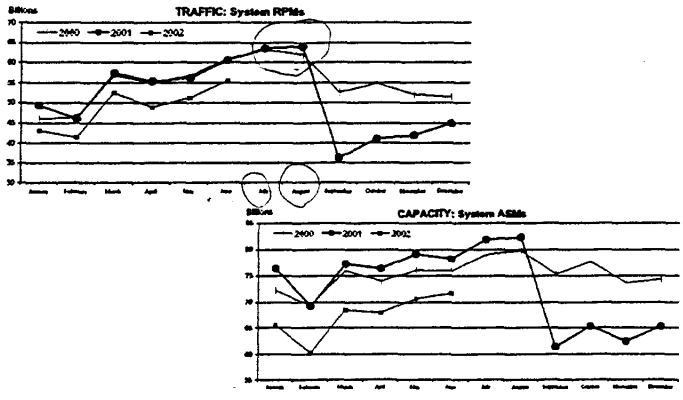


圖 1-4　近年來美國航空客運量發展情形

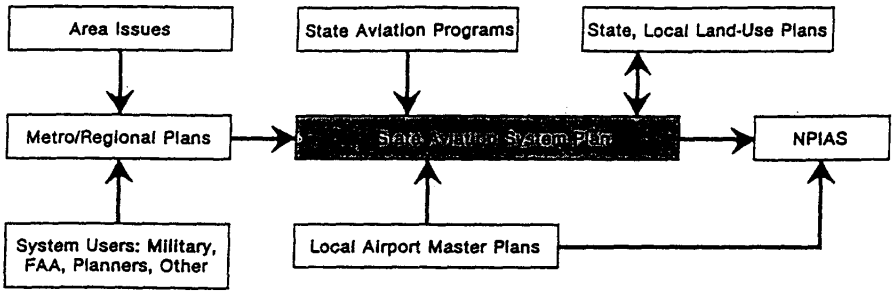


圖 1-5　不同範圍之計畫間關係圖

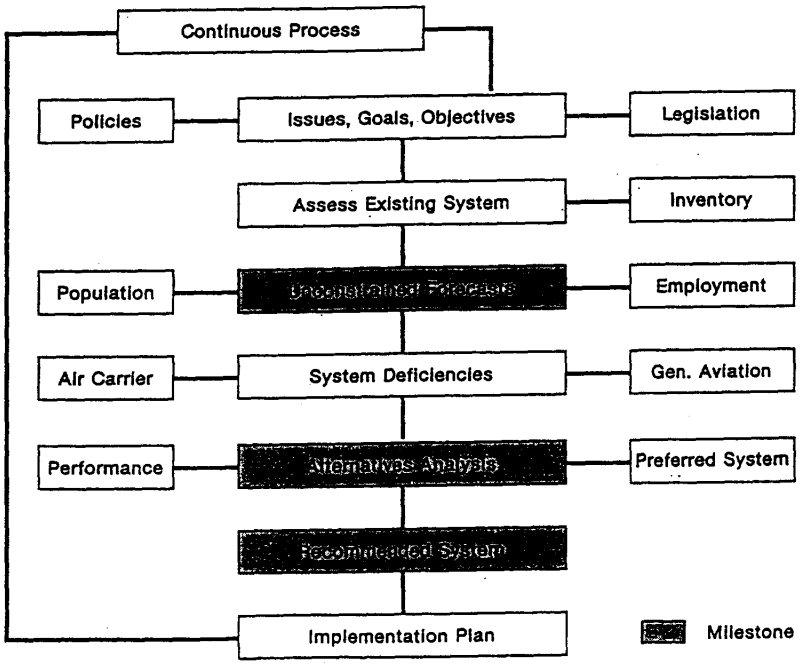


圖 1-6　空運規劃之程序圖

二、空運需求預測（Air Traffic Demand Forecasting）

（一）講師(職稱)：Geoffrey D. Gosling (Aviation System Planning Consultant)

（二）單位：Institute of Transportation Studies, U.C. Berkeley, California

（三）時數：1.5 小時

（四）課程內容：

預測為規劃程序中之主要項目，本課程之內容包括：規劃程序中預測所扮演之角色、傳統之預測方法、預測之方法、整體預測模式之架構、機場相關運具選擇問題、實例解析及預測方法中尚待突破之問題等。

1.規劃程序中預測所扮演之角色

（1）為一系統性規劃

（2）為規劃之主要項目

（3）攸關機場設施之設計

2.傳統之預測方法

（1）僅就個別機場進行預測

（2）預測之主要內容

a、預測年客運量(包括:起迄運量/航線運量/國際、國內運量)

b、預測年貨運量(包括:一般貨運量/快遞貨運量/郵件運量/國際、國內運量)

c、預測未來主要航機型式

（3）預測尖峰月/日/小時之營運量

a、旅客運量

b、航空貨運量

c、航機起降架次

（4）進行相關之預測

a、機隊組成

b、尖峰月/小時之尖峰係數

c、航線

（5）預測方法中尚待突破之問題

a、需考慮不同市場需求下所導致之運量改變

b、需考慮機場間之競爭(舊金山灣區各機場歷年市場佔有率圖詳如圖 1-7)

c、相關預測之基礎假設可能改變

3.預測之方法

（1）經驗法則判斷

（2）時間序列分析（舊金山灣區空運量時間序列預測模式與歷年實際運量比較詳如圖 1-8）

（3）模式建立與應用（舊金山灣區空運預測模式詳如圖 1-9）

a、社經及運量相關數據之蒐集

b、自變數之資料蒐集

- 人口數
- 就業人數
- 收入
- 吸引遊客之因素
- 空運服務成本
- 可及性
- 架次頻率

c、模式之型式

- 線性模式
- 對數線性模式

- 羅吉特選擇模式

d、模式建立面臨之課題

- 變數之遴選
- 如何確切描述空運行為

4.整體預測模式之架構

（1）持續進行系統規劃

a、各機場之空運需求加總為地區之空運需求

b、同地區各機場之空運市場佔有率與其服務特性假設應一致

（2）持續進行空運預測

a、同地區各機場之空運特性與市場佔有率應一致

b、預測機場空運量與地面運輸交通量

（3）民用航空機場

a、先以服務市場為基礎加以預測

b、從一地區預測之空運量推導機場運量及各相關系統之未來需求

c、航機起降架次

- 機隊組合
- 尖峰架次及航線分佈

（4）一般飛行場

a、一地區之運輸需求影響其空運活動

- 了解不同旅次目的之飛行時數
- 了解機隊型式

b、航機分派之考慮因素

- 機場及航機營運者之區位
- 機場特性
- 與營運相關之要素

5.分析不確定之狀況

（1）了解任何預測之限制

a、未來具不確定性

b、模式不完美

（2）資料不確定或有誤將影響以下之預測

a、模式界定

b、模式估計

c、自變數之預測

d、發展時程及最終決策

（3）處理不確定問題之研究方法

a、多種假設

b、情境預測

c、風險分析

（4）值得重視風險及不確定問題之處理

6.機場相關運具選擇模式

（1）旅客及運具選擇程序

a、機場到特定地點之可及性

- 公路旅行時間
- 替選之地面運具

b、各機場營運特性

- 航空費率
- 到達目的地之架次頻率
- 直接與間接之服務
- 航空公司所服務之市場

（2）可提供之空運服務需視空運量而定

a、到達目的地之空運量

b、空運網路效應

（3）考慮正面回饋之效果

（4）機場需求分配模式目前之發展情形

a、多項羅吉特模式

b、目前預測尚未處理回饋程序問題

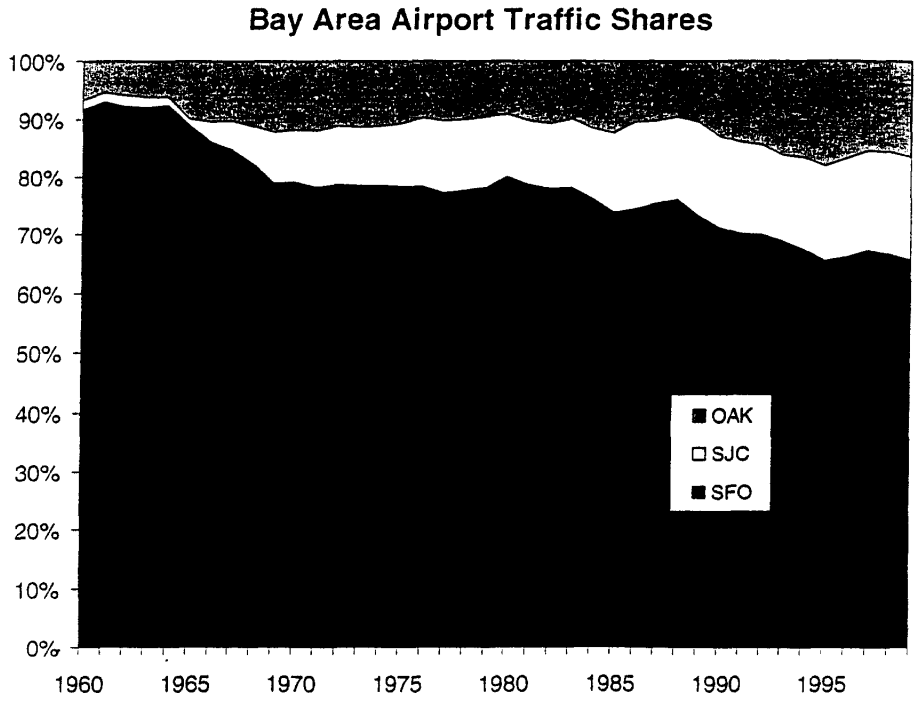


圖 1-7　舊金山灣區各機場歷年市場佔有率圖

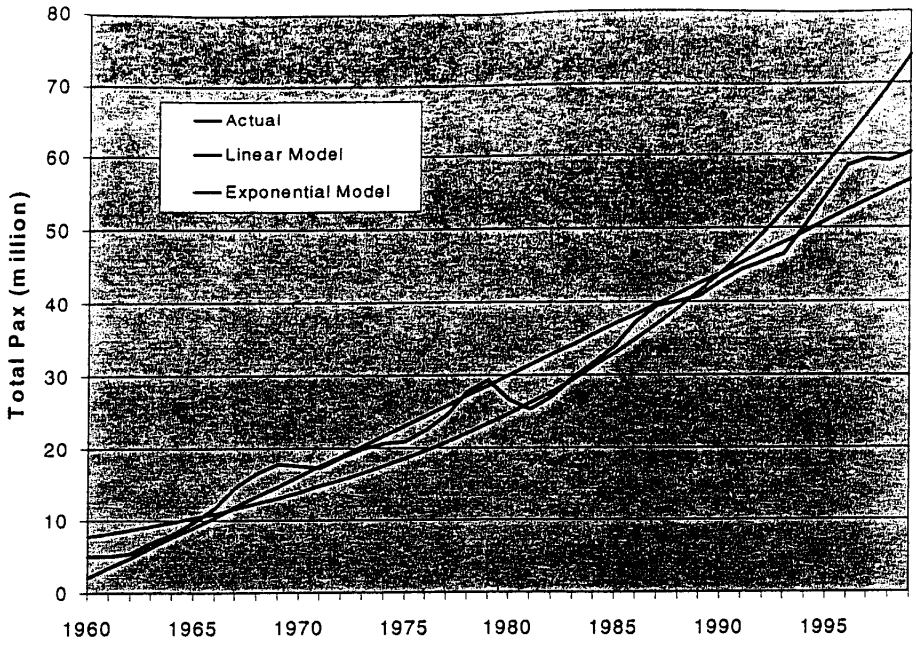


圖 1-8　舊金山灣區空運量時間序列預測模式與歷年實際運量比較

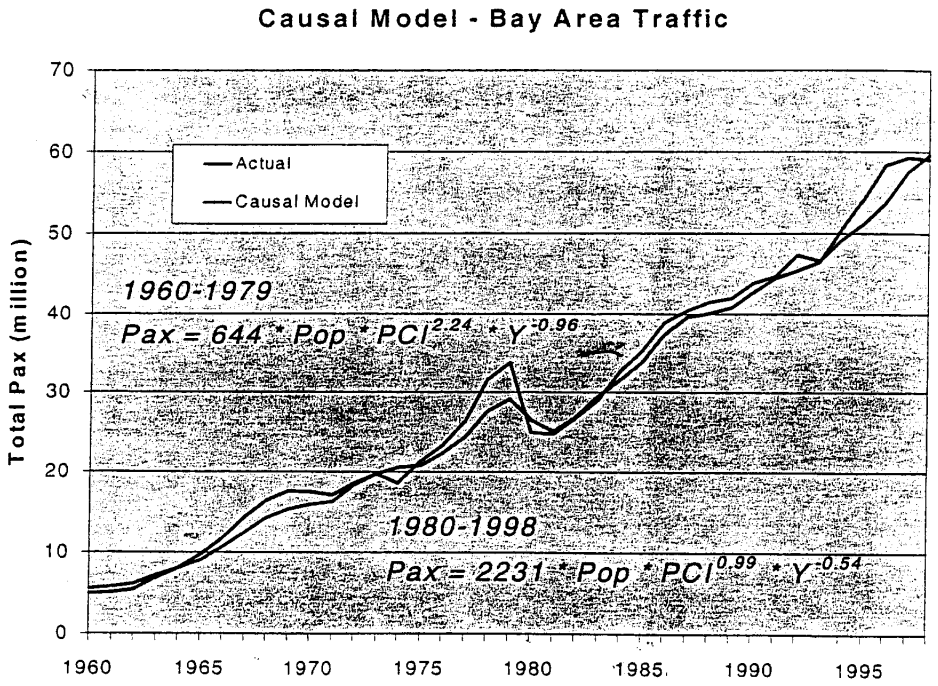


圖 1-9　舊金山灣區空運預測模式

三、機場主計畫（Airport Master Planning）

（一）講師(職稱)：Burr Stewart (Strategic Planning Manager)

（二）單位：Port of Seattle & Seattle-Tacoma Int'l Airport

（三）時數：1.5 小時

（四）課程內容：

機場主計畫旨在鉤勒出一個機場未來持續發展之整體藍圖， Stewart 先生因來自於機場管理之實務界，其介紹乃集中在以系統與策略規劃之角度討論一個機場主計畫應注意到的課題，至於規劃設計的方法與技術則較少說明。

1.主計畫之位階(詳見圖 1-10)

2.一般之規劃程序

（1）確立目標及目的

（2）確認現有設施及績效

（3）建立計畫方案

（4）評估計畫方案

（5）遴選最適方案並執行

（6）評估執行結果與目標之差異

（7）重複規劃程序

3.三種基本之策略

（1）提昇產品之領導性（產品創新）

（2）提高顧客忠誠度（鎖定特定顧客群）

（3）增加組織之優越性(系統效率)

4.了解該機場所扮演之角色

（1）以系統角度思考機場之角色定位

a、在一都市中

b、在各機場中

c、在各區域中

d、在各州中

e、在該國中

f、在全球中

（2）了解誰才是機場的資金持有人？

（3）了解機場資金持有人之需要為何？

（4）了解機場營運者之需要為何？

（5）了解如何與不同團體對象溝通？

（6）了解何人能決定作何事？

5.了解何者正在改變

（1）全球經濟及其變化率

（2）航空公司共通點及服務特性

（3）電子商務及技術

（4）安全系統及安全需求

（5）環境保護意識抬頭及其策略

（6）可忍受度或三條管制線

（7）持續規劃及決策制定

（8）財務選擇及合作單位之等級

（9）內部組織、管理及合夥關係

6.界定機場營運者之目的

（1）了解時程

（2）了解可用資金之多寡

（3）了解何者較有爭議

（4）了解機會是什麼？

（5）了解該計畫是屬於策略性或戰略性？

7.了解不同團體間之目的是衝突的

8.四個向度測試規劃是否良好

（1）好的方法（資料）

（2）好的決策（方便執行）

（3）好的溝通（參與）

（4）好的行動（一貫性）

9.FAA 主計畫制定之程序（詳如圖 1-11）

10.其他有用之方法

（1）問題解決與決策制定

（2）官方簡報

（3）各策略計畫

（4）商業計畫與預算

（5）溝通與行銷計畫

（6）債券發行者之正式聲明

11.規劃延遲之成本

（1）營運成本增高

（2）使相關方案推動延遲

（3）環境策略改變之成本

（4）財務策略改變之成本

12.實例探討－西雅圖塔可瑪機場

13.結論

（1）主計畫介於系統規劃與方案規劃之間

（2）必須整合機場應盡之功能與機場資金提供者之意見

（3）需要清楚之目標與資料分析，並需公眾參與決策制定

（4）確保政策、管理與技術性目標能完滿達成

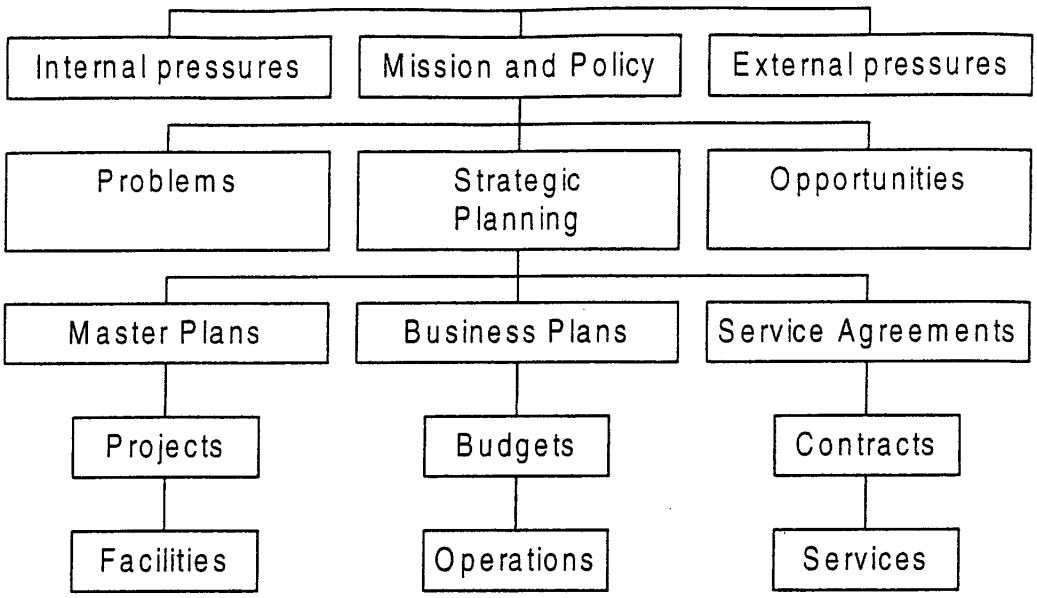


圖 1-10　主計畫之位階圖

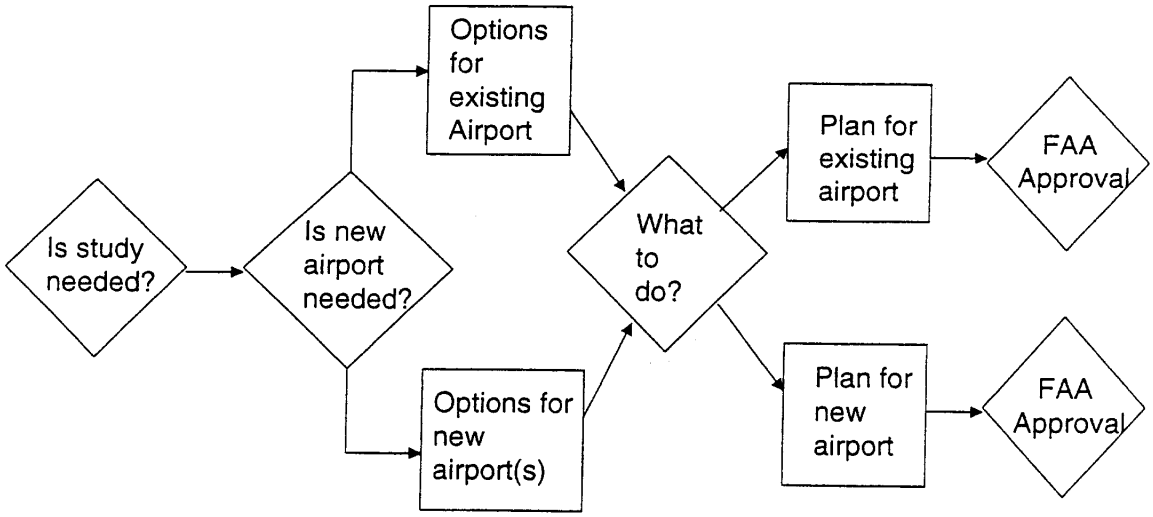


圖 1-11　FAA 主計畫制定之程序

四、機場佈設之規劃與設計（Airport Layout Planning and Design）

（一）講師（職稱）：Jasenka Rakas (Postdoctoral Researcher)

（二）單位：Institute of Transportation Studies, U.C. Berkeley

（三）時數：1.5 小時

（四）課程內容：

本課程在介紹機場空側與陸側設施配置的規劃設計方法，Rakas 小姐介紹的主軸在 FAA、ICAO 等機構對機場空側與陸側設施設計的標準或規範，可供設計之依據或參考。

1.機場主計畫之程序（階段）

階段一：機場需求

a、現有設施之狀況

b、社經條件

c、未來交通量需求預測

階段二：場址選擇

階段三：機場各計畫

a、機場配置

b、土地使用

c、航站區域各計畫

d、機場聯外道路

階段四：財務規劃

2. 機場配置

（1）陸側各設施

a、航站大廈

- 目的
- 對航站大廈之觀點
- 登機門

b、環場道路之行駛路線規劃

- 目的
- 配置之型式

- 說明
- 擴建的方式

c、停車設施

- 停車設施之型式
- 停車配置

d、機場道路與運輸設施

- 機場道路分類
- 機場道路與運輸設施屬性

（2）空側各設施

a、跑道系統

- 跑道構造
- 方位
- 長度與寬度
- 標線
- 燈光
- 參考碼
- 能見區

b、滑行道系統

- 入口滑行道與出口滑行道
  - ✧跑道佔有時間之考量
  - ✧影響滑行道系統設計之因素
- 滑行道幾何設計
  - ✧滑行道數
  - ✧滑行道配置
  - ✧等待機坪與等待區

c、航站空域

- ✧ 假想面(請參閱 FAR Part 77 與 ICAO Annex 14 之規定)
- ✧進場角度
- ✧清除區與進場區

五、空域與機場容量（Airspace and Airport Capacity）

（一）講師（職稱）：Bill Dunlay (Principal)

（二）單位：Leigh Fisher Associates

（三）時數：1.5 小時

（四）課程內容：

航管作業之目的，在維護航機安全，提高空域與空側之容量，因作業方式、使用設備等之不同，均將使空域與空側之容量不同，故正確的空域分析與適當的航管作業方式安排，將可適度提高空域與空側之容量。

1. 影響機場容量與延滯之因素

（1）需求尖峰之型態

（2）天氣狀況

（3）空運航管規定

（4）航機機隊組合

（5）跑道型式與出口滑行道

（6）進場與離場之程序

（7）空域內之互動

2. 需求尖峰之型態

（1）何者最能適當測量？

a、OAG 班表 VS 起降次數

b、使用者要求

（2）現況尖峰 VS 未來尖峰

a、轉運中心之運作

b、壅塞之影響

c、推動轉運功能連續運作

3. 天氣狀況

天候狀況影響風向、風速、雲冪與能見度等，因此與航管或航機之飛行關係密切，而各種導航方式所可適用之天候條件並不相同，如 VFR 或 VMC（visual meteorological condition）、IFR 或 IMC（instrument meteorological condition），相關作業必須在導航設施允許之狀況下，始可確保飛航安全。

4. 空運航管規定

（1）IFR 與 VFR 飛行計畫

（2）塔台管制（Towers）與 TRACONs、ARTCCs

（3）中央流量控制系統（Central Flow Control Facility，CF2）

（4）IFR 路徑，STARS 與 SIDS

（5）雷達偵測系統

（6）請參閱 FAA Order 7110.65N，Air Traffic Control, Aug. 8, 2002

5. 航機分類(以載重區分)

（1）小型機→ <=41,000 磅（eg. SF-340 與 ATR-42）

（2）大型機→ >41,000 磅 但 <=255,000 磅

（3）Boeing 757→ MGTOW（Maximum Gross Take Off Weight）=255,000 磅

（4）重型機→ >255,000 磅

6. 航機機隊組合

為維護航機於空中之安全，航機間需進行各種隔離（separation），然因航機重量、航速、渦輪引擎之噴氣漩渦影響範圍等不同，需採用嚴格與寬鬆之標準亦不同。

一般而言，最少需有 3 海浬之水平隔離間距，1,000 英呎之垂直隔離間距，且隨前機機型之增大，所需之隔離間距亦將加大。

7. 跑道型式

跑道型式有單跑道、平行雙跑道、交叉雙跑道、三或多跑道、橫風跑道等不同之跑道佈設，均會影響空域之容量，而目前對此課題，可資運用之助航設施有：PRM（Precision Runway Monitor system）、CRDA（Converging Runway Display Aid）、FAST（Final Approach Spacing Tool）等，未來則更有 DGPS（Differential Global Positioning System）、WAAS（Wide Area Augmentation System）、ADS-B（Automatic Dependent Surveillance-Broadcast mode）。

8. 空域與機場容量之模擬軟體

（1）快速模擬軟體（Fast-Time simulations），如：ADSIM、RDSIM、SIMMOD、Airport Machine、FLAPS、AIRNET、NASPAC、TAAM、RAMS 及其他軟體。

（2）即時模擬軟體（Real-Time simulations）

9. 進場與離場之程序

（1）同時獨立儀降進場

（2）平行儀降進場

（3）同時集中儀降進場（SCIAS）

（4）同時集中儀降進場（CRDA）

10. 空域內之互動

對於多跑道機場，或一區域內存在兩個以上機場時，其空域內之互動狀況，均會影響整體空域之容量。

六、機場財務分析（Airport Finance）

（一）講師（職稱）：Warren Adams（Principal Associate） and Amanda Thomas

（二）單位：Leigh Fisher Associates

（三）時數：1.5 小時

（四）課程內容：

本課程係分別由機場財務及機場費率定價兩大課題討論機場的財務分析，並就美國機場的實例探討成本與收入項內容，並進而探討各項費率的定價法則，茲摘錄部分重點如下：

1. 法定之體制與管理

（1）美國大部分之機場是獨立且是非營利實體

（2）私人參與美國機場營運之範圍

（3）機場私有化在海外愈來愈普遍

2. 機場建設資金來源

（1）發行免稅的債券 (Tax-exempt bonds)，約佔 53%

（2）聯邦政府之補助款 (Airport Improvement Program grants, AIP grants)，約佔 20%

（3）旅客服務費(Passenger Facility Charges, PFCs)，約佔 16%

（4）發行特殊設施之債券 (Special facility bonds)，約佔 6%

（5）州政府之補助款 (State grants)，約佔 4%

（6）機場營運收益 (Airport revenue)，約佔 2%

3. 大型空運中心機場的營運收入

（1）降落費，約佔 24%

（2）航空公司租金收入，約佔 33%

（3）航廈內特許營業費，約佔 11%

（4）租車設施收入，約佔 8%

（5）停車場收入，約佔 17%

（6）其他地面運輸系統場站收入，約佔 1%

（7）其他航空事業收入，約佔 2%

（8）其他，約佔 4%

4. 小型空運中心機場的營運收入

（1）降落費，約佔 18%

（2）航空公司租金收入，約佔 28%

（3）航廈內特許營業費，約佔 7%

（4）租車設施收入，約佔 13%

（5）停車場收入，約佔 20%

（6）其他航空事業收入，約佔 4%

（7）其他，約佔 10%

5. 機場成本中心結構

（1）主要直接成本

a、航站大廈（包括陸側及登機廊廳）

b、飛行場（包括滑行道）

c、停機坪

d、停車場或地面運輸系統場站

e、其他建築物或土地，如普通航空業、軍事設施、航油以及貨運園區

f、普通航空業機場

（2）次要間接成本

a、行政組織

b、環場道路

c、安全

d、 日常維護成本

e、航機搶救及消防站

f、 車輛維修

g、 公共設施

6. 基本定價方法

（1）補償法 (Compensatory)

a、投資成本完全回收

b、 使用者付費

c、機場投資者的財務風險

d、 機場營運者維持非航空公司類的營收

（2）殘值法 (Residual)

a、扣除非航空公司類的營收後的投資成本回收

b、 將財務風險轉嫁給航空公司

c、混合法 (Hybrids)

d、 投資成本扣除自償部分

e、利潤共享原則

7. 各類費率的定價方法

（1）航站大廈租金費率：補償法及殘值法為主

（2）降落費：補償法及殘值法為主

8. 機場特許營業費類別

（1）飲食類

a、飲食區

b、餐廳

c、特殊品牌食品

d、點心吧

e、特殊名產品

f、其他

（2）物品類

a、書刊報紙攤

b、禮品店

c、特殊名產品

（3）租車設施

（4）停車設施

（5）廣告

（6）電話

（7）其他

9. 機場特許營業費合約

（1）招標類別

a、比價

b、比計畫書

c、協議

（2）合約類別

a、各商店分開簽約

b、與主要特許營業公司簽約

c、與管理單位簽約

10.機場商業管理趨勢

（1）特許範圍將日益擴大

（2）零售業者將加入

（3）價格趨向於一般市價

（4）趨向多合約制

（5）航空公司將介入商業服務

（6）在大型空運中心機場則趨向將航廈營運整體外包簽約。

11.租車費用結構

（1）特權費用

（2）運輸費用

（3）旅客設施收費

（4）偶發之租金(如：提供額外之安全與平衡風險之服務)

（5）空間/地板租金

七、機場聯外交通（Airport Access）

（一）講師(職稱)：Geoffrey D. Gosling (Aviation System Planning Consultant)

（二）單位：Institute of Transportation Studies, U.C. Berkeley, California

（三）時數：1.5 小時

（四）課程內容：

Gosling 教授將機場聯外規劃之課題，分為六大部分說明：

1.研究範圍

（1） 機場內

（2） 機場鄰近地區

（3） 地區性

2.機場聯外系統規劃之目的

（1） 改善往返機場之時間、成本，提高方便性

（2） 減少因機場旅次所帶來之交通與環境衝擊

（3） 自成本效益觀點，提高資源的有效使用

（4） 複合運輸之考慮

而機場聯外規劃時，除上述四項目的外，亦應考慮下列諸項課題：

（1） 因航空旅次所帶來聯外系統之交通擁擠

（2） 空氣污染問題

（3） 道路、停車場及路緣停靠空間之吸納能量

（4） 公共運輸之提供

（5） 轉運設施

（6） Funding Facilities and services

（7） 指引標誌與資訊系統

（8） 新科技之運用

（9） 大型貨車之考慮

3.地面交通旅次特性

不同之旅次特性，對機場聯外系統將帶來不同之衝擊影響，如機場各類員工其停車時間長轉換率低；貨車則量大但流動快轉換率高；至於私人運具則亦量大，轉換率低，但相對卻可創造機場許多之停車收益，溢注機場營運收益。此外，若以旅次本身特性分析，則當地居民之旅次及商務性旅次，多偏好使用私人運具，其他一般性旅次則較願意使用大眾運具。蓋此現象應與美國私人運具發達之背景環境有關，我國機場聯外之大眾運輸，應可有較大之發展空間。

4.地面交通設施之規劃設計

（1） 地面交通設施之規劃設計項目包括：停車場、航廈路緣車輛停靠、動線循環設計、及接駁轉運設施等、

（2） 而透過每百位旅客使用各種特徵運具之數量分析、停車時間長度分析，可了解需求之水準及各月份之變化，據以推估相關停車設施之需求量，進行適當之規劃設計。

（3） 在路緣車行動線之安排上，應兼顧直行車輛及路緣停靠車輛之特性及需要，必要時可增設島式月台，以增加路緣停靠之空間。

（4） 在航廈之路緣設計方面，三層式開放月台設計理念，不但可增加路緣長度，分離到站與離站之動線，更有助廢氣之擴散，避免旅客候車空間，因車輛廢氣排散困難，所造成旅客之不適。

5.機場聯外交通規劃所需之資料

完善之規畫建立在充分之資料蒐集之上，一般而言，機場聯外交通規劃所需之主要資料為：旅次地面端點分佈資料、尖峰特性因素、運具使用型態、旅次量變化情形及地面運輸系統之各項資料等。

6.聯外交通運具選擇（mode choice）

Gosling 教授建議在運具選擇方面，首先需釐清可供運具選擇之運具種類及其相互屬性關係，再以個體多項羅吉特模式進行運具選擇之分析及指派。

7. 聯外交通運具運具選擇模式

（1） 總合模式

（2） 分散模式

a、多項羅吉特與巢式羅吉特

b、效用函數

（3） 校正與應用

8.最後進行計畫之評估

（4） 定義績效門檻

（5） 機場進出道路使用行為之回應

（6） 比較運具之績效

（7） 財務考量

八、客運航站規劃與設計（Passenger Terminal Planning and Design）

（一）講師(職稱)：Edward G. Blankenship(Vice President),
Joe K. Barden (Sr. Consultant)
James D. Wilson (Consultant)

（二）單位：AIA

（三）時數：1.5 小時

（四）課程內容：

本課程主要在介紹航廈的型式，並針對不同的旅客流程訂出各個流程所需的功能空間，再提出航廈設計的準則、方法以及未來航廈設計的趨勢。重要內容如下：

1.緒論

航站大廈為機場內提供旅客服務之最主要設施，其除了提供旅客空運及陸運間運具轉運的必要運輸設施，以及結合旅客處理設施及等候區域外，並可作為當地的地標以及零售業等商業中心與各種運具間轉運之聯運中心。

2.航站大廈的型式及案例

（1）集中式：

a、開放式機坪

b、直線型：Kansas City International Airport

c、指狀突出式：Washington National Airport

d、衛星式：Tampa International Airport

e、遠端機坪

f、混合式：Seattle-Tacoma International Airport

（2）非集中式：係指多個航廈的複合型式，包括 Chicago O'Hare International Airport, Los Angeles International Airport, Dallas/Fort Worth International Airport, and JF Kennedy International Airport.

3.旅客流程

（1） 出境：抵達路緣→航空公司櫃台購票及報到→安檢→登機門報到登機

（2） 入境：下機→證照查驗（國際旅客）→離開管制區→領取行李→離開路緣

4.主要功能性區域

（1） 聯外運輸及陸側的介面：路緣、下車處。

（2） 處理區：

a、購票及報到區：櫃台數、等候長度限制、座位數及走道。

b、安檢區

c、登機門報到區

d、登機門及停機坪

e、提領行李區：行李轉盤數、等候長度限制、行李服務辦公室、座位數及走道。

f、國際旅客部分：海關、證照查驗、檢疫及農產品檢查

（3） 等候區：中央等候區、座位區、候機室、航空公司貴賓室、免稅商店區、公共區域。

（4） 內部走道及與空側之介面：包括樓梯、走廊、電走道、自動化旅客運輸系統、電扶梯、電梯、空橋及移動式空橋。

（5） 非公共使用區域：包括航空公司、機場管理單位、政府單位等之辦公室、行李處理區、倉儲區及塔台。

（6） 公共設施：包括電力、機械、結構以及通訊系統。

5.航廈設計準則及主要規劃課題

（1） 考量各個區域所需面積及平面動線與垂直動線的旅客量。

（2） 相關設施的一致性。

（3） 以服務功能來作垂直分隔，如出、入境旅客。

（4） 保留未來擴充的彈性。

（5） 維持安全性。

（6） 以旅客便利性及一定的服務水準為設計考量。

（7） 瞭解旅客的種類及特性。

（8） 以當地的特色來設計航站大廈的外觀。

（9） 與航空公司共榮共存。

（10） 將施工期間的衝擊減少至最小。

6.規劃方法及工具

（1） 所需面積：利用 IATA 的規劃手冊估算各類旅客型態的比例、尖峰時刻運量、空間配置標準、電腦模式及模擬。

（2） 對機場使用者進行調查。

（3） 由其它機場的規劃經驗學習。

7.未來趨勢

（1） 新型雙層航機的引進，將改變登機門及候機室的設計。

（2） 將朝向設施共用的方向，即資源共享。

（3） 航空公司將逐漸合併，並採低票價以吸引旅客，並將加強旅客的安全檢查。

（4） 軌道運輸將成為機場的重要聯外運輸系統，而各航廈間的聯繫也日益重要。

（5） 市區報到服務以及旅客聯運中心的報到服務將成為

新趨勢。

（6） 資訊系統、通訊系統、報到及行李處理設備的技術將日益進步。

（7） 機場內將引進旅館及會議中心。

九、陸側模擬技術（Landside Simulation and Modeling Techniques）

（一）講師：Belinda G. Hargrove

（二）單位：TransSolutions

（三）時數：1.5 小時

（四）課程內容：

為因應高尖峰需求、整合各項服務設施、因應機場或航空事業的變遷，以及滿足消費者的期望，舊有機場設施規劃設計程序已無法滿足複雜度如此高的要求，因此 Hargrove 小姐以其公司所研發之模擬軟體來說明如何進行機場設施的規劃設計。

1.各項規劃設計技術的優劣比較

（1） 規劃設計規範

a、優點

- 容易應用。
- 便宜。

b、缺點

- 不適用於動態系統。
- 許多機場需要更複雜的分析。

（2） 利用圖表分析

a、優點

- 容易得到結果。
- 便宜。

b、缺點

- 常受限於一些無法接受的假設條件。
- 無法明確反映真實狀況。
- 無法進行敏感度分析。
- 很多系統無法模式化。
- 常需應用複雜的數學運算。

（3） 模擬分析

a、優點

- 能分析各種不同的方案。
- 即使輸入資料不足，仍可進行模擬分析。
- 由模擬得到的資料成本較由真實狀況得到的資料來的低。
- 易於應用。
- 模擬分析並不需考量數學處理上的困難。
- 可以經由模擬分析得到想要的分析結果。
- 模擬分析常常是得到解決方案的唯一方法。

b、缺點

- 成本大，必須耗費大量的時間來構建及校估。
- 需經過多次的測試，因此耗費高電腦成本。
- 模擬分析有時會應用過度。
- 構建模擬程式時必須大量投資人力資源。

2.圖表分析與模擬分析之比較

（1） 假設條件：

a、顧客到達率係成 Uniform [.1,4.1] 分配，平均值為 2.1 分鐘。

b、每人服務時間為 2 分鐘。

（2） 圖表分析

a、在圖表分析中，到達率等參數只能以平均值表之。

b、由於平均到達率為 2.1 分鐘，而每人接受服務時間為 2 分鐘，因此不會產生延滯。

（3） 模擬分析

a、可以以實際到達率分配來模擬實際狀況。

b、經過五次的測試後，得出最大的等候長度為 15

個顧客，而平均等候長度則為 1.1 個顧客。

（4） 結論

a、當知道實際的分配時，使用模擬分析可以得到較正確的結果。

b、模擬分析才能實反映動態系統的變化。

3.模擬分析的程序

（1） 問題程式化

（2） 計畫目標

（3） 蒐集資料

（4） 與業主討論假設條件

（5） 構建模式

（6） 輸入程式碼

（7） 校正

（8） 案例分析

（9） 比較實際設計與模擬設計之差異

（10） 是否需再測試

（11） 輸出成果

4.模擬分析考量因素

（1） 資料輸入－確保蒐集的資料完整。

（2） 亂數資料庫－確保變數並非亂數產生。

（3） 重複進行多次模擬－將模擬結果容許在某一信賴區間內，並確保其一致性。

（4） 資料輸出－不要將輸出結果限制在解決特定的問題。

5.模擬分析的優點

（1） 能在建造之前預先估算設施容量。

（2） 能進行敏感度分析。

（3） 能顯現各模組間的互動性。

（4） 能很快且便宜的評估各種不同的替選方案。

（5） 能在施工前獲知不適宜之設計，並加以修正。

（6） 能評估新的技術。

（7） 能初期就得到較佳方案。

6.陸側的應用

（1） 購票櫃台

（2） 安全檢查過程

（3） 證照查驗過程

（4） 旅客休息區

（5） 海關及移局民設施

（6） 行李處理及分揀系統

（7） 環場道路及航廈路緣使用情形

（8） 運人系統(People-Mover Systems)

7.案例分析

（1） 旅客流程－柏林 Schonefeld 機場

（2） 評估海關及證照查驗設施－舊金山機場

（3） 行李流程－吉隆坡機場

（4） 環場道路及航廈路緣使用－波士頓 Logan 機場

（5） 運人系統－達拉斯機場

十、環境影響分析（Environmental Planning & Management）

（一）講師：David J. Full

（二）單位：Environmental Science Associates

（三）時數：1.5 小時

（四）課程內容：

本課程係在說明美國機場在進行規劃設計時，所必須考慮的因素及程序，並教導如何撰寫環境評估說明及環境衝擊報告等。然其係為美國的標準，我國仍應依照行政院環保署所訂定之「環境影響評估法」，提出環境影響報告。本課程主要內容如下：

1.機場規劃階段所需考量的環境因素

（1）必須研究的課題

a、噪音影響範圍。

b、與現有或未來的土地使用規劃相容。

c、與機場外的土地使用分區管制相容。

d、對公園、遊憩區、學校及其他敏感地區的衝擊。

e、對歷史古蹟、考古以及文化資源的潛在衝擊。

f、與少數民族及低收入地區的不相稱衝擊。

g、對相關次級社會經濟發展的衝擊。

（2）基本原則

a、環境與機場規劃程序息息相關。

b、套用生態環境(ecosystems)的觀念。

2.初期審核之項目

（1）投資者初期的環境分析

a、對環境的潛在影響力，包括噪音、土地使用、空氣及水。

b、是否會影響歷史古蹟、考古資源等？

c、是否會影響稀有或瀕臨絕種動植物棲習地？

d、是否會影響受環境保護之公共區域？

e、是否會造成加成效果？

（2）美國聯邦航空總署的審核

a、是否已針對問題提出正確且適宜的解決方案。

b、所提出的解決方案是否對周遭環境無任何影響等。

（3）環境分析報告的內容及架構

a、環境評估說明(Environmental Assessment)

- 計畫簡介
- 計畫目標
- 討論替選改善方案
- 討論基本環境影響狀況
- 分析替選改善方案的成果
- 確定無法避免的負面衝擊
- 列出工作人員的名字及資格
- 列出連繫過的權責單位

b、環境影響報告(Environmental Impact Statement)

- 計畫目標
- 討論替選改善方案
- 討論基本環境影響狀況
- 分析替選改善方案的成果
- 確定無法避免的負面衝擊
- 列出工作人員的名字及資格
- 列出連繫過的權責單位
- 短期必須考量與現有環境的關係，長期則需加強及維持現有環境。
- 列出任何無法對環境資源挽回的影響。

c、替選改善方案的類別

- 基本方案－需要的設施種類或服務水準。
- 替選場址方案
- 發展方案－包括配置、型式、設施大小。
- 非實體的發展方案－如組織、排班及費率方案。
- 零方案－即不進行任何改善之方案。

d、環境分析報告所應包含的評估項目

- 噪音
- 土地使用相容性
- 社會衝擊
- 衍生社會經濟衝擊
- 空氣品質
- 水質
- 美國交通部 1966 年所頒定的法規
- 歷史古蹟、特殊建築物、考古及文化資源
- 生物群居地
- 稀有或瀕臨絕種動植物棲息地
- 濕地
- 洪水區
- 海岸地區管理規定
- 海堤
- 野生或觀光河流
- 農場
- 能源補給及自然資源
- 懸浮污染物
- 固體廢棄物

- 建造期間衝擊
- 設計、藝術及建築
- 任何無法對環境資源挽回的影響

十一、機場噪音管理（Airport Noise Management）

（一）講師：Sanford Fidell

（二）單位：Fidell Associates, Inc.

（三）時數：1.5 小時

（四）課程內容：

機場噪音為世界各國均汲汲於解決的問題，在本次的課程中，Mr. Fidell 由機場噪音的鄰近地區的影響開始，逐漸帶入如何解決之、如何監測之，並進而強調應在機場規劃設計階段即著手謀求解決之道，以使機場能與地方共榮共存。

1.機場噪音引起民怨的原因

（1）營運中的機場

a、機場周邊佈滿社區。

b、未對周邊社區的抱怨有充足的說明。

c、航機操作不佳或機隊老舊。

d、缺乏噪音防制措施。

e、機場擴建。

（2）新機場

a、無適當的周邊環境規劃。

b、低估噪音影響範圍。

2.如何減少噪音的影響

（1）透過土地使用分區管制

a、緊臨機場地區：一般供作航空相關產業使用，如貨物承攬業、倉儲業、租車服務業、汽車旅館、速食簡便餐廳、停車場、會議中心，以及機場相關地面運輸場站等。

b、近臨機場區域：除原有沿著街廓的老舊住宅區外，一般均不准新建房舍。

c、離機場更遠的區域：一般則以朝向低密度開發之住宅區發展。

（2）由政治層面來處理噪音議題

3.噪音監測指標

（1）最大音量 Lmax

（2）事件均能音量 SEL

（3）均能音量 Leq

4.航機噪音範圍模式軟體所需蒐集資料項目

（1）跑道佈設情形

（2）不同航機的跑道使用情形

（3）航機混合比

（4）每天不同時段的起降架次

（5）各類航機的起降航道

（6）地面運轉及滑行

5.噪音線的基本特性

（1）沿著跑道兩側延伸，成橢圓形。

（2）離場的噪音線比進場噪音線來的寬。

（3）進場噪音線比離場噪音線來的直。

（4）跑道兩側的噪音線比跑道延伸的噪音線來的陡。

（5）各分貝噪音線的範圍大多決定於某特定航機。

（6）在大型機場，每一噪音階層所涵蓋的範圍常達數千呎。

6.不同團體對於土地使用相容性的展望

（1）美國聯邦航空總署：周邊土地使用不會損壞或威脅現有或未來的機場運作。

（2） 當地居民：周邊土地使用能限制機場的運作及成長。

（3） 解決兩者間的差異：必須賦予當地機構更多責任來協助機場管理單位進行土地使用規劃，使兩者之間相互平衡之。

十二、航空公司營運及經濟性（Airline Operations and Economics）

（一）講師（職稱）：Scott D. Nason（Chief Information Officer & Vice President）

（二）單位：Information Technology Services American Airlines

（三）時數：1.5 小時

（四）課程內容：

Nason 先生為美國航空公司(American Airlines)的副總裁，在本課程中，Nason 先生以他在美國航空公司的經驗，暢談航空公司的營運特性、現正面臨的環境、以及如何進行機組員排班與收益管理來達到最大的利潤。重要內容分別如下：

1.航空公司的營運特性

（1）為資本、勞力密集的產業。

（2）有非常明顯的尖峰特性。

（3）具備一定的經濟規模。

（4）提供完整的資訊給消費者。

（5）為長期投資的產業。

（6）受天候影響相當大。

2.航空公司面臨的環境

（1）機場

a、登機門的使用時間及型式

b、跑滑道系統型式

c、宵禁的限制

d、噪音的限制

（2）美國聯邦航空總署的限制

a、時間帶

b、運載客運量

（3） 相關規定

a、 國際上的權利

b、 交通部的監督

3.排班

（1） 利潤面

a、 由城市與城市間的總需求、航空事業佔整個運輸市場的佔有率、航空公司的市場分配率，以及需求的時間分佈，來作為需求面的考量。

b、 考量規模經濟性、航線複雜性、起迄市場的需求以及機場設施、地理環境及市場競爭性等因素，而形成空運中心的發展。

（2） 航機面

在航機面的排班必須考慮航機維修基地及航機本身特性，如載重、航程能力、有效的航距、有效利用座位數、運轉時間等。

（3） 組員面

組員排班的限制包括無重複使用相同設施、組員基地、組員所需最小休息時間以及最長服勤時間。而在組員排班的成本上，則需考量服勤時間、休息時間、旅館費用及生活費用。

4.如何讓航空公司運作

（1） 長期而言，將以航空公司利潤面、航機數量、型式及維修基地面、機場設施面以及組員數量及品質面來規劃。

（2） 短期而言，則僅就航空公司利潤面、航機使用率面以及最小組員成本面來規劃。

（3）每天的運作面而言，則必須考量所有旅客、航機、當天天候狀況、機場運作情形等來規劃。

5.營收管理(Yield Management)

（1）問題：如何解決空位未賣、旅客願意花更多錢買座位以及超賣等問題。

（2）策略：當增加一個折扣票的價值超過將這個座位留下賣給較高票價的期望值時，則可以增加一個折扣票的訂位；當增加一個超額訂位的期望值大於成本時，則可以增加一個超額訂位。

（3）模式輸入變數：包括費率、成本、各費率水準的運量預測值、訂位行為、取消訂位行為、未出現(No Show)行為以及旅客未取得較佳座位時的行為。

（4）複雜性：預測旅客的行為以及航線網路的效果。

十三、機場規劃、設計與建設之急要課題（Emerging Issues in Airport Planning， Design & Construction）

（一）講師： William A.Fife.P.E.

（二）單位：Frederic R.Harris,Inc.

（三）時數：1.5 小時

（四）課程內容：

自 1996 年 ASCE 國際空運研討會（International Air Transportation Conference）起，許多資深之規劃師、工程師，開始討論機場在未來所將面臨的主要問題，故而發展出此一領域。Fife 先生首先說明未來之產業發展趨勢：

1、航空公司走向航線結構化，並朝建立空運中心方向發展。

2、航空客貨運市場持續成長。

3、政府角色轉弱，並朝向公/民共同合作方式發展。

4、世界經濟成長，及全球政治環境改變。

因此，未來之機場營運必需更具彈性，以因應未來快速變動的環境及產業技術。而在未來所面臨之急要課題方面，分別討論如下：

1.容量與延滯

未來航空運量的快速成長，勢必將造成包括現有空域之容量不足與延滯增加，因此新技術引進（如 GPS、PRM）與人力之增加（如航管人員）…等，均為現階段應預為綢繆之重要課題。

2.航機型態之變化

所謂「超大型航機 New Large Aircraft」（簡稱 NLA）的出現，使各項航空設施需配合變更，亦使大小航機混和之問題益加嚴重，不但衝擊空運產業，亦將對機場之規劃產生重大的影響。雖然 Fife 先生亦提到，對於 NLA 之發

展，目前仍有兩派看法，一派認為基於以往協和機之經驗，及業者考量投資風險性，NLA 的商業營運可能性不高；但另一派人士則堅信，這是未來不可避免的必然趨勢，航空業與機場規劃者，應預做準備。然而，無論兩派何者正確，NLA 對未來航空運輸之衝擊或效應，確實相當值得大家的注意。

3.環境因素

多年前，機場之環保問題多侷限在「噪音」問題上，但近年來機場環保問題，業已逐漸擴及至空氣品質、能源節約…等各方面的環保議題上，而這發展趨勢將會衍生許多包括：到底如何的標準才是真正的「無污染」、目前科技所可達到之程度限制、相關成本如何回收…等許多問題，對規劃與管理人員而言，亦將是重大之轉變。

4.科技發展

科技發展太過迅速，未來航空運輸上，包括新的保安設施（如 CTX5000）、無票旅行系統（Ticketless travel）、智慧型運輸系統（ITS），及全球定位系統（GPS）等各項重要新科技，均為重要之發展趨勢，但其進步太過迅速，迅速到超過機場各項軟硬體，或作業程序方面所需接受與配合改變之速度，使得機場設施之科技水準，永遠無法趕上真正科技之進步速度。造成機場規劃設計上之一項重要問題。

機場參訪紀要

貳、溫哥華國際機場參訪紀要

一、機場簡介

溫哥華國際機場(Vancouver International Airport ,簡稱 YVR)地理位置位於加拿大西岸，卑詩省溫哥華市之南方，距溫哥華市中心約 13 公里(8 哩)，24 小時全日營運，為加拿大西岸第一大機場(外觀詳見圖 2-1)。因佔地球大圓曲線距離優勢之故(倫敦至溫哥華航線之距離比倫敦至洛杉磯航線、倫敦至舊金山航線之距離為短)，使得溫哥華機場成為歐洲進入北美洲之出入口。溫哥華亦為最近於亞洲之北美洲西岸城市，加上溫哥華機場提供直達美國 25 個城市(如：紐約)之服務，促使溫哥華機場成為亞洲通往北美洲各都市之客、貨運主要門戶之一。

機場營運起始於 1992 年，現年客運量為 1,548 萬人次，位居北美洲機場第 32 位，加拿大機場第 2 位，僅次於多倫多皮爾森機場 (Toronto Pearson Airport, 簡稱 YYZ)；貨運方面，年運量則為 22.9 萬公噸，位居北美洲機場第 30 位，加拿大機場第 2 位【ACI 2001 North American Airports Traffic Statistics】。

於 2001 年 911 攻擊事件時，美國空運暫時停擺之際，機場接受 34 架大型噴射客機在此降落，轉運了 8,500 位須經由北美至其他地區之旅客與超過 20,000 件託運行李，充分展現了本機場以服務為本之宗旨。

二、機場組織

機場管理當局隸屬加拿大政府之下，為一非營利之組織，以 60 年之租約向加拿大政府承租機場地上權，建設與營運資金來源並非來自政府，而是將機場收益再轉投資機場之相關營運與建

設。機場管理當局之組織成員來自加拿大專業工程師協會、省市地科專家、法律協會與貿易理事會之會計師等。機場管理當局員工僅 284 人，至機場相關工作人員則約 26,000 人。

三、機場佈設

機場全部佔地 1,340 公頃，機場各設施說明如後：

（一） 空側

機場現有三條跑道，其中有二條為東西向平行跑道，南跑道 08R-26L 跑道長 11,000 英呎；北跑道 08L-26R 跑道長 11,000 英呎；另一條跑道 12-30 則為側風跑道(Crosswind Runway)，跑道長 7,300 英呎（機場空側及陸側系統空中俯視圖詳見圖 2-2，機場空側與陸側系統配置圖詳見圖 2-3）。

（二） 陸側

1.客運航廈

機場現有航站二座－主航站與南航站，主航站分為國際與國內航廈二部分，彼此相連，國際與國內航廈各含第一~三層，第一層提供旅客之一般服務，如：電話、郵局、健身中心、精品商店街、便利商店...等；第二層為到達層(Arrivals Level)，第三層為離境層(Departure Level)（機場航廈配置圖詳見圖 2-4，機場國際及國內航廈設施營運情形詳見圖 2-5）；南航站則是小型機、水上飛機、直昇機、包機與其他飛行設備之地區轉運中心，於 1999 年擴建完成（南航站位置圖詳見圖 2-6）。

2.機場內運輸

主航站、南航站與停車場間有機場巴士（The YVR/Pacific Coastal Shuttle）穿梭其間供旅客使用，頗為方便。本機場目前並未提供機場旅客運輸系統之服務。

3.路緣停車及停車場

在路緣停車方面，溫哥華機場路緣停車空間充足，主航站第一~二層外側路緣可供公車、租賃車循迴巴士，共乘巴士…等營業性車輛停靠並上、下客，小客車與計程車亦可在此停靠。機場站緣停停車之情形詳見圖 2-7。

停車場分為經濟型停車場(Economy Parking Lot)與長時間停車場(Long-Term Parking Lot)兩種，經濟型停車場設置於主航站站前道路之外（經濟型停車場設施及從該設施連接至航廈之走道詳見圖 2-8），P1 層以半小時為單位計費，P2~P3 層則是分為以時、天、週三種方式計費；長時間停車場位於航站進出道路旁(加拿大楓葉航空維修棚場旁)，分為以時、天、週與月四種方式計費。以上均提供代客停車服務，另外，南航站之站內與地下室亦提供停車場設施。

四、機場營運

溫哥華國際機場在旅客滿意度上，在全球三個獨立調查中，均名列前茅。其營運狀況說明如後:

1.運量分析

2001 年溫哥華國際機場年客運量為 1,548 萬人次，其中，國內旅客運量為 787 萬人次/年，約佔 51% ；國際旅客運量為 361 萬人次/年，約佔 23% ；轉機旅客人數為 400 萬人次/年，約佔 26

% ，排名北美洲機場第 32 位。貨運方面，每年平均以 7.6% 之成長率成長，2001 年貨運量為 22.9 萬公噸，全美洲機場排名第 30 位。

2.主要航線、航點

機場可直達國際及國內共 47 個城市，其中，有 5 個加拿大都市、24 個美國城市與 18 個其他國際都市。

3.航空公司

目前於機場營運之航空公司計有 131 家，77 家為經營客運業務，其餘 54 家為專營貨運業務，包括 UPS 及 FedEx 等貨運航空公司。

4.財務狀況

溫哥華機場雖隸屬加拿大政府之下，但財政卻完全獨立，自給自足，政府機關並無任何補助，機場每年尚需繳納稅收給政府，其中，70% 繳予聯邦政府，30% 歸給地方政府及省政府。2001 年機場總收入為 2.8 億美元，其中，7,260 萬美元為航站特許營業費收入。

五、聯外運輸

溫哥華機場旅客以使用私人運具為主，機場聯外道路主要為 99 號公路、91 號公路與橋港路（Bridgeport Road），機場聯外道路詳見圖 2-9。溫哥華機場當局曾於 1999 年斥資 4 億加幣改善機場聯外道路，其中，包含興建 99 號公路之一處交流道、新建進入機場之三個車道與周邊道路短期交通改善。

六、機場主計畫

為因應機場客、貨運量之成長，機場當局規劃並結合社區參與及公眾意見完成機場主計畫，並經加拿大運輸部於 1996 年正式核准，內容如下：

1. 興建北跑道：北跑道已於 1996 年完成，預計可容納至 2015 年之預估起降架次。
2. 增設全球衛星導航系統(Global Positioning System Navigation)。
3. 擴建國際航站：國際航站擴建係列於擴建計畫之第二期與第三期，預計年容量可增至 2,200 萬人次。
4. 保留航站區東側土地，作為未來擴建客運航站之用地(2015 年機場土地使用計畫詳見圖 2-10)。
5. 保留北跑道北邊土地，作為未來貨運航站空側進出道路使用。
6. 保留機場所在海島之北部土地，作為野生動物保護區。
7. 保留 Arthur Laing 與 Moray 之間之路廊，作為未來地面運輸（包含大眾運輸）使用。
8. 以運輸管理手段，鼓勵大眾使用大眾運輸工具，並減少使用私人運具；興建高承載率及商用車輛專用道。
9. 減少噪音之影響。

圖 2-1 溫哥華國際機場外觀

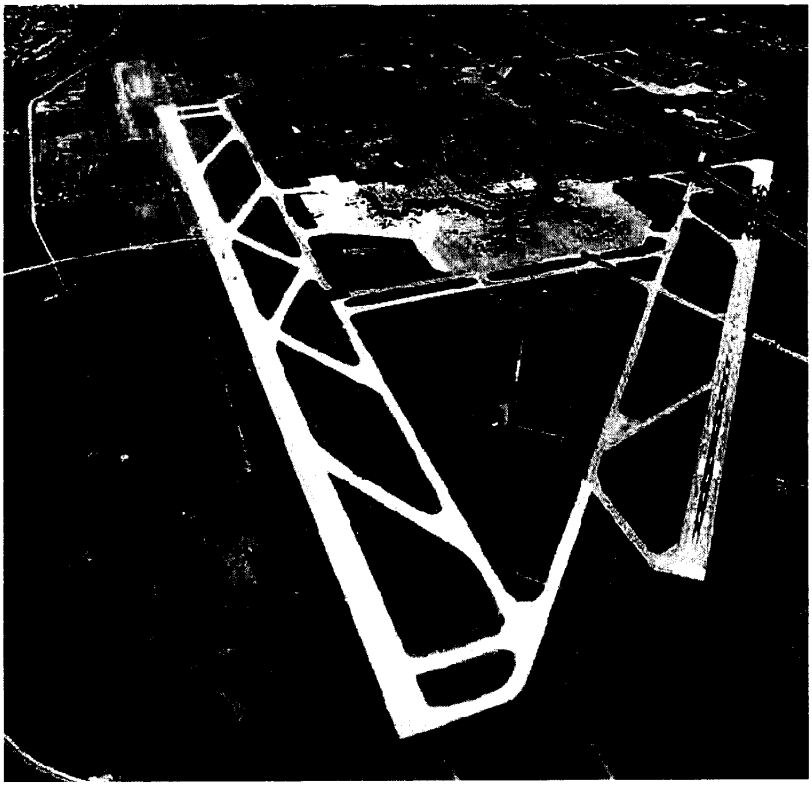


圖 2-2 機場空側及陸側空中俯視圖

(資料來源:www.ae.ca)

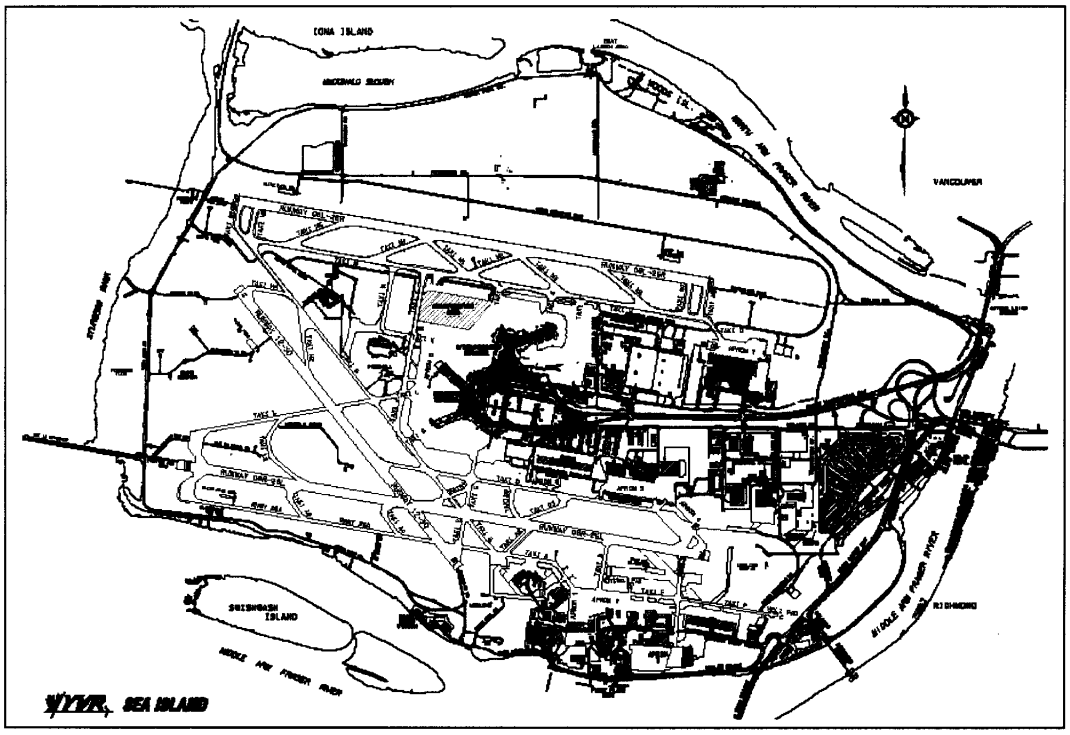


圖 2-3 機場空側與陸側系統配置圖

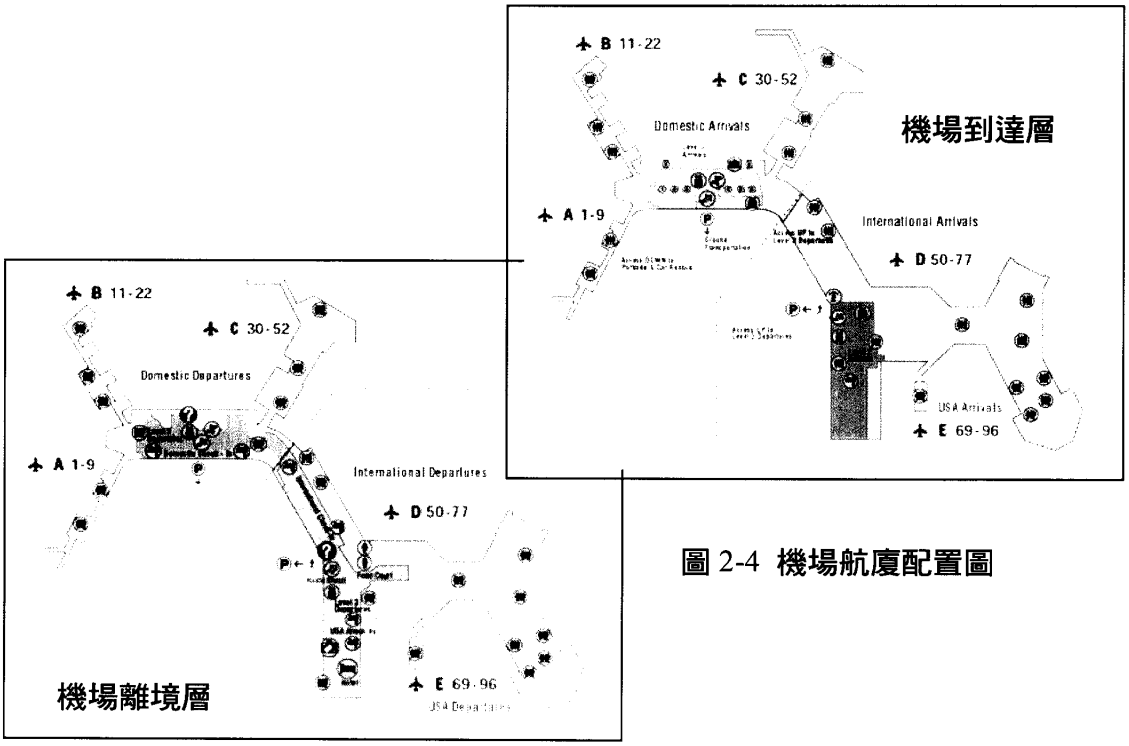


圖 2-4 機場航廈配置圖

圖 2-5 機場國際及國內航廈設施營運情形

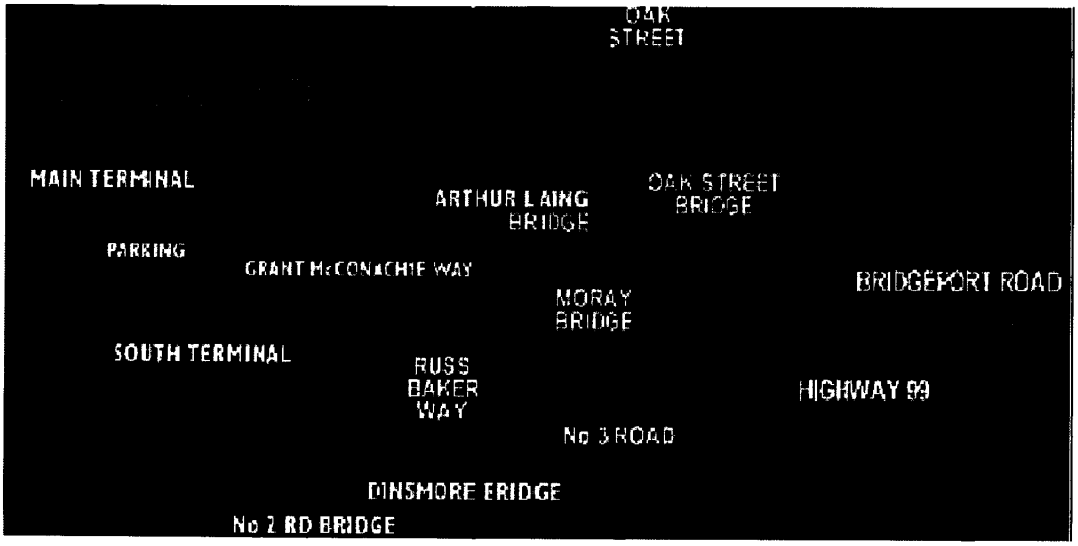


圖 2-6 南航站位置圖

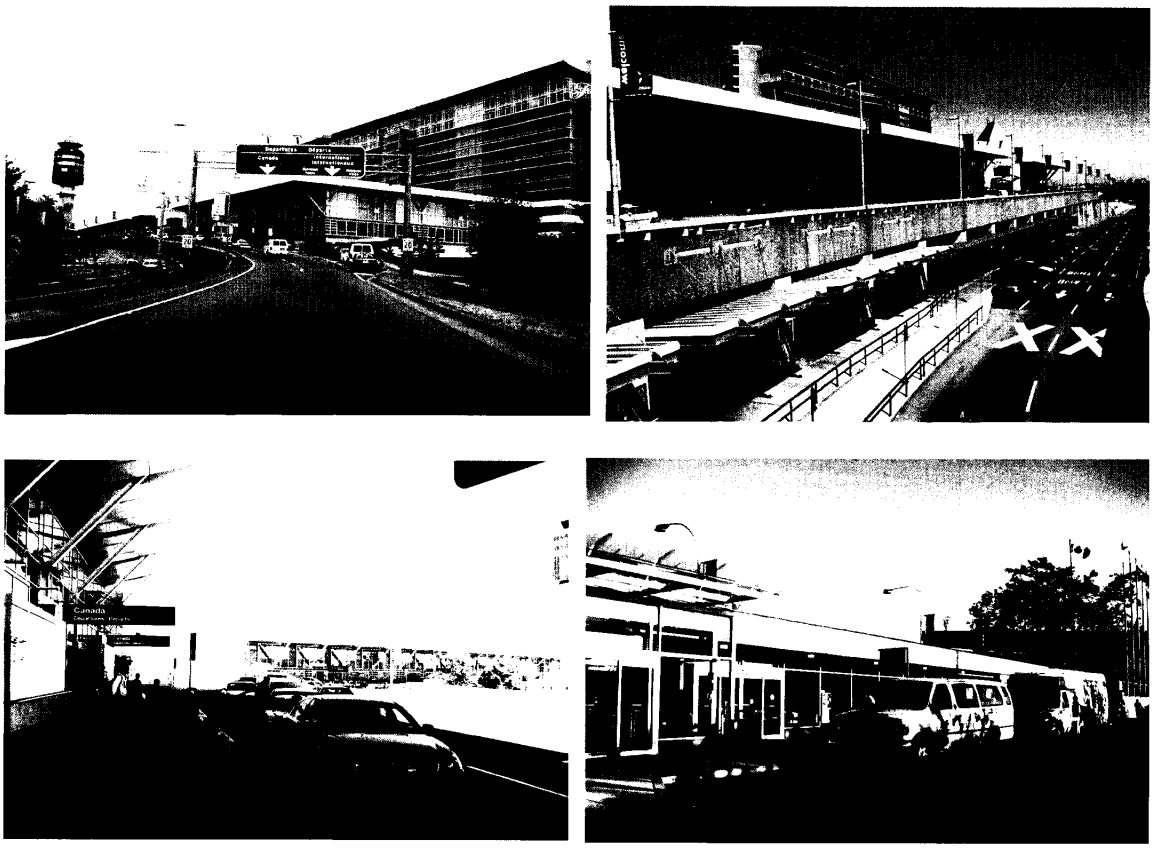


圖 2-7 機場站緣停車之情形

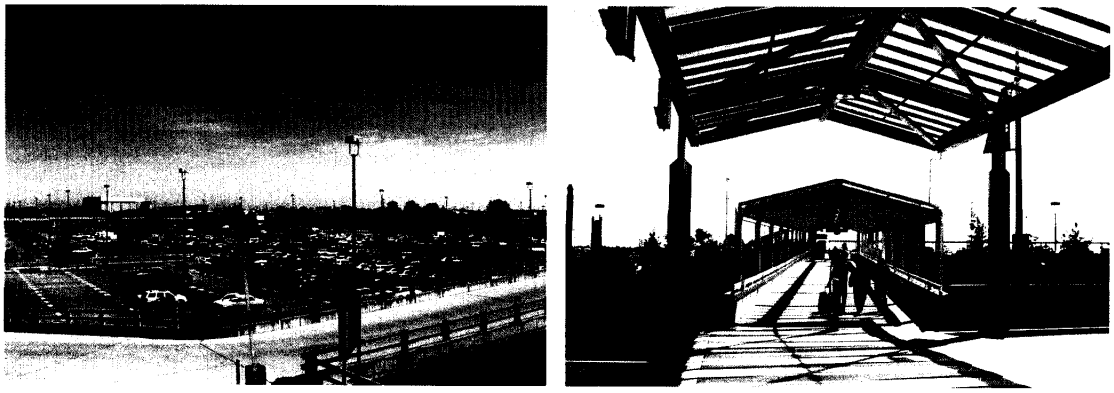


圖 2-8 機場停車場設施及從該設施連接至航廈之走道

圖 2-9 機場聯外道路

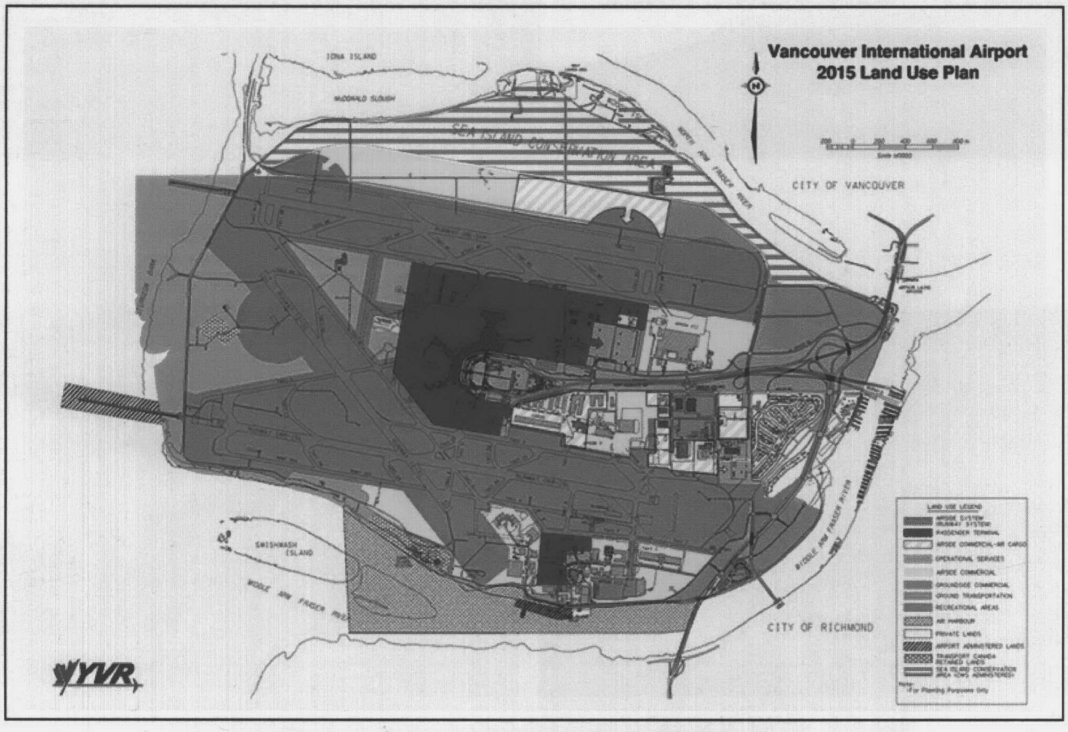


圖 2-10　2015 年機場土地使用計畫

參、西雅圖國際機場參訪紀要

一、機場簡介

西雅圖塔可瑪國際機場（Seattle－Tacoma International Airport, 簡稱 SEA-TAC，外觀詳見圖 3-1）位於華盛頓州西雅圖市之南方，距西雅圖市中心 12 英哩，塔可瑪市以北 20 英哩，24 小時全日營運，為西雅圖-塔可瑪都會區唯一提供商業航線服務之機場、東華盛頓州客貨運關鍵節點，亦為華盛頓州及美國西北部之重要空運中心。

機場營運起始於 1962 年，客運量當時為 200 萬人次/年，現已為美國西岸客運第三大機場及轉運中心（2,704 萬人次/年，全球第 27 位），僅次於洛杉磯國際機場（6,102 萬人次/年，全球第 3 位）及舊金山國際機場（3,463 萬人次/年，全球第 15 位），全美機場排名為第 16 位【2001 年 Airports Council International】；貨運年運量為 40 萬公噸，全美機場排名第 18 位【西雅圖機場 Activity Report 2001】。

二、機場組織

西雅圖塔可瑪機場之所有人及經營者均為西雅圖港(Port of Seattle)，機場管理局現有員工 6,000 多人。機場相關工作人員約 15,000 人，機場亦間接創造了 78,000 多個觀光業相關工作機會。

三、發展歷史

1944 年完成一條跑道及簡單的房舍，尚未設置航站大廈；1949 年完成簡易航站大廈，為四層樓建築物，其中兩層為旅客服務區，另兩層則為辦公區，採開放式機坪型式，並設有塔台；

1950~1960 年代陸續完成 4 個指狀登機廊廳，並分期分階段延長；1972~1973 年完成第一座主要航站大廈，並設置兩個衛星航廈供轉機使用，並設置停車場及興建道路系統；1972~1990 年完成第二座主要航站大廈及南側衛星航廈，並配置行李處理系統及提供商店區的服務；1992 年加大三個登機廊廳，並將停車場面積增為兩倍大之空間。

四、機場佈設

(一)空側

西雅圖塔可瑪機場現有兩條平行跑道，16R-34L 跑道長 2,873 公尺，寬 45 公尺；16L-34R 跑道長 3,627 公尺，寬 45 公尺(機場空側及陸側系統配置圖詳見圖 3-2)。由於天候及飛航安全等因素，多僅以單一跑道起降，故跑道容量極受限制。

(二)陸側

1.客運航廈

機場客運航站設有主航站、4 座指狀之登機廊廳(Concourse A,B,C,D)及 2 座南、北衛星登機廊廳(機場航廈配置圖詳見圖 3-3)，其中，南衛星登機廊廳為西北航空主要停靠基地，機場國際及國內航廈設施營運情形詳見圖 3-4。

2.機場內運輸

主航站與南、北衛星登機廊廳係靠地下環狀式之旅客自動運輸系統（Passenger Transit System, PTS）載運，1969 年開始啟用，旅客搭乘該系統前必須先完成報到、行李拖運等手續，並通過主航站安檢設備方能搭乘。旅客運輸系統共有兩種不同方向之循環

系統，各系統各停靠 3 個車站(詳見圖 3-3)，班距 2 分鐘，每車廂容量為 100 人，搭乘後可藉由電扶梯通往各登機廊廳（詳見圖 3-5）。

3.路緣停車及停車場

機場路緣可臨時停靠接駁大客車(詳見圖 3-6)、中型巴士與私人運具，佔總停車比例之 56% ，惟若停靠太久則將被拖吊(須付拖吊費 150 美元及停車費 20 美元)。機場於航廈路緣外側，另設置島式月台，供公車、租賃車循迴巴士、共乘巴士…等營業性車輛停靠並上、下客。

機場停車場設於主航站站前道路外圍，剛完成擴建，可提供 9,000 個停車位，藉由人行天橋通往主航站二樓(詳見圖 3-7)，採差別定價法，分為以日計費（佔總停車比例之 12% ）、以小時計費(佔總停車比例之 13% ，長時間每小時 6 美元，短時間(不超過 2 小時)每小時 2 美元)，機場全年總停車轉換次數為 370 萬停車次。

五、機場營運

1.運量分析

西雅圖塔可瑪機場 2001 年客運量為 2,704 萬人次/年，其中，國內旅客運量為 2,468 萬人次/年，約佔 91.3% ，可知本機場之營運以國內旅次為主；國際旅客運量為 235 萬人次/年，約佔 8.7% ；機場總營運量全球排名第 27 位，全美機場排名為第 16 位(機場歷年國際與國內客運量發展趨勢詳見圖 3-8)。

貨運方面，2001 年貨運量為 40 萬公噸/年，其中，國際貨運

量為 7.8 萬公噸/年，約佔 18.7% ，其中，仍以往來亞洲為最大宗，約佔國際貨運量之 48.8% ；國內貨運量為 21.9 萬公噸/年，約佔 54.6% ，可知機場之貨運服務以國內為主；郵件貨運量為 10.7 萬公噸/年，約佔 26.8% ，全美機場排名第 18 位(機場歷年國際與國內貨運量發展趨勢詳見圖 3-9)。

2.主要航線、航點

機場可直達美國國內 68 個城市，主要客運起迄點為加州灣區三城市—舊金山、奧克蘭(Oakland)、聖荷西(San Jose)，共約佔國內總旅次數 10.3% ，其次為奧勒岡州之波特蘭(Portland)，約佔國內總旅次數 10% ；國際客運航線可直達國際 17 個城市，往返各地之客運量以加拿大居多，約佔 83.8% (其中，往返溫哥華旅次約佔 51.7% ；往返維多利亞旅次約佔 12.3%)，其次為日本，約佔 5.3% 。

3.航空公司

目前於機場營運之航空公司主要計有 95 家，36 家為經營客運業務，以阿拉斯加航空(Alaska Airlines)、聯合航空(United Airlines)與地平線航空(Horizon Airlines)為主，各航空公司營運量分佔總營運量之 29.2% 、13.1% 與 12.6% ，機型多為波音 737、Dash 8 與 MD-80，所佔之百分比分別為 28.4% 、21.8% 與 11.9% ；其餘 59 家為專營貨運業務，包含 FedEx、阿拉斯加航空及西北航空等航空公司，其中 FedEx 所佔比例最高，約佔 37.6% 。

六、聯外運輸系統

西雅圖機場旅客以使用私人運具為主，佔總聯外交通旅次之

51% ，其次為出租汽車，比例為 19% ，公車、租賃車循迴巴士、共乘巴士等營業性車輛比例為 15% ，計程車與豪華出租轎車(limo)的比例則為 8% 。

機場聯外道路主要為州 518 號公路（北側快速道路）、99 號公路、182 街、160 街與 170 街，其中，以州 518 號公路之交通量最大，日平均雙向交通量為 65,757pcu，機場聯外道路交通量系統圖詳見圖 3-10。

七、機場主計畫

機場主計畫完成於 1995 年，為因應機場客、貨運量之成長，機場當局結合社區參與及公眾意見，正積極進行以下計畫：

1. 興建第三跑道：因機場天候條件長處於不佳之狀態、現有二跑道間距(2,500 英呎)因不符合 FAA 之規定(二跑道間距至少 4,300 英呎)，而無法同時起降，與客運量需求逐年增加之原因，機場正增建第三跑道，興建後可增加跑道之作業能量，預計 2003 年完成。
2. 增建機場旅館。
3. 改善候機廊廳。
4. 增建管制塔台：FAA 計畫投資 2,000 萬美元興建 265 英呎高之全新藝術造景管制塔台。
5. 其他：包含環境保護、能源效率化、交通量減少、提高空氣品質、減少噪音與經濟衝擊等項目，目前正積極朝主計畫之目標努力。

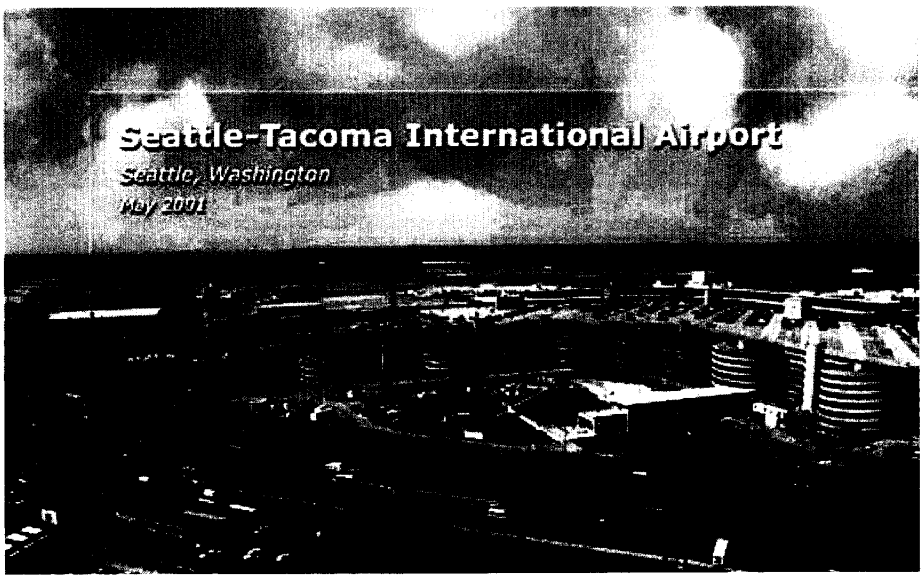


圖 3-1 西雅圖塔可瑪國際機場外觀

(資料來源:www.parsons.com)

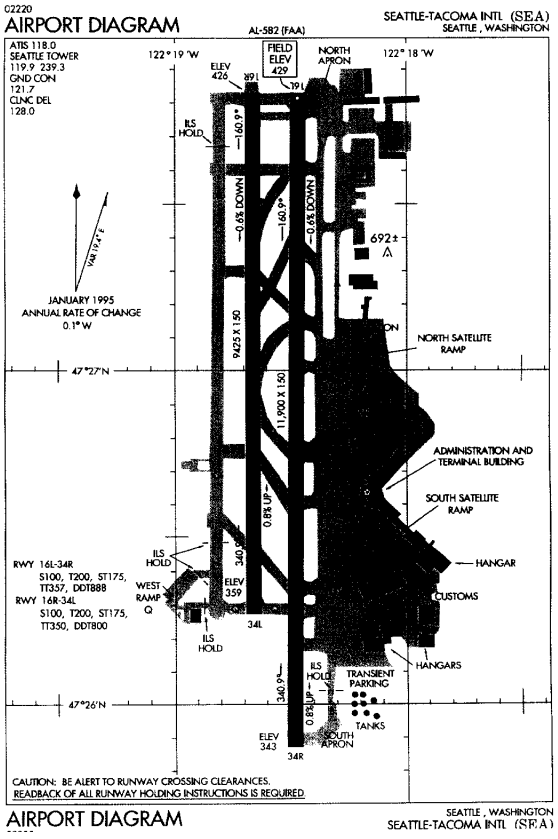


圖 3-2 機場空側及陸側系統配置圖

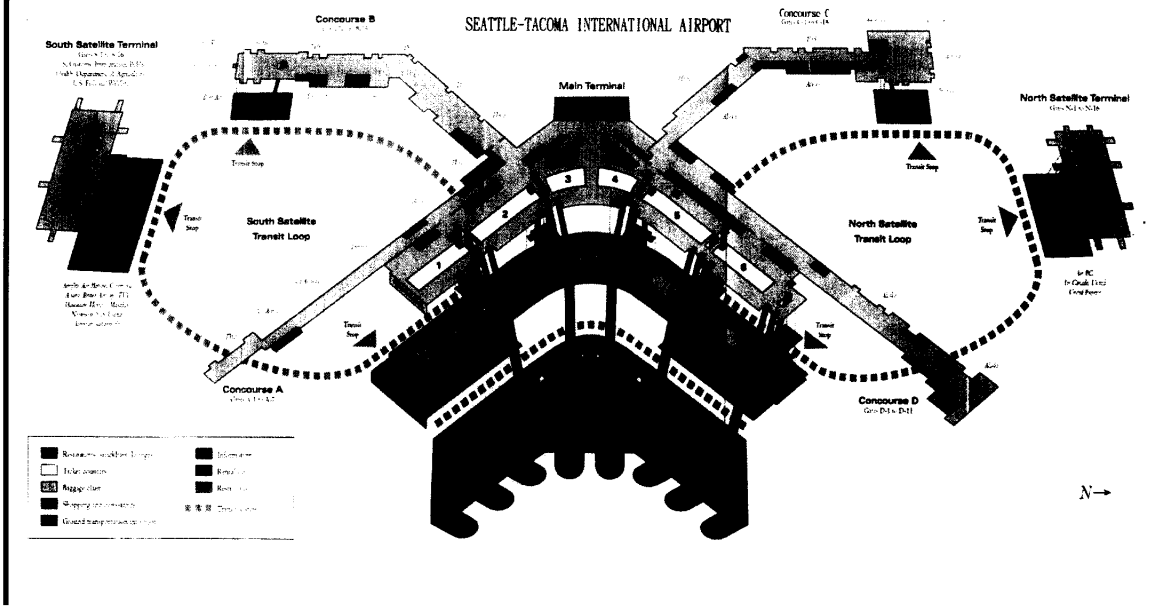


圖 3-3 機場航廈配置圖

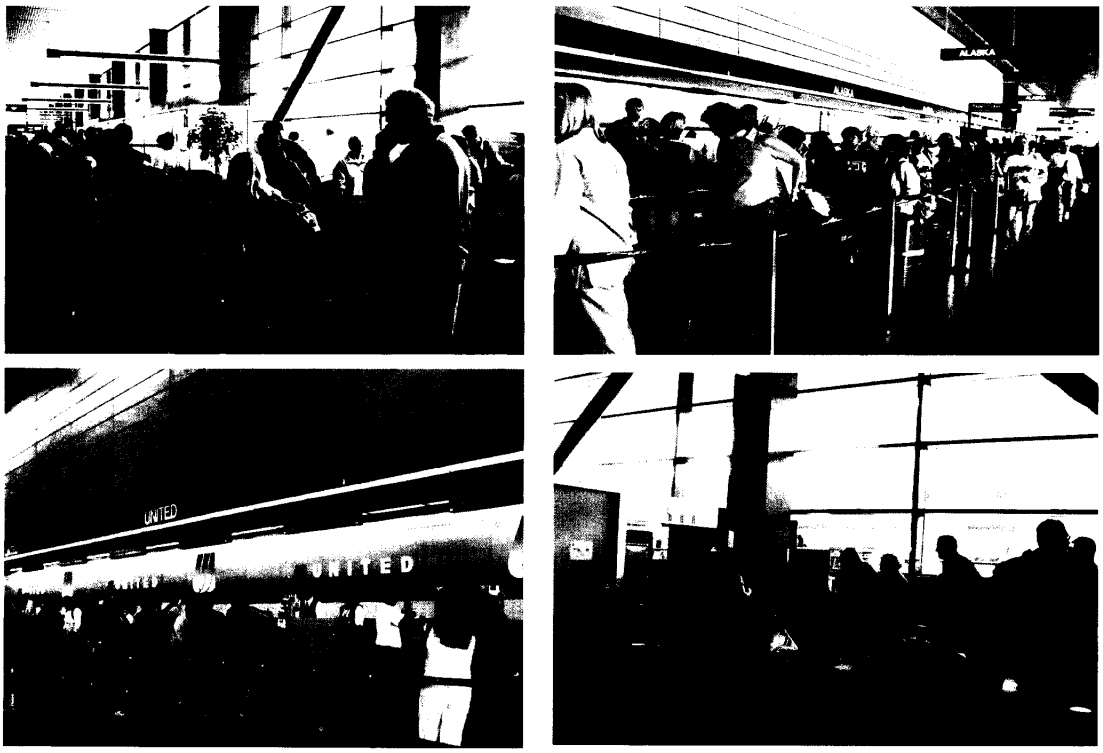


圖 3-4 機場國際及國內航廈設施營運情形

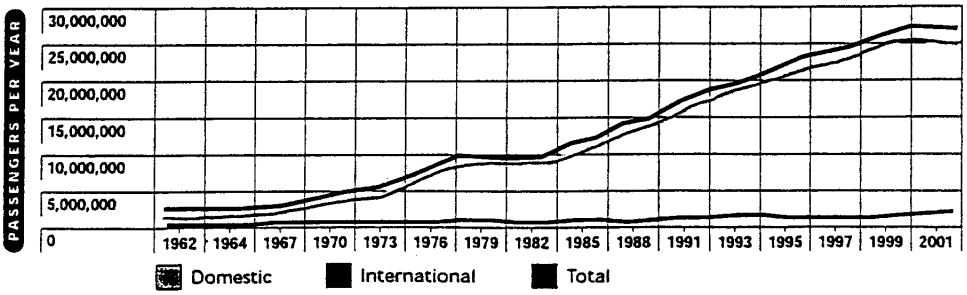
圖 3-5 機場旅客運輸系統與搭乘後連接至衛星登機廊廳之電扶梯

圖 3-6 接駁大客車於機場站緣上下客之情形

圖 3-7 旅客經由人行天橋可連接停車場

HISTORIC AIR PASSENGER LEVELS

	DOMESTIC			INTERNATIONAL				
YEAR	DEPLANED	ENPLANED	DOMESTIC	DEPLANED	ENPLANED	INTERNATIONAL	TOTAL	CHANGE
1962	899,725	897,739	1,797,464	101,440	101,395	202,835	2,000,299	23.5%
1963	801,799	802,396	1,604,195	92,108	84,230	176,338	1,780,533	-11.0%
1964	911,529	877,705	1,789,234	95,790	115,907	211,697	2,000,931	12.4%
1965	1,060,865	1,024,971	2,085,836	109,092	142,773	251,865	2,337,701	16.8%
1966	1,293,050	1,246,532	2,539,582	134,330	148,095	282,425	2,822,007	20.7%
1967	1,748,307	1,766,523	3,514,830	165,173	173,604	338,777	3,853,607	36.6%
1968	2,032,180	2,038,018	4,070,198	178,606	185,974	364,580	4,434,778	15.1%
1969	2,209,692	2,213,308	4,423,000	189,446	192,482	381,928	4,804,928	8.4%
1970	2,108,752	2,161,505	4,270,257	192,879	190,307	383,186	4,653,443	-3.2%
1971	2,123,492	2,195,844	4,319,336	203,753	174,516	378,269	4,697,605	1.0%
1972	2,173,572	2,208,289	4,381,861	220,149	186,952	407,101	4,788,962	1.9%
1973	2,324,909	2,319,144	4,644,053	291,225	269,815	561,040	5,205,093	8.7%
1974	2,590,436	2,547,298	5,137,734	318,890	315,592	634,482	5,772,216	10.9%
1975	2,763,880	2,733,298	5,497,178	309,544	305,701	615,245	6,112,423	5.9%
1976	3,093,460	3,064,585	6,158,045	331,424	317,279	648,703	6,806,748	11.4%
1977	3,350,766	3,295,647	6,646,413	355,712	330,318	686,030	7,332,443	7.7%
1978	3,851,444	3,814,539	7,665,983	366,095	335,899	701,994	8,367,977	14.1%
1979	4,520,879	4,496,726	9,017,605	420,255	382,559	802,814	9,820,419	17.4%
1980	4,129,401	4,117,825	8,247,226	486,802	460,622	947,424	9,194,650	-6.4%
1981	4,080,647	4,069,976	8,150,623	500,511	466,496	967,007	9,117,630	-0.8%
1982	4,274,979	4,243,387	8,518,366	395,125	365,246	760,371	9,278,737	1.8%
1983	4,663,125	4,592,911	9,256,036	469,738	415,963	885,701	10,141,737	9.3%
1984	4,759,120	4,709,324	9,468,444	550,325	457,861	1,008,186	10,476,630	3.3%
1985	5,232,001	5,204,160	10,436,161	551,317	479,277	1,030,594	11,466,755	9.5%
1986	6,222,502	6,242,841	12,465,343	609,579	567,744	1,177,323	13,642,666	19.0%
1987	6,551,463	6,629,119	13,180,582	645,484	619,416	1,264,900	14,445,482	5.9%
1988	6,455,644	6,639,843	13,095,487	725,989	674,043	1,400,032	14,495,519	0.4%
1989	6,739,574	6,970,881	13,710,455	769,438	761,365	1,530,803	15,241,258	5.1%
1990	7,058,429	7,341,100	14,399,529	955,960	884,820	1,840,780	16,240,309	6.6%
1991	7,232,741	7,526,440	14,759,181	786,455	767,653	1,554,108	16,313,289	0.5%
1992	8,208,312	8,254,203	16,462,515	775,165	724,537	1,499,702	17,962,217	10.1%
1993	8,693,210	8,700,317	17,393,527	722,749	684,248	1,406,997	18,800,524	4.7%
1994	9,747,373	9,735,598	19,482,971	754,296	735,552	1,489,848	20,972,819	11.6%
1995	10,537,274	10,570,672	21,107,946	846,191	819,849	1,666,040	22,773,986	8.6%
1996	11,337,675	11,301,540	22,639,215	853,934	831,447	1,685,381	24,324,596	6.8%
1997	11,460,325	11,427,015	22,887,340	928,397	914,376	1,842,773	24,730,113	1.7%
1998	11,900,047	11,810,210	23,710,257	1,095,432	1,057,777	2,153,209	25,863,466	4.6%
1999	12,664,025	12,606,377	25,270,402	1,239,327	1,195,759	2,435,086	27,705,488	7.1%
2000	12,999,473	12,962,578	25,962,051	1,235,328	1,211,174	2,446,502	28,408,553	2.5%
2001	12,339,268	12,344,569	24,683,837	1,190,825	1,161,411	2,352,236	27,036,073	-4.8%

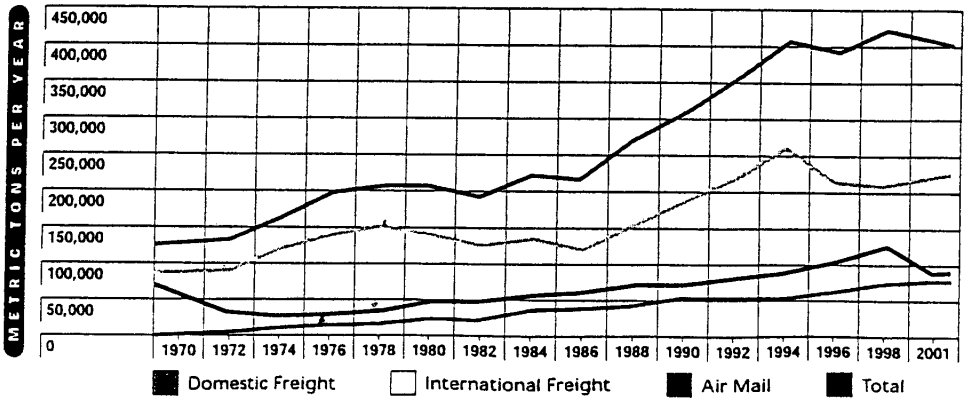


Source: As reported to Port of Seattle by the airlines.

圖 3-8 機場歷年國際與國內客運量發展趨勢圖

HISTORIC AIR CARGO LEVELS *(metric tons)*

YEAR	DOMESTIC AIR FREIGHT	INTERNATIONAL AIR FREIGHT	AIR MAIL	TOTAL	PERCENT CHANGE
1962	26,183	937	15,159	42,279	21.8%
1963	25,548	308	13,944	39,800	-5.9%
1964	33,231	271	15,158	48,660	22.3%
1965	39,590	294	19,871	59,755	22.8%
1966	47,190	490	25,888	73,568	23.1%
1967	58,949	427	37,061	96,437	31.1%
1968	68,649	793	54,135	123,577	28.1%
1969	77,908	859	60,411	139,178	12.6%
1970	74,031	1,047	55,093	130,171	-6.5%
1971	82,988	1,495	48,074	132,557	1.8%
1972	92,555	1,977	42,738	137,270	3.6%
1973	108,151	4,172	38,369	150,692	9.8%
1974	127,077	3,792	37,141	168,010	11.5%
1975	141,680	11,434	37,126	190,240	13.2%
1976	148,359	14,184	37,699	200,242	5.3%
1977	161,075	12,543	41,746	215,364	7.6%
1978	153,797	15,266	43,477	212,540	-1.3%
1979	150,042	21,395	42,759	214,196	0.8%
1980	141,461	19,949	49,767	211,177	-1.4%
1981	142,535	18,899	49,195	210,629	-0.3%
1982	129,873	18,077	50,697	198,647	-5.7%
1983	137,073	21,844	54,618	213,535	7.5%
1984	139,685	28,019	59,859	227,563	6.6%
1985	118,871	27,271	64,050	210,192	-7.6%
1986	121,193	35,834	65,975	223,002	6.1%
1987	146,701	46,608	65,680	258,989	16.1%
1988	161,630	49,602	65,845	277,077	7.0%
1989	173,998	52,241	65,196	291,435	5.2%
1990	186,114	59,022	68,324	313,460	7.6%
1991	208,810	59,411	79,445	347,666	10.9%
1992	225,736	58,506	77,366	361,608	4.0%
1993	246,280	51,046	84,216	381,542	5.5%
1994	265,065	54,962	90,109	410,136	7.5%
1995	248,797	60,882	98,519	408,198	-0.5%
1996	222,017	63,960	102,241	388,218	-4.9%
1997	208,828	72,319	112,639	393,786	1.4%
1998	221,132	73,033	134,162	428,327	8.8%
1999	225,898	74,603	143,723	444,224	3.7%
2000	236,527	74,854	145,539	456,920	2.9%
2001	218,513	74,737	107,249	400,499	-12.4%



Source: As reported to Port of Seattle by the airlines.

圖 3-9 機場歷年國際與國內貨運量發展趨勢圖

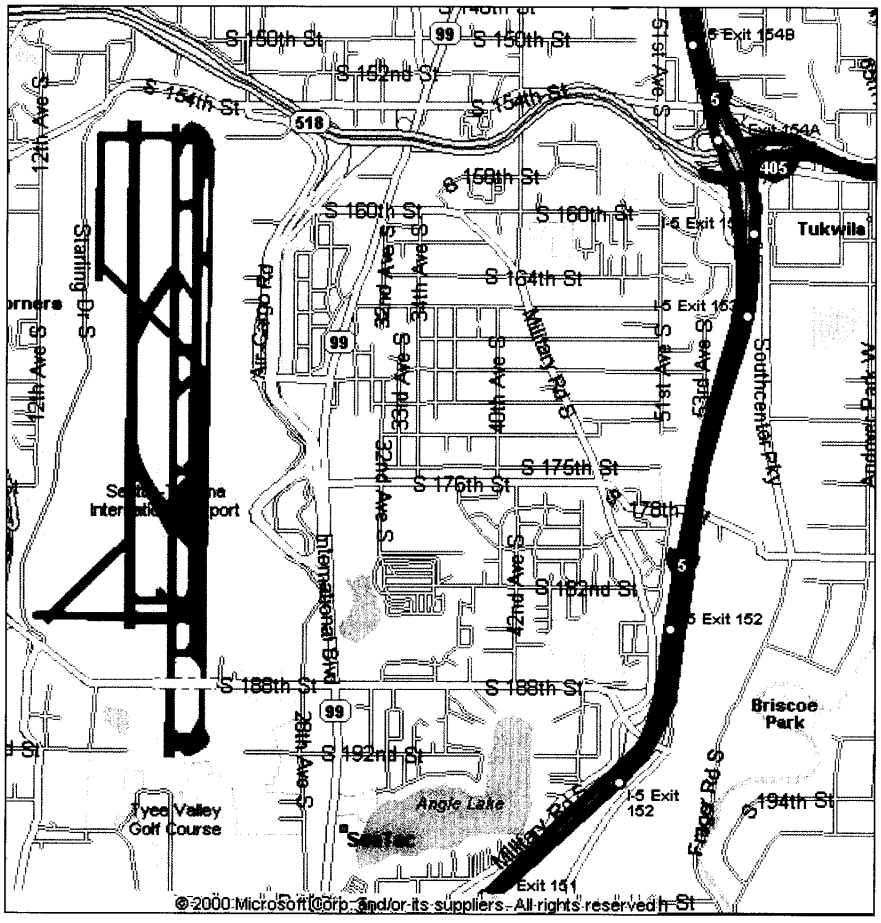


圖 3-10 機場聯外道路系統圖

肆、舊金山國際機場參訪紀要

一、機場簡介

舊金山國際機場（San Francisco International Airport, 簡稱SFO，新主計畫之航站全景及空中俯視圖詳見圖 4-1 及圖 4-2）地理位置於北緯 37 度 37 分，西經 122 度 22 分，位於舊金山灣西側，加州舊金山市之東南方，距舊金山市中心 22 公里（14 英哩），隔舊金山灣與奧克蘭國際機場（Metro Oakland International Airport, 簡稱 OAK）相望，南邊為聖荷西國際機場（San Jose International Airport, 簡稱 SJC）。

機場營運起始於 1928 年，客運量當時為 3.8 萬人次/年，現已為美國西岸客運第二大機場及轉運中心（3,463 萬人次/年，全球第 15 位），僅次於洛杉磯國際機場（6,102 萬人次/年，全球第 3 位），全美機場排名為第 10 位；貨運方面位居全球第 24 位（63.5 萬公噸/年；中正機場為 119 萬公噸/年，全球第 16 位），全美機場則排名第 12 位【2001 年 Airports Council International】。

二、機場組織與運作

機場管理局現有員工 1,391 人左右，其上設委員會，為機場最高決策機構，五位委員為無給職，由舊金山市長任命。其下設有管理局局長（Director），管理一般例行事務，並秉承委員會之決議事項執行業務，其組織架構詳如圖。

機場管理局隸屬舊金山市政府之下，所有人員之任用均遵循市府人事任免規定，其中主管任命權僅約 15%，其餘均需透過市府徵才，另外，FAA、海關、警察、消防…等政府人員，均由聯邦或州、市政府指派，由機場管理局負責支薪，其人事上之彈性

並不如想像之容易。另外，機場管理局尚需面對全機場 16 個不同之工會，如何折衝協調各工會之需求以避免罷工事件，亦為一項管理課題。

三、機場佈設

機場全部佔地 5,171 英畝，其中 2,788 英畝為未開發之土地，其中部分已劃為保護區，現有機場則佔面積約 2,383 英畝。

(一)空側

舊金山機場現有兩對交叉之雙平行跑道，共計四條跑道，28R-10L 跑道長 11,870 英呎，28L-10R 跑道長 10,600 英呎，1R-19l 跑道長 9,500 英呎，1L-19R 跑道長 7,000 英呎（機場空側及陸側系統配置圖詳見圖 4-3）。由於跑道係為交叉佈設，又濱臨舊金山灣邊，機場未來空側之發展將頗受限制，飛機停等之延滯可能為其隱憂。

目前聯合航空公司於舊金山機場設有轉運中心（Hub），共佔地 129 英畝土地，300 萬平方英呎樓地板面積，及 12 個飛機維修棚廠，為舊金山機場之最主要航空公司。

(二)陸側

1.客運航廈

機場客運航廈計有 3 座國內航廈及 1 座國際航廈（機場航廈配置圖詳見圖 4-4），可同時停靠 34 架廣體客機，航廈間則有通廊可步行而過。

國內航廈第一~第三航廈(Terminal 1~3)呈環狀佈設，面積共有 262 萬平方英呎，票務櫃檯及登機門(現有 70 個，其中第 50~

第 59 號登機門現正整建中)均位於離境層(Departure Level)，行李提領區(Baggage Claim)計有 25 區，位於入境層(Arrivals Level)，航廈環狀之中央並設有立體停車場。第一航廈（Terminal 1）面積計有 85 萬平方英呎，內設有 A,B,C 三登機區(Boarding Area)；第二航廈（Terminal 2）面積計有 61 萬平方英呎，目前封閉，正重新整建中，預計 2003 年完工；第三航廈（Terminal 3）面積計有 116 萬平方英呎，內有 E,F 二登機區（Boarding Area)。

國際航廈部分，為北美洲最大之國際航廈，主航廈面積共有 180 萬平方英呎，內有 12 區行李提領區，168 個共同使用之報到櫃檯，每小時可容納 5000 名到達旅客。國際航廈並設有 A,G 二登機區及 H 大廳，A 登機區面積為 35 萬平方英呎，登機門 12 個；G 登機區面積為 38 萬平方英呎，登機門 12 個；H 大廳離報到櫃檯約 225 英呎，連接航廈與機場之停車場，面積共有 21.7 萬平方英呎，其中有 9 萬平方英呎規劃作為 BART 捷運站之使用，Airtrain 亦在此設站，預計西元 2002 年開始啟用。機場國際及國內航廈設施營運情形詳見圖 4-5。

2.貨運航站

貨運航站計有 11 座，面積共約 100 萬平方英呎(不含航空郵件及轉運貨物之空間)，航空郵件處理區面積為 25 萬平方英呎，轉運貨物處理區面積為 6.9 萬平方英呎。其中，北區第一貨運站(North Field Cargo Building 1,NFCB1)及西區第一貨運站(West Field Cargo Building 1,WFCB1)為新近營運之航站，起始營運時間分別為西元 2000 年 1 月及 2001 年 5 月。

3.機場內運輸

各航廈間有機場巴士（shuttle bus）穿梭其間供旅客使用，頗為方便，一天約可載運旅客約 600 來回旅次，一年之運量約為 20 萬旅次。惟預計於 2002 年秋季開始，由 Airtrain 旅客自動載運系統(People Mover System，詳見圖 4-6)取代其功能，預估可減少機場內道路交通量 23%。

Airtrain 為一全自動、無污染並省能源之旅客輕軌電車輸送系統(輪胎為膠輪)，規劃行駛於機場陸側設施之間，平均站距為 0.3 英哩，行駛最高速度為 30 英哩/小時，共有紅、藍二線，藍線巡迴一次之旅行時間為 19 分鐘，紅線為 9 分鐘。每列車廂數為 2~3 節，每節車廂座位數為 12 個，每車廂之容量為 40 人(含推車)~60 人(不含推車)，列車容量為 3,400 人旅次/小時。將在機場航站、停車場及租車中心間來回行駛，共計停靠 9 個車站(其中二站直接連接國際航廈，並有三個車站藉行人專用天橋連接至國內航廈)，另外，未來亦規劃第 10 號車站連接至機場旅館。

4.路緣停車及停車場

在路緣停車方面，由於舊金山機場使用私人運具之數量龐大，路緣停車空間不足，因此機場於航廈路緣外側，設置島式月台，供公車、租賃車循迴巴士，共乘巴士…等營業性車輛停靠並上、下客。而為維持其秩序，機場管理局乃於其路邊緣石上，漆以不同顏色色漆，據以區別停靠車輛性質，各車輛則依各自性質分別停靠。機場站緣停靠小汽車之情形詳見圖 4-7。

機場國內及國際航站均設置停車場，分為短時間停車場(The Short-Term Parking Lot)與長時間停車場(The Long-Term Parking

Lot，設於 101 號公路與 San Bruno 大道之交流道東側下方，各停車場位置及停車情形詳見圖 4-8)。計費方式分為時數與天數兩種方式（Hourly and Daily Parking），並設有代客停車之服務。而停車場之停車費收入，目前為機場最大宗之收益來源。

四、機場營運

1.運量分析

2000 年舊金山國際機場客運量為 4,104 萬人次/年，其中，國內旅客運量為 3,208 萬人次/年，約佔 78.17% ；國際旅客運量為 820 萬人次/年，約佔 19.98% ；轉機旅客人數為 76 萬人次/年，約佔 1.85% 。2001 年機場客運量降為 3,463 萬人次/年，全球排名第 15 位，全美機場排名為第 10 位，年成長率為-15.7% 。

貨運方面，2000 年貨運量為 87 萬公噸/年，其中，國際貨運量為 43 萬公噸/年，約佔 49.5% ；國內貨運量為 26 萬公噸/年，約佔 30.15% ；郵件貨運量為 17.7 萬公噸/年，約佔 20.36% 。2001 年機場貨運量降為 63.5 萬公噸/年，位居全球第 24 位，全美機場則排名第 12 位，年成長率為-27.2% 。

2.主要航線、航點

舊金山國際機場可直達美國國內 65 個城市，主要客運起迄點為洛杉磯及紐約，約佔國內總旅次數 10.9% 及 9.9% ；國際客運航線可直達國際 31 個城市，往返各地之客運量以亞洲居多，約佔 50.4% ，其次依序為大洋洲、歐洲及墨西哥，分別約佔 5.4% 、4.5% 及 1.8% 。

3.航空公司

目前於機場營運之航空公司計有58家(其中有28家為國際型航空公司)，45家為經營客運業務，其餘13家為專營貨運業務，包括UPS、DHL及FedEx等貨運航空公司。

聯合航空(United Airlines)與美國航空(American Airlines)分佔舊金山機場市場佔有率第一、第二大航空公司，佔有率分別為47.4% 及7.7% ；總收入百分比則分別為22% 及5% 。聯合航空並在機場設有轉運中心，共佔地129英畝土地，樓地板面積約300萬平方英呎，並設有12個飛機維修棚場。

4.財務狀況

舊金山機場雖隸屬舊金山市政府之下，但卻被要求財政完全獨立，自給自足，市府並無任何補助，甚至機場每年需上繳市府約 2,500 萬美元之營餘，而其資金來源則可分為自有及貸款兩項。雖然機場管理局可向聯邦政府請求，自機場費（AIF）基金下補助建設或維護，但被嚴格限制於空側方面之使用。因此，目前機場之財源，主要係由機場當局將機場內所有資產或設施，出租予民間各類公司獲利所得。故機場內外，從航廈內之零售店面，航廈外之停車場，到機場貨運站，均為出租標的，且機場當局為維持機場內各種商業競爭行為，維持管理局對設施之控制，並保障消費者權益，及機場各項服務品質，乃堅持不以統包方式出租處理，也使得機場目前對民間之租賃合約高達數百件。

五、聯外運輸系統

舊金山機場之聯外運輸使用上，七成以上旅客使用私人運

具，其次為使用計程車、旅館巴士、共乘巴士等，再其次為使用租賃小汽車，大眾運具（包含 BART）之使用者則更少，顯示道路系統之負擔沉重（機場聯外道路詳見圖 4-9）。而機場以 101 號公路（Bayshore Freeway，）連接舊金山市區與南灣之矽谷地區，往來極為方便。

目前舊金山地區雖有 BART 捷運系統（BART 路線圖、行駛及車廂乘坐情形詳見圖 4-10），但因機場當局堅持進入機場範圍之捷運系統該部分亦必須歸屬機場所有，導致 BART 規劃起始時期未將路線聯接至機場內，旅客必需搭 BART 至 Colma 終點站後，轉乘機場巴士進入機場，雖然巴士班車不少，但仍相當不便，也造成使用比例明顯偏低。最新之機場主計畫已將 BART 捷運接入機場內，預計 2002 年底完成，其建設費用 7,800 萬美元由機場管理局支應，惟該路段仍歸機場所有，機場可收取租金，對其內捷運站之各項設施，機場當局亦將比照一般機場內之設施，出租以收取租金收益。

在其他公共運輸方面，雖有機場巴士，但戶及戶之共乘巴士（door-to-door shuttle）卻擁有最高之市場佔有率，惟所有營業性車輛進入機場前，均需先取得機場之許可，始可於機場範圍內載客，且每輛營業車均裝設「車輛辨識卡（Tag card）」，俾利機場車輛電子識別系統（AVI）之作業，及收取費用。

六、機場主計畫

最新之舊金山機場主計畫於 1986 年完成，內容包含 50 項以上之擴建或改善計畫，預計 2006 年相關工程將全部完成，預估經費 24 億美元，其中第一階段之計畫，已於 2000 年完成並開放營運。新的機場主計畫主要包含以下內容:

1. 國際航廈：樓地板面積將有 2,50 萬平方英呎，約 35 個足球場大，24 個登機門（gates），使現有 75 個登機門（gates）增加至 100 個以上，機場容量則增加至 5,000 萬人次/年。可同時供 12 架廣體客機停靠，預計每小時處理之旅客數將由目前之 1,200 人次/小時，提高到 5,000 人次/小時，平均出機場時間降低至 45 分鐘以內，且未來將專供國際旅客使用，現有之航廈則全部供國內旅客使用。

2. Airtrain：2002 年秋季預計建造完成。

3. 新停車場設施：提供 3,200 個旅客用新停車位，5,000 個員工停車位。

4. 進入機場道路：由 101 號公路進入機場時，分為三層高架道路進出，直接區分國際與國內之旅客，以減少機場交通量。

5. 租車中心：已於 1998 年完工。

6. BART 連接至機場：新的國際航廈將有灣區捷運（BART）直接聯接至航廈之內，航廈間，再銜接機場內 Airtrain 全自動輕軌電車輸送系統，乘客至機場航站相關設施將更為便利。預計於 2002 年完工，至舊金山市中心為 29 分鐘。BART 的引進，預計可疏緩目前之交通負荷，尤其對 101 號公路之交通，頗有助益，同時亦可減少大量能源之消耗，及廢氣污染的產生。

7. 貨運站：將新增 20.9 萬平方英呎貨運站空間，供貨運使用，可同時供 6 架廣體客機停靠。

8. 其他為環境保護、能源效率化、交通量減少、提高空氣品質、減少噪音與經濟衝擊等項目，目前正積極朝主計畫之目標努力。

圖 4-1 舊金山國際機場新主計畫之航站全景

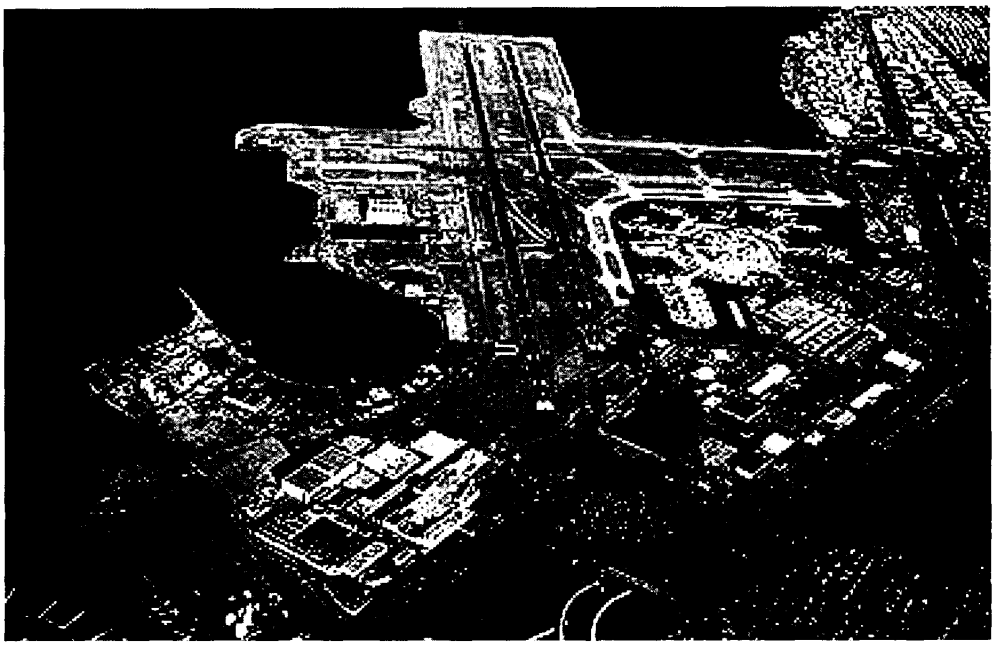


圖 4-2 舊金山國際機場空中俯視圖

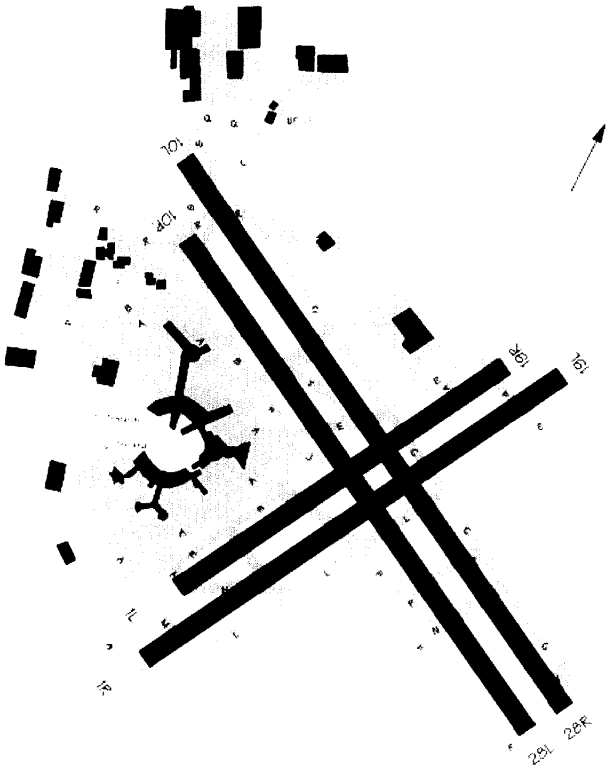


圖 4-3 機場空側及陸側系統

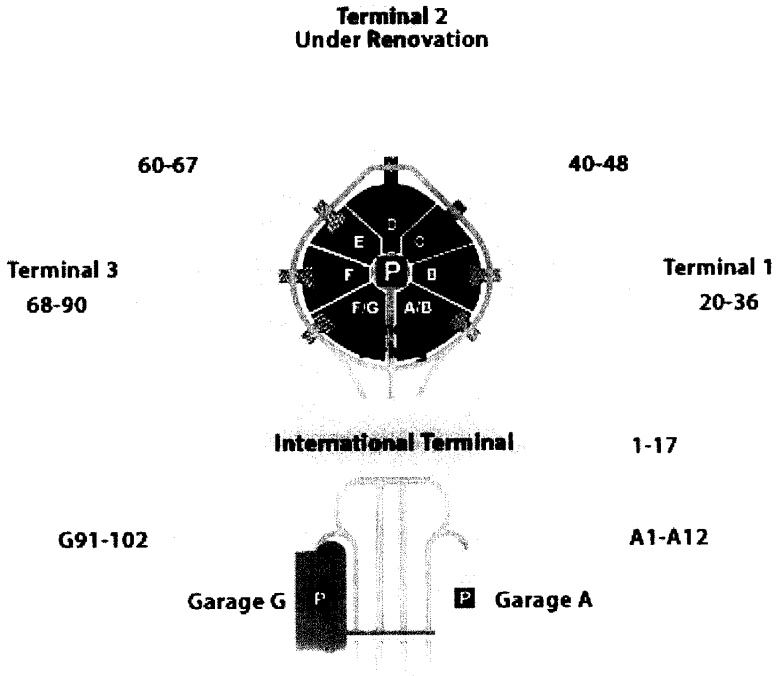


圖 4-4 機場航廈配置圖

圖 4-5 機場國際及國內航廈設施營運情形

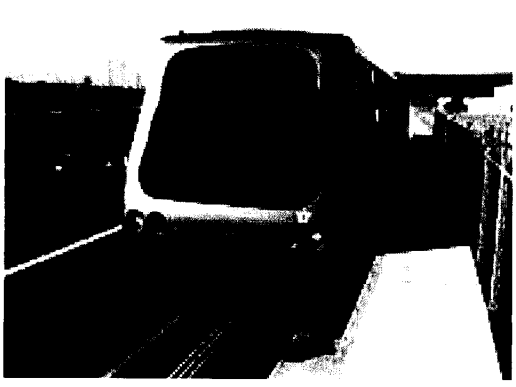
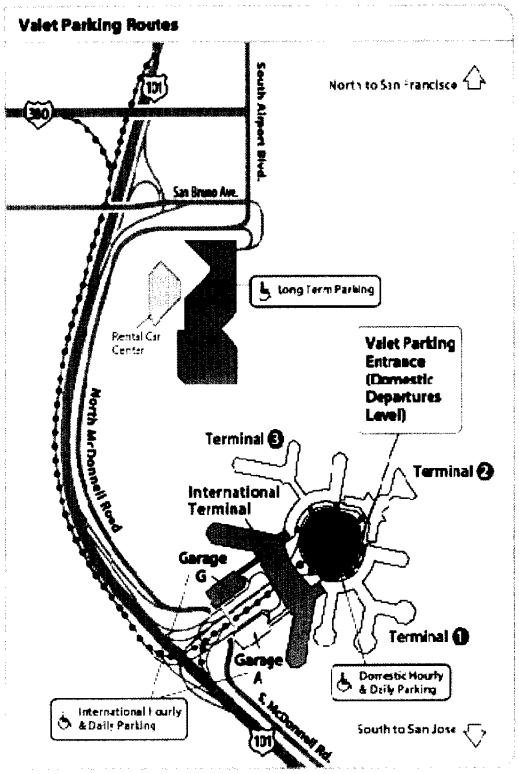


圖 4-6 Airtrain 旅客自動載運系統

圖 4-7 機場站緣停靠小汽車之情形



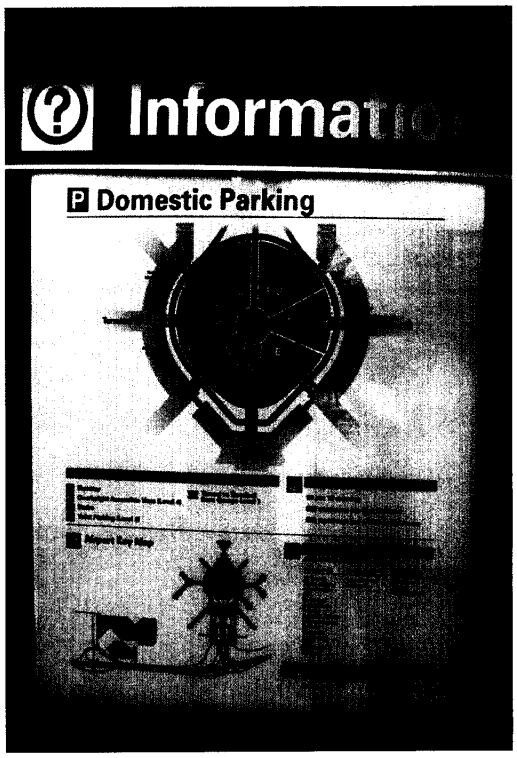


圖 4-8 機場停車場位置及停車情形

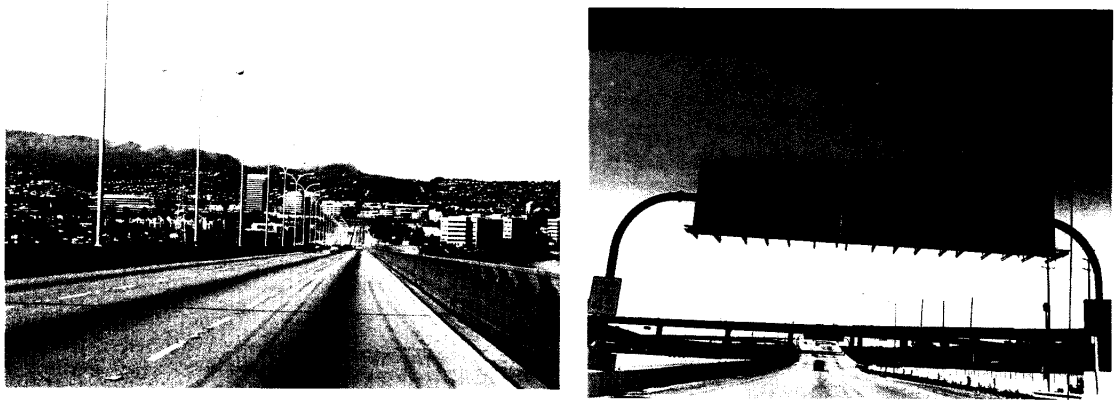
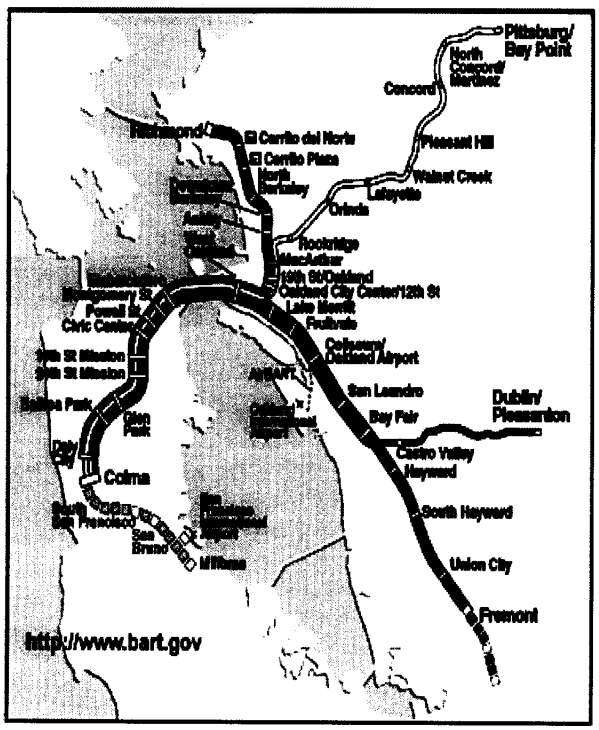


圖 4-9 機場聯外道路



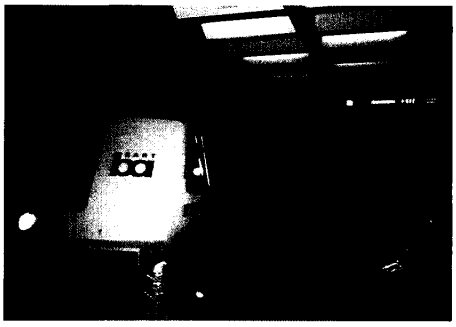


圖 4-10 機場捷運(BART)路線圖
、行駛及車廂乘坐情形

結論與建議

伍、結論與建議

一、結論

1、加州大學柏克萊分校多年來持續舉辦機場規劃與設計短期課程，在師資遴選上，大多來自實務界、學術界與政府相關機構；在課程編排上，係累積各屆課程參與者之意見而逐年更新，並與空運與機場實務相關法規、規定、時事、現況面臨問題與市場發展趨勢結合，可說是一實務與理論兼具之課程，使參與課程者受益良多。

2、本次課程之講師與參與人士多來自美國各機場、民間顧問公司之管理階層、資深規劃師與工程師，課程中不乏美國部分機場之實例解說，參與人士亦踴躍提出問題彼此熱烈討論，對於機場規劃與設計之相關工作者而言，實為一次相當寶貴之學習機會。

3、空運與機場之規劃、設計必須時刻掌握時代趨勢之脈動，航機大型化、高科技航管技術之引進、環保與噪音等課題，已為時勢所趨，其所衍生之機場、空域管理與設計上及法規修正等問題，值得我國各航空主管機關密切注意，俾便及早規劃因應。

4、本次研習雖無飛安與安檢之專項課程，惟在大多數之課程中均述及此一重要課題，實乃因美國於 2001 年剛遭遇 911 恐怖攻擊事件，美國各機場在設施佈設、規劃與營運上，均已對此有所因應，而世界各國機場對此早已紛紛予以加強，此項課題所衍生之機場規劃與設計等相關問題，亦值得我國加以重視。

5、本次研習參訪溫哥華、西雅圖與舊金山三大國際機場，溫哥華國際機場為亞洲通往北美洲各都市之客、貨運主要門戶之一；西雅圖國際機場為東華盛頓州客貨運關鍵節點，亦為華盛頓州及美國西北部之重要空運中心；舊金山國際機場為美國西岸客

運第二大機場及轉運中心，三者在北美洲及全球空運中均有其重要之地位。其規劃與營運作業均聘請專業經理人及相關專業人士或公司，在機場未來發展規劃上，不僅重視機場土地使用與設施之擴建，更重視環保、噪音問題及與社區共存共榮等永續發展之課題；在營運上，亦以企業化經營方式，快速滿足旅客之需求，以爭取其營運之利基。

二、建議

1、此次參加本短期課程，個人覺得收穫頗豐，可增進本職學能，開拓規劃之視野，又可與其他學員交換工作心得與經驗，雖課程時間僅限於４日內完成，但不失為一良好之在職進修管道，建議相關單位可定期派員參加。另，據悉新加坡航空學院對於機場系統規劃訓練課程有較深入之介紹、講師均有實際參與機場規劃之經驗，並有多次小組研討與實地參訪機場解說之機會，亦為一可考量參加之課程。

2、參酌溫哥華、西雅圖與舊金山三大國際機場之規劃與營運理念，國內中正、高雄國際機場欲掌握在世界機場中之競爭優勢，亦須相對密切注意相關之營運課題，如:機場設施使用與動線安排之便利性、財務管理、機場定價策略等之運用，俾藉以提昇競爭力。

3、溫哥華、西雅圖與舊金山三大國際機場，雖無政府之資助或補助有限，每年還須從收入中繳納相當比例之稅費，其收益之來源除航空公司繳納之租金收入外，停車場之收入則為其主要之收益來源；而就資金來源而言，發行免稅債券為其資金主要來源，就開創機場財源之靈活思考而言，實值得作為國內各事業性機關之參考。

4、機場之聯外運輸系統之健全與否，左右一機場之長遠發展。此次參觀之各機場之聯外運輸系統改善與新軌道運輸系統連接

至機場之經費投入可謂花費不訾，其改善機場聯外交通之決心值得我國借鏡。而中正機場未來之發展，其聯外運輸系統之發展亦為一重要課題，建請加速新建與擴建相關工程之時程，俾使機場發揮最大之效用。

5、溫哥華機場之國際航廈與國內航廈相連，機場管理人員可視國際與國內旅客運量之多寡，彈性調整陸側各設施與停機坪之調度。台灣地區地狹人稠，機場附近用地或因已高度發展，或因民眾抗爭等因素，土地取得不易。若能於航廈規劃時，藉由樓層分配區隔國際、國內航線，或如溫哥華機場將國際、國內航線之營運分隔兩側，不僅可方便旅客之轉乘，更可使機場設施運用更靈活，機場建設經費投入更具經濟性，建議可作為我國未來設計航廈之參考。

附　錄

Before the Committee on Government Reform
United States House of Representatives

For Release on Delivery
Expected at
12:00 p.m. EDT
Wednesday
August 7, 2002
CC-2002-203

Progress in Implementing Provisions of the Aviation and Transportation Security Act

Statement of
Alexis M. Stefani
Assistant Inspector General for Auditing
U.S. Department of Transportation

Mr. Chairman, I appreciate the opportunity to testify today before the House Committee on Government Reform concerning the Transportation Security Administration's (TSA) progress in implementing provisions of the Aviation and Transportation Security Act (Act).

We all recognize that the mission of ensuring that our transportation systems are secure is a tremendous task. Although TSA is charged with securing all modes of transportation, the Agency's efforts so far have mostly focused on addressing aviation security and meeting deadlines established in the Act. The task is one that has never been undertaken before on a scale of this magnitude, and TSA has very little empirical experience to draw on. It should be noted that TSA could not be working any faster or harder than it already is.

TSA has made progress in implementing the requirements of the Act, but the heavy lifting still lies ahead. To date, TSA has had several notable accomplishments including:

- Completed the deployment of Federal passenger screeners at nine airports including Baltimore/Washington International (BWI) Airport–the first location to have a federalized passenger screener workforce.
- Let three major contracts–two to Lockheed Martin for training all passenger screeners and modifying airport checkpoints, and one to Boeing Services Company to do site assessments, modify airports, install equipment, and train personnel for screening checked baggage. The three contracts have a combined total dollar value of about $1 billion, not including contract options.
- Addressed several cost concerns that we identified, among them TSA has agreed to use part-time positions which will help match staffing to traffic patterns at many airports.
- Entered into an agreement with the Office of Special Counsel to handle whistleblower complaints from TSA screeners.

Since the Act was passed, it has also become apparent that the price of good security is substantial. For fiscal year (FY) 2002, TSA has been appropriated over $6.2 billion and has requested $4.8 billion for FY 2003. TSA anticipates that in FY 2003 the agency's workforce will have grown to about 67,000. However, revenues from the new passenger security fee will pay for only a fraction of these costs. Current estimates are that the fee will generate about $900 million this year, and $1.7 billion next year. It is evident TSA will require a large infusion of cash from the General Fund at a time when the General Fund is already strained to pay for vastly increased fiscal needs throughout the Federal Government.

Today, the deadline to have a federalized screener workforce in place is just over 3 months away, and the deadline to begin screening all checked baggage is less than 5 months away. While there has been much debate as to whether these dates are achievable, we can attest that TSA is working diligently to meet these deadlines.

Today, I would like to discuss two areas—meeting the deadlines in the Act, and building cost controls into the Agency's infrastructure.

- ***Meeting the Deadlines in the Act.*** As we get closer to the deadlines with only a fraction of the airports completed, the task ahead becomes more formidable. In the next 30 days it should become clearer as to what exactly must be done–airport by airport–to meet the deadlines of the Act. As TSA and the contractors begin rolling out plans for deploying Federal screeners and installing explosives detection equipment, it will be extremely important to communicate information to all parties (Congress, the Administration, airports, and airlines) if corrections are needed. Because airport assessments for the deployment of explosives detection equipment are scheduled to be completed at the largest airports by the end of August, and because of the current ramp-up in hiring passenger screeners, we will be in a much better position at the end of this month to judge what is or is not feasible to accomplish by the deadlines.

- ***Building in Cost Controls.*** The overriding goal for TSA must be to provide tight and effective security in a manner that avoids waste and ensures cost-effective use of taxpayer dollars. TSA faces significant challenges in overseeing the large number and dollar volume of new contracts it is letting. Contracts associated with deploying a new Federal screener workforce and screening all checked baggage total over $2 billion, including all contract options; while contracts with the current screening companies are expected to cost about $1.6 billion. Because the agency is new, it does not have an established infrastructure that provides an effective span of control to monitor contractor costs and performance.

  The President's proposal to create a Department of Homeland Security (which should offer economies of scale) could have significant implications for TSA. The implications extend to activities TSA anticipates performing and staffing up, such as intelligence gathering and analysis, performing criminal investigations, establishing an administrative support structure, and office space requirements at airports. With the tremendous tasks facing TSA, it is important that the Agency avoid extending itself beyond the basic tenets of the Act.

Meeting the Deadlines in the Act

The two most critical deadlines in the Act are federalizing the screening workforce and the screening of all checked baggage. First, TSA is required to have enough Federal screeners in place to conduct the screening of passengers and their carry-on property at all commercial airports by November 19th. Second, TSA must have a sufficient number of explosives detection systems in place to screen all checked bags by December 31st.

Hiring and Training TSA's Passenger Screener Workforce

The deadline for hiring and training all passenger screeners is now just over 3 month away. TSA is estimating it will need up to 33,000 screeners and screener supervisors to meet this requirement. As of July 31, 2002, TSA had about 4,400 passenger screeners onboard with another approximately 6,800 having accepted offers for employment. TSA has also hired over 600 other staff, including Federal Security Directors, attorneys, criminal investigators, program analysts, computer and information technology specialists, and administrative staff. These figures do not include 1,034 former employees of the Federal Aviation Administration (FAA), which brings TSA's total to over 6,100 employees, exclusive of Federal Air Marshals.[1]

Hiring Passenger Screeners. The next 30 days will be crucial in determining if TSA will meet the deadline for a federalized workforce. With just over 3 months left, TSA needs to hire and train more than 8,000 passenger screeners a month to meet the November 19th deadline. This is to hire the estimated 33,000 passenger screeners needed and does not include an estimated 21,600 checked baggage screeners that will be needed.

TSA contracted with Lockheed Martin to convert airport checkpoints to a new Federal model and coordinate the conversion of passenger screeners to a Federal workforce. This conversion includes both a physical reconfiguration of screening checkpoints and deployment of Federal screeners. Lockheed Martin had over 100 teams conducting assessments at over 200 airports during the month of July to determine how each checkpoint needs to be reconfigured. In addition, Lockheed Martin subcontracted with a consulting firm to develop a computerized model to determine the number of passenger screeners needed at each airport. A breakdown of passenger screeners per airport from the new computerized model should be available within the next couple of weeks. By the end of this month,

[1] The actual number of Federal Air Marshals is classified information.

TSA should have a better idea of the number of passenger screeners needed at each airport.

TSA contracted with NCS Pearson for recruiting and hiring. As of July 31, 2002, NCS Pearson was accepting applications for about 415 airports, and had opened 53 centers to assess applicants and hire screeners for 119 airports.

As of July 31, 2002, TSA had completed the hiring, training and deployment of passenger screeners for nine airports. (Baltimore, MD, Louisville, KY, Mobile, AL, Kalamazoo, MI, Bedford, MA, Hartford CT, Chicopee, MA, Columbus, OH, and Athens, GA) In addition to these nine airports, a Federal workforce has taken over passenger screening at three terminals at John F. Kennedy International Airport (JFK) in New York and two terminals at Orlando International Airport in Florida.

There is no doubt that over the last month the pace of hiring has increased. TSA has more than tripled the number of screeners hired (from 1,248 to about 4,400) and increased the number of airports currently in the assessment process from 3, during the week of June 17, 2002, to 119 as of July 31. In addition to the screeners hired, as of July 31, about 6,800 individuals have accepted offers for employment as screeners. *These employees will be added to TSA's payroll and considered hired, upon reporting for training.*

However, TSA is still having difficulties in hiring enough screeners in major metropolitan areas such as New York, Boston and Chicago. For example, TSA estimated it will need about 2,300 passenger screeners in total for the three largest airports in the New York area: JFK, La Guardia, and Newark. The assessment center for these three airports has been opened since June 24, 2002. As of August 1, 2002, TSA had 774 job offers accepted, 33 percent of the targeted amount.

The delays in hiring are largely due to the high percent of "no shows" and the number of applicants failing the aptitude test portion of the assessment process.

- Based on experience, TSA now expects one third of the scheduled candidates not to show up at the assessment centers. At BWI airport, 26 percent of qualified, scheduled candidates did not show up for assessments.

- A significant number of applicants are failing the first phase of the assessment process. The first phase of the assessment process consists of a computer-based test for English proficiency and overall aptitude skills. For the three New York airports, 61 percent of applicants who completed the first phase of the assessment process failed. This is similar to TSA's experience at

BWI, where 53 percent of applicants failed the first phase of the assessment process.

TSA is experiencing difficulty hiring a sufficient number of women. Initially, TSA's target was to hire 50 percent men and 50 percent women. However, of the over 9,100 individuals who have been hired or who have accepted job offers for employment at a specific airport (excluding the mobile screeners[2]) as of August 1, 2002, only 26 percent are women. TSA has recently addressed this issue, by modifying its hiring targets to one third women, one third men, and one third either. If TSA is successful in getting the new mix, there should still be a sufficient number of female screeners to ensure that female passengers are wanded by female screeners, since screeners rotate positions at screening checkpoints.

Training Passenger Screeners. The May conversion at BWI to a Federal workforce provided TSA with a valuable test of its planned process to train passenger screeners. BWI was TSA's first attempt to locate its training operation near an airport, and for Lockheed Martin instructors to conduct the courses. As of July 8th, there were 539 Lockheed Martin instructors who had passed the 44-hour basic screener course and are available to conduct training classes.

Through the week of July 22, 2002, Lockheed Martin instructors conducted basic screener training for the 11 airports where TSA has at least partially taken over passenger screening. Basic screener training was planned for 12 airport sites and at the FAA Academy in Oklahoma City the week of July 29, 2002. Training is planned for 30 airport sites and in Oklahoma City during the week of August 5, 2002.

As of July 27th, TSA had over 3,100 passenger screeners who had completed the basic training course, about 1,500 in the mobile screener workforce and about 1,600 permanent workforce screeners now working at 11 airports.

While the quality of the in-class instruction has been satisfactory, TSA experienced other difficulties with the training.

- The training contractor is not being required to provide x-ray machines and trace machines for hands-on training during the classroom instruction. For the training to be effective, students need to have hands-on practice with screening equipment. TSA has addressed this by conducting hands-on training using equipment at airport checkpoints that are closed for the night. So far, the contractor has been able to use equipment at the airports because TSA had

[2] The Mobile Screener Force consists of about 2,100 supervisory screeners who were hired or accepted job offers to deploy to airports around the country as the Federal workforce takes over screening.

taken over checkpoint operations before starting any on-site training. However, TSA has changed its deployment procedures, due to the number of airports it needs to convert to Federal screeners each week, so that it will not take over checkpoint operations at an airport before it starts the on-site training. As a result, TSA will need to work closely with airport managers and screening contractors to get access to screening equipment and ensure screeners receive this critical hands-on training.

- The hiring contractor needs to do a better job of providing accurate and timely information to the on-site training coordinator on the number and identity of the personnel who are to report for training. Significant differences have occurred between the roster of personnel scheduled for training and the actual students who report. For example, at the training that started on July 15th in New York, a roster listing 127 students was provided, but only 63 students reported to training. However, 21 of the 63 students reporting were not on the roster. The training contractor had to verify that the 21 additional students were supposed to be in training and then run the class for half as many students as planned. This problem is occurring in the major cities where the rate of hiring has not met initial expectations and the hiring contractor is scheduling applicants for training within days of passing the assessment and accepting a job offer.

Hiring Screeners in Large Metropolitan Areas Is Presenting a Challenge. While TSA has recently made progress in both hiring new screeners and conducting training at the airports, it only has just over 3 months left to meet the November 19th deadline. TSA is having the most difficulty in hiring screeners in large metropolitan areas. TSA estimates that overall, it takes an average of 5 weeks to build a Federal workforce for each airport, which includes 2 weeks to conduct assessments, 2 weeks for new screeners to notify current employers that they are leaving their jobs, and 1 week for classroom training. For two of three airports federalized to date, TSA has been able to beat this estimate. It was able to deploy a classroom trained screener workforce in Louisville and Mobile in just over 3 weeks after starting the on-site assessment and hiring process. However, the total passenger screener workforce for these two airports is about 200.

In the metropolitan areas of New York, Boston and Chicago, assessment centers were open for at least 3 weeks before local screeners started reported for training. The on-site training in these cities now is scheduled to last several weeks. Given the hiring difficulty TSA is experiencing in metropolitan areas, TSA should consider immediately opening assessment centers in all major metropolitan areas to ensure that sufficient screeners are hired to meet the November deadline.

Meeting the Deadline for Screening All Checked Baggage

The challenge facing TSA in meeting the statutory December 31st deadline[3] to screen 100 percent of checked baggage is both unprecedented and monumental. An effort of this magnitude—an estimated 1,100 explosives detection systems (EDS) and 6,000 explosives trace detection (trace) machines to be deployed—has never been executed in any single country or group of countries. In fact, the amount of explosives detection equipment necessary to screen all checked baggage at more than 400 U.S. airports is estimated to be at least three times the amount of equipment currently deployed at airports worldwide. It is in this context that TSA and the Department are working fervently to meet the deadline, and they could not be working any faster or harder than they already are.

Today TSA faces the task of deploying all the necessary explosives detection equipment in less than 5 months to more than 400 airports around the country, and at the same time hiring and training a checked baggage screener workforce of 21,600, not including the 33,000 passenger screening workforce that will need to be hired and trained. To help fulfill its December 31st mandate, TSA awarded a contract to Boeing Services Company to deploy EDS and trace machines to the Nation's airports and to train the checked baggage screener workforce needed to operate the equipment. *In our opinion, it should become clear by the end of this month as to what must be done–airport by airport–to meet the December deadline, as TSA and the contractors begin rolling out airport by airport plans for installing explosives detection equipment and for hiring and training screeners.*

The success of the deployment effort requires that TSA effectively manage three major program activities running on three parallel tracks. Therefore, TSA must:

- Obtain the necessary funding to place the remaining equipment orders and ensure that equipment manufacturers meet the delivery schedules laid out in their contracts.

- Ensure that Boeing executes its master plan for deploying the necessary equipment needed to screen all checked baggage, staying within the

[3] Section 110(d) of the Aviation and Transportation Security Act (Public Law 107-71) mandates that the Under Secretary of Transportation for Security shall take all necessary action to ensure that explosive detection systems are deployed as soon as possible to ensure that all United States airports have sufficient explosives detection systems to screen all checked baggage no later than December 31, 2002, and that as soon as such systems are in place at an airport, all checked baggage at the airport is screened by those systems; and that all systems deployed are fully utilized; and if explosive detection equipment at an airport is unavailable, all checked baggage is screened by an alternative means.

established timeframes for each of the major milestones in the deployment process.

- Ensure that a checked baggage screening workforce of 21,600 is recruited, hired and properly trained.

These activities must be done in tandem given the fact that, among other things, the deadline is less than 5 months away, and that each activity has specific milestones allowing for little, if any, schedule slippage. Since the activities are interrelated, schedule slippage in any one activity affects the ability of the other activities to stay on track.

Current Deployment Status on Equipment Needed to Meet the Deadline. As of August 1, 2002, 217 EDS and 275 trace machines were in use at 59 airports for screening checked baggage. Nearly 60 percent of this equipment was installed prior to the events of September 11th, over a 5-year period beginning in February 1997. That leaves more than 1,000 EDS and over 5,600 trace machines that will have to be installed and made operational by December 31, 2002.

TSA has an ongoing 5-airport pilot project for screening all checked baggage using EDS, trace or some combination. Of the 5 airports selected, only 1 is considered a large airport (but is not 1 of the 20 largest airports) with the other 4 being medium and small airports. The five airports participating in the project are currently screening all checked baggage using explosives detection equipment. Of the five airports, passengers' checked baggage is being screened using trace machines at three airports; all EDS at one airport; and a combination of EDS and trace machines at the other airport. According to TSA, results from the pilot project will be used to determine the "most effective equipment layouts and best procedures to expedite the movement of passengers through check-in screening without compromising security."

Utilizing Existing Equipment. During the 5-year period when air carriers were responsible for screening checked baggage, we testified repeatedly that the EDS machines were woefully underutilized. *During this time the majority of machines were screening, on average, fewer bags per day than the machines were capable of screening in 2 hours. Although we have seen a steady increase in utilization since TSA took over the screening company contracts in February 2002, machines continue to be underutilized.*

For May 2002, the latest available data, over 82 percent of the machines in use were screening, on average, 750 bags or less per day. These machines can screen 125 bags per hour and should be screening, at a minimum, 1,250 bags per day. Of the 160 machines for which data were available, only 10 were screening more than

1,000 bags per day. The following table shows usage rates for the latest available data on 160 EDS machines for May 2002.

Number of EDS Machines	*Bags Screened Per Day*
39	1 – 250
55	251 – 500
38	501 – 750
18	751 – 1,000
9	1,001 – 1,250
1	1,251 – 1,500

One of the overriding reasons the machines are underutilized is that air carriers are only required to have the equipment screen the baggage of passengers requiring additional security measures based on the Computer Assisted Passenger Prescreening Systems (CAPPS). The air carriers are currently allowed to use alternative methods, such as positive passenger bag match, to screen all other passengers' checked baggage.

It makes good sense to get real world experience by maximizing the use of machines currently in operation, especially at large airports. Fully utilizing the installed machines will (1) assist TSA in determining how many machines are needed to screen 100 percent of checked baggage; (2) give TSA and the air carriers real world experience with screening all checked baggage using lobby-installed EDS; and (3) provide insight into how machine downtime and maintenance requirements will impact security and passenger operations.

TSA needs to direct that the current rate of machine usage pick-up substantially; otherwise we will miss out on the opportunity to practice screening a higher percentage of checked baggage in order to better understand the logistical and physical constraints of lobby-installed machines, and the human factors involved.

Equipment Orders and Deliveries. With the equipment orders that are currently placed, TSA must ensure that equipment manufacturers meet the delivery schedules laid out in their contracts. Delivery dates under the current orders have not always been met because of problems found with the machines during factory acceptance testing.

As of August 1, 2002, TSA has placed orders for 1,025 EDS, including orders for almost 400 long-lead items in the amount of $682 million; and 1,410 trace machines, including long-lead orders in the amount of $7 million. TSA needs $427 million to turn the long-lead items into complete units, and place orders for an additional 75 EDS and 4,590 trace machines to meet the projected equipment deployment quantities.

EDS manufacturers have certain machine components that need long-lead times, in some cases up to 60 days. Manufacturers of trace also have certain machine components with long-lead times of 60 to 90 days. Orders will have to be placed by the end of September 2002 if the equipment is to be delivered, installed and made operational by year-end.

Under TSA letter contracts awarded to the two EDS manufacturers in February and April 2002, 114 machines were to be delivered by the end of June 2002. However, as of July 27th, 100 machines have been delivered and 29 of those have been installed and made operational. By the end of September 2002, TSA expects to take delivery of a total of 558 EDS.

Before the February and April 2002 TSA contracts, prior FAA contracts with one EDS manufacturer were limited to about 100 machines per order with delivery dates spread out over a 2-year period. An average monthly production rate was about 4 to 5 machines per month. Under the current TSA letter contract, this EDS manufacturer has an order for 418 machines to be delivered by the end of September 2002. To meet the September delivery deadline, a monthly average of 138 machines will have to be produced and factory acceptance tested before TSA can take delivery. That equates to an average production rate of about 28 times what this particular manufacturer had earlier experienced.

Any time a manufacturer dramatically ramps up production of complex systems such as EDS that heretofore have been produced in limited quantities, a great deal of attention must be focused on quality control efforts (for both software and hardware) to ensure that new systems will work as intended. TSA is working closely with the manufacturers to resolve the quality control issues and anticipates that the manufacturers will be able to meet revised delivery dates. Obviously, meeting the revised delivery dates will be key to meeting the December deadline.

Deploying the Necessary Equipment Needed to Screen All Checked Baggage.
On May 18, 2002, TSA reported to selected committees of Congress on its deployment strategy for meeting the December 31st deadline to screen all checked baggage. TSA has planned a two-phase approach. The initial phase is an interim solution to meeting the deadline where some airports will use EDS, with trace machines used only for resolving alarms; others will use trace machines exclusively; and some will use a mix of EDS and trace machines to screen checked baggage to meet the December 31st deadline. An interim solution was selected because it was not possible for manufacturers to produce enough EDS to screen all checked baggage, and even if they could, there would not be enough space in airport lobbies to install the EDS. Nor was it possible to complete the

necessary modifications to baggage handling facilities to integrate EDS into the baggage handling systems.

There are cost and staffing tradeoffs associated with using trace instead of EDS. Trace requires much more staff than EDS to operate, while integrating EDS machines into airport baggage handling systems takes substantially more up-front capital. The following table shows the cost and staffing trade-offs estimated by officials at Dallas/Fort Worth International Airport (DFW).

Item	Lobby-Installed Trace and EDS Machines	In-Line EDS
Equipment Mix	157 Trace machines 12 EDS	60 EDS 19 Trace machines
Workforce	1,444 screeners	628 screeners
Labor Costs (Annual)	$72.3 million	$31.4 million
Facility Modifications and Explosives Detection Equipment (Up Front) Costs	$67 million	$281 million

The trade-offs estimated by DFW show that lobby-installed trace machines compared to in-line EDS will require over twice the number of screeners and annual labor costs but only one-quarter of the costs for facility modifications and explosives detection equipment.

In phase two, at a future date not yet established, TSA will move the EDS machines into baggage systems at the largest airports. It is unclear how much this will cost and who will have to pay. A review of its FY 2003 budget shows that TSA is not planning to fund any equipment relocations from the lobby to the baggage handling facility. For now, it is also unclear whether some airports will rely exclusively on trace machines to screen checked baggage even in phase two.

The task will not be to simply move the machines from lobbies to baggage handling facilities but will require major facility modifications. For example, TSA recently approved Boston's Logan International Airport proposal for in-line EDS at an estimated cost of $100 million to the airport, while DFW estimates nearly $196 million in facilities costs in its own EDS in-line proposal.

Hiring a General Contractor. To execute its deployment strategy for meeting the December 31st deadline, TSA hired Boeing Services Company. On June 7th, TSA issued Boeing a cost-plus award fee contract for an estimated cost of $508 million from now until December 31st, with $862.4 million in options through calendar year 2007. Boeing has been tasked to (1) complete airport site assessments at over 400 airports scheduled between early July through November 2002, with 266 airports being completed by the end of August; (2) submit to TSA a proposal on the right mix of equipment for each airport and where the equipment will be

installed; (3) modify facilities to accommodate the equipment; (4) install and make the equipment operational; (5) maintain the equipment; and (6) train a workforce estimated at 21,600 to operate the equipment.

Boeing's contract does not include the purchase of explosives detection equipment, which will be funded separately by TSA. Boeing has been authorized to expend up to $340 million for installations and facility modifications at airports nationwide. However, it is unclear who will pay for any additional airport modifications in excess of the $340 million.

Beginning last month, Boeing started the first phase of a six-phase deployment process. The six phases include site assessment, site survey, design, construction, installation, and site acceptance testing of the equipment. As part of the site assessments, Boeing will determine the equipment mix and quantities needed at each airport. Henceforth, site assessments become the driving force behind the actual number of machines needed to be procured and manufactured, and the actual number of employees that need to hired and trained for each airport. Site assessments have been started at 202 airports. Of these, 45 have been completed as of July 26th. The next 30 days of site assessments will tell what can and cannot be accomplished by the deadline.

The remaining 5 phases (site survey, design, construction, installation, and site acceptance testing of the equipment) are stretched out over the remainder of the year with 43 of the largest airports (e.g., DFW, San Francisco, Atlanta) scheduled to be completed the last week in December. Of the remaining 386 airports, 88 are scheduled to be completed between mid-November and mid-December, and completion of the other 298 airports will be staggered throughout the remainder of the year with the earliest scheduled for completion this month. Boeing needs to stick to its milestones for each phase. Schedule creep in any one phase can affect the ability to meet the milestones of the other phases and ultimately the December deadline for all airports.

Also, this is an enormous effort that requires large amounts of money expended in a short period of time. The span of control over this effort is far-reaching because there are numerous subcontractors. With respect to this contract, TSA needs to ensure that three basic oversight steps are taken:

- monitoring contractor billings, especially when such a large amount of money is being spent over a short period of time;

- monitoring contractor performance with respect to cost, schedule and quality with regards to the $31 million available in award fees; and

- drawing on work that has already been done by Raytheon and airport operators with respect to the recently completed airport site assessments. For example, DFW alone spent 12 weeks and over $2 million to complete its assessment.

Hiring and Training a Baggage Screener Workforce. TSA must ensure that a screening workforce is recruited, hired and properly trained, and it estimates that 21,600 screeners are needed for checked baggage screening operations. This is in addition to the 33,000 passenger screening workforce. The workforce of 21,600 screeners will be responsible for operating EDS and trace machines used in the screening of passengers' checked baggage at the Nation's 400-plus airports.

As of July 16, 2002, TSA has hired, trained and deployed 166 Federal baggage screeners. That leaves more than 21,400 screeners to be recruited, hired and trained before the December 31st deadline, which means nearly 4,300 screeners need to be recruited, hired and trained each month. It is too early at this time to tell whether TSA will experience the same problems hiring this workforce as it has experienced with hiring the workforce for passenger screening, such as the high percentage of applicants failing the aptitude test portion of the assessment process. Nevertheless, we believe the earlier experiences with hiring passenger screeners can be instructive and provide valuable lessons for TSA and its contractors in this effort.

It is also important to keep in mind that the driving force behind the staffing levels for checked baggage screeners is the mix and quantity of equipment used in screening checked baggage, whether the equipment is all EDS, all trace or some combination. Boeing is currently conducting site assessments at airports nationwide to determine what equipment is needed and where. Once the assessments are completed, TSA will know how many screeners will be needed at each airport.

Building in Cost Controls

Since passage of the Act, it has become increasingly clear that TSA will require a large infusion of cash from the General Fund. This comes at a time when the General Fund is already strained to pay for vastly increased fiscal needs throughout the Federal Government. Within this context, the need for TSA to build cost control mechanisms into its infrastructure is critical. Controls are particularly important in terms of defining the scope of its missions, establishing employee compensation and controlling salaries, overseeing contracts, and utilizing space at airports.

Defining the Scope of the Agency's Missions. With the tremendous tasks facing TSA, it is important that the agency avoid extending itself beyond the basic tenets of the Act's requirements. For example, while the law is only explicit about a Federal law enforcement presence at checkpoints, we have seen TSA proposals for staffing activities such as criminal investigations at airports and intelligence gathering. In these instances, it is unclear what TSA's role would be or how it would relate within the jurisdiction of other agencies such as the Federal Bureau of Investigation or the proposed Department of Homeland Security.

The President's proposal to create a Department of Homeland Security (which should offer economies of scale) could have significant implications for TSA—particularly in overlapping functions, such as intelligence gathering and analysis, criminal investigations, administrative support, and space requirements at airports. For example, under the President's proposal, TSA would be merged with Customs Service and the Immigration and Naturalization Service, which already have a combined criminal investigative workforce of approximately 5,000.

Similarly, the proposed Department of Homeland Security will include an Under Secretary for Information Analysis and Infrastructure Protection whose responsibilities will include receiving and analyzing law enforcement information and intelligence. It may be premature for TSA to expend resources now to expand an intelligence function beyond the existing staff of the Department and Coast Guard when that function could be merged into the new Department of Homeland Security.

Establishing Employee Compensation and Controlling Salaries. TSA has much flexibility in establishing salaries for newly hired employees, and employees can be hired anywhere within the pay band for their position. Use of this flexibility bears watching to ensure that salaries for TSA employees are commensurate with the position duties and not arbitrarily higher than salaries for comparable positions in other agencies. For example, we have seen numerous reports that recruitment of Federal Air Marshals is draining other agencies' law enforcement resources.

We found that most Federal Air Marshals were being hired at the lower half of their assigned pay band, which starts at $36,400, excluding locality pay. However, Air Marshals also receive a 25 percent Law Enforcement Availability Pay (LEAP) differential, which would put their total starting salary at $45,500. This salary level is higher than law enforcement salaries at other agencies that do not receive LEAP.

While law enforcement positions without LEAP may receive intermittent overtime, it is important to bear in mind that LEAP is constant. TSA had originally planned to provide LEAP to all its law enforcement positions including

checkpoint guards. However, after concerns were raised, TSA reconsidered that approach. TSA is currently planning to provide LEAP to Air Marshals and criminal investigators but not to checkpoint guards.

We also have concerns regarding the salary levels being established for some general and administrative positions. As of July 27, 2002, TSA had hired 614 employees for non-screener positions. Of these employees, 360 (59 percent) had salaries over $90,000, and 269 (44 percent) had salaries over $100,000. In fact, within most of the job categories for general and administrative positions, the preponderance of employee salaries were over $90,000. For example:

- Of 58 attorneys hired, 48 (83 percent) have salaries ranging from $90,000 to $144,000.

- Of the 71 employees hired in the General Inspection, Investigation, and Compliance series, 50 (70 percent) are receiving annual salaries between $91,149 and $141,500.

- Of 50 criminal investigators hired, 36 (72 percent) have salaries ranging from $90,395 to $138,200, which does not include a 25 percent LEAP differential.

It is important that TSA exercise caution in how it structures employee compensation and benefits, since these costs represent the largest portion of the agency's operating expenses. For a workforce of about 67,000, these costs will be significant in 2003 and will have a tremendous impact on future financial needs. FAA, which has similar flexibilities in setting pay, has experienced huge cost growth in its operating costs largely due to employee salaries. As a result, containing operating costs has now become a critical issue for FAA.

Ensuring Adequate Contract Oversight. TSA faces significant challenges in overseeing the large number and dollar volume of contracts being let by the agency. For example, the contracts with Boeing, Lockheed Martin, and NCS Pearson alone total over $2 billion, including all contract options. In addition, TSA estimates that the current screening contracts will cost about $1.6 billion. Because the agency is new, it does not have an established infrastructure that provides an effective span of control to monitor contractor costs and performance. Cost and performance oversight are key tenets in any internal control system, and we are prepared to assist TSA, however possible, in establishing adequate internal controls.

One recommendation we have made is that TSA set aside or "fence off" a specific amount to be used for overseeing contractor performance with respect to cost, schedule, and quality. In recent hearings before the House Appropriations Subcommittee on Transportation and Related Agencies, we recommended that TSA reserve at least one half of one percent of the available contract award dollars for oversight activities. For example, TSA can contract with the Defense Contract Audit Agency for a wide variety of services, including audits of incurred costs claimed by contractors on cost reimbursable contracts. In TSA's FY 2002 Supplemental Appropriation, Congress has subsequently required the agency to adopt this process.

As far as the $1.6 billion screening contracts, in April, we testified before the House Subcommittee on Transportation Appropriations that controls over the existing security screener contracts were lacking and that improvements were drastically needed. Since that time, we met with TSA officials who agreed that internal controls over the screener contracts were inadequate. They stated that additional staff would be assigned and TSA would provide more guidance to security field representatives for reviewing contractors' on-site documentation. TSA also set out to obtain a contractor to provide oversight of screening contracts and contractors, and sent out staff to review contractors at three airports.

Notwithstanding these initiatives, we continue to find that further action is needed immediately. During our visits to two airports and six screening contractors, we saw virtually no on-site monitoring of screener contractors by TSA employees. While we were able to locate all contractor employees who signed in for duty at the time of our visits, we observed contractor employees arriving late and leaving early, but they signed in as though they were on duty the entire time. For example, a contractor employee arrived at 1:53, but signed in as though he arrived about an hour earlier at 1:00. In this case, TSA would be paying for about 1 hour of work that was not performed.

We also found that hourly and overhead rates charged by the contractors vastly exceeded the rates they charged before TSA assumed the contracts. The following table shows the loaded labor rates (which include amounts paid to contractor employees and for the contractors' overhead costs) charged by contractors before and after TSA became responsible for screener contracts (February 17, 2002).

Overhead Rates

Screeners	Employee Pay Rates	Loaded Rates Billed to Customers*	Overhead Rate
Company 1			
Before Feb. 17	$8.25	$11.11	35%
After Feb. 17	$11.00	$19.81	80%
Company 2			
Before Feb. 17	$10.00	$14.91	49%
After Feb. 17	$14.00	$28.00	100%
Company 3			
Before Feb. 17	$6.90	$9.83	42%
After Feb. 17	$10.13	$19.39	91%

**Rates before February 17 were billed to airlines, while rates after February 17 were billed to TSA.*

While contractors should recover their costs and overhead, they are required to provide TSA with specific cost and pricing data including components of and support for the loaded hourly rates. At the locations we visited, we asked the contractors for support for their loaded labor rates. However, they did not provide evidence to support their rates nor did they explain why the overhead rates billed to TSA more than doubled under contracts to TSA, as compared to contracts with airlines.

Because of the urgent need for continuing coverage, when TSA took over these contracts in February, letter contracts were originally awarded to screening contractors who were already under contract with the airlines. Immediately after signing the letter contracts, the screening contractors were to begin negotiating the price and any price-related terms with the agency's contracting officer. The intent was that these negotiations would result in definitized firm-fixed price contracts with each company.

It is now nearly 6 months since the letter contracts were issued and cost and pricing data have not been submitted, negotiations have not been conducted, and the contracts have not been definitized. In accordance with the terms of the Aviation and Transportation Security Act, TSA employees must be in place performing the screening services at the Nation's airports by November 19, 2002. After the screener contracts end, it could be very difficult to recover any improper or unsupported payments. Accordingly, TSA needs to take immediate action to: (1) require contractors to submit proposals and cost and pricing data; and (2) definitize the contracts.

In addition to our work, TSA's Office of Inspection performed similar reviews at two screening contractors and three airports. These reviews also found that internal controls were not followed, contractors billed TSA for employees who were on vacation, and TSA was overcharged for services not performed. TSA notified us of its intent to refer the results to our Office of Investigations.

TSA is in the process of developing a statement of work to hire a contractor to perform oversight of screening contractors' billings. Based on our initial findings, the oversight contract needs to be in place quickly and clarified to ensure that the oversight contractor verifies cost and pricing data at the screener contractors' offices, focusing specifically on cost data used to support the loaded labor rates.

Additionally, TSA is planning to enter into an agreement with the Defense Contract Management Agency to provide contract administration services. If implemented, this would be a good step in the right direction.

That concludes my statement, I would be happy to address any questions you might have.

August 2002

SECURITY IMPLICATIONS ON AIRPORT LANDSIDES

Since September 11, 2001, aviation security has entered a totally new age. Regulations promulgated in response to the terrorist attacks have had often-drastic effects on airport landside operations. Airport provisions can be found in Section 106 of the Aviation and Transportation Security Act (ATSA or 'The Act'), which was signed into law on November 19, 2001.

Passenger and baggage screening

The most visible changes in service levels have occurred in this area. Processing or 'transaction' times at security checkpoints have increased by about 400 percent. For those reasons, well-wishers have been prohibited from entering airport sterile areas. As security checkpoints are redesigned by both TSA and airports, there will likely be some incremental improvements in transaction times that will somewhat ameliorate the horrendous queues at peak periods. Nevertheless, we do not expect well-wishers to be accommodated for at least several years.

Curbside check-in

Curbside check-in is currently back in business, IF there is a reservations computer at the check-in point. Skycaps may not accept the baggage of "selectees" (i.e., profilees) identified in the reservations computer; selectees' baggage must be transported to the ticket counter.

This will change dramatically when 100% screening of bags by certified Explosives Detection Systems (EDS) is implemented on December 31, 2002. Only those curbside check-in positions supported by EDS on the airside (or—highly unlikely—EDS *at* curbside) will be able to accept bags. Additionally, TSA should preserve the identification of selectees in the event that additional screening may be required of their bags irrespective of EDS automated clearance of their bags.

100%-EDS Inspection of Checked Baggage

The Act requires this "Mission Impossible" inspection by December 31, 2002. Airports are having enormous difficulty placing the initial, incomplete issuance of this large and heavy equipment. To meet the Congressionally-imposed deadline, the vast majority of interim installations will be in airport terminal lobbies, with catastrophic results for passenger flow and levels of service. As time-consuming build-out can occur to place the EDS machines "behind-the-wall" or integrated with ticket counter take-away belts, the adverse effects will be ameliorated somewhat.

Remote and Off-Airport Checked Baggage Acceptance

Remote (i.e., garage or parking lot) and off-airport (hotels and cruise ship terminals) checked baggage acceptance, discontinued in the immediate wake of the 9/11 attacks, will be reborn with the need to reduce the baggage inspection load on airport terminal lobbies. In each case, what must be present at any such location include (1) a reservations computer (usually common/multi-user) operated by air carrier representatives, (2) an EDS machine and supporting Explosives Trace Detection (ETD) machine, (3) TSA screeners to operate the equipment, (4) a capability for immediate response by law enforcement, and (5) a means of securing inspected baggage (truck with sealed doors) during its transport to the aircraft.

The 300-Foot Parking Rule

Background:

The controversial 300-foot parking rule, also known as "SCA-3," had its origins in a 1991 "AVSEC Plan," a contingency plan for airports, arising from parking restrictions invoked during the Gulf

War. The SCA-3 countermeasure was previously invoked only once (October 1-November 18, 1995) following the conviction of 12 Islamists for plotting to destroy 12 New York City landmarks virtually simultaneously.

What It Requires:

No *non-governmental* vehicles may be parked (i.e., left unattended) within 300 feet of the face of an airport terminal building, unless those vehicles have been inspected for a large explosive charge. The rule seeks to prevent the catastrophic collapse of a terminal building; it does ***not*** attempt to prevent the mass casualties on the roadway and sidewalks in front of terminal buildings that would result from the detonation of a large explosive charge within 300 feet. If vehicles are subjected to inspection (not difficult, as the "large" charge represents several hundred pounds of explosives, and inspection does not require examination of the vehicle's undercarriage), they may be parked within the 300 foot distance. The Transportation Security Administration (TSA—successor agency to FAA Civil Aviation Security) may grant exceptions on the basis of individual airports' applications supported by blast damage analyses prepared by certified engineering firms. These exceptions may reduce the distance partially, but will virtually never exclude from the requirements an open top deck of a parking garage, for example.

Bottom line: If a vehicle bomb detonation occurs on the terminal loop road anywhere in the United States, it is almost certain that all passenger pickup and delivery will be mandated to occur off-airport, such as was accomplished at LAX for approximately 5 weeks following September 11.

Service, delivery and small package vehicles

These vehicles, previously left unattended curbside while the drivers performed their duties, have often been granted airfield access (as during the Gulf War and in 1995) with the unintended result of increasing the number of vehicles and personnel authorized access to the airfield ("Secured Area" and "Air Operations Area").

The Act requires the screening of persons, vehicles, and goods entering the Secured Area of airports, generally to the same standards as passenger screening "as soon as practicable," which—barring a major incident—will not likely be mandated until at least mid-2003. When this latter requirement is implemented, only a very small number of outside vendor vehicles can be accommodated. Airports should consider establishing a commissary (or transfer building) on the airport perimeter, to whose landside outside vendors can deliver goods. Those goods would be inspected to TSA standards within the facility, then delivered fieldside by permanent party personnel.

Other considerations:

Community light rail (e.g., BART)

Even today, no Federal standards exist for separation of community light rail stations from terminal buildings or aircraft parking areas. The threat is that an explosive device contained in baggage can be detonated upon the train's arrival. Airports should consider establishing blast walls or sufficient stand-off distances to preclude damage to terminals or aircraft.

Gasoline tankers, Rental Auto Center (RAC) fuel supplies

Under no circumstances should gasoline tankers be permitted to approach terminal buildings. RAC fueling areas should be stringently protected against unauthorized access.

August 2002

AIRPORT SECURITY REQUIREMENTS IN THE WAKE OF THE 9/11 INCIDENTS

As soon as air travel was again permitted, the FAA established several critical new requirements under Security Directives and Emergency Amendments to airport security programs, including:

- Prohibition of well-wishers past passenger screening
- Unattended, uninspected vehicles prohibited with 300 feet of terminal facades
- Re-validation of all airport ID media authorizing fieldside access
- Increased law enforcement and civilian patrols
- Posting of armed officers at passenger screening checkpoints (supplemented by National Guard for six months)

Congress responded to the terrorist attacks of 9/11 by creating the Aviation and Transportation Security Act (ATSA), which was signed by President Bush on November 19, 2001. This extremely ambitious piece of legislation mandated a number of actions, some with deadlines, some without. These mandate deadlines are described in ATSA as "xx days after enactment". Calendar dates are provided for selected mandates which follow:

Required actions with specific deadlines:

- Jan. 18, 2002 Positive Passenger Bag Match (first leg only) mandated.
- Feb. 17, 2002 Transportation Security Administration (TSA) is established (Sec. 101). TSA takes over control of passenger and baggage screening, and takes over airlines' contracts with passenger screening companies Sec. 110). TSA assumes ownership of all screening equipment.
- Jan. 19, 2002 Some form of checked baggage screening OR Positive Passenger-Bag Match required (Sec. 110).
- Nov. 19, 2002 All screening personnel must be TSA employees or companies under contract to TSA (Sec 110).
- Dec. 31, 2002 All originating checked baggage will be subjected to examination by "explosives detection systems" (EDS) (Sec. 110).
- Apr. 9, 2003 Permanent reinforcement of cockpit bulkheads.

Required actions with no specific deadlines –"As soon as practicable":

- Screening of personnel, vehicles, and goods entering a "secure area of an airport." Screening is to "...assure at least the same level of protection as will result from screening of passengers and their baggage" (Sec 106).
- Vendors have direct access to the airfield shall develop security programs (Sec. 106).
- Airports must establish security awareness programs (Sec. 106)
- Cargo: "A system must be in operation to screen, inspect or otherwise ensure the security of all cargo that is to be transported in all-cargo aircraft...." (Sec. 110).
- Federal Security Directors appointed (Sec. 103).

Effects on airports:

Parking restrictions reduce revenue

Financial loss to concessions, both pre-screening and post-screening

Drain on law enforcement resources

Increased contract security coverage

Increased space needed for passenger screening operations and queuing

Increased support space needed for TSA screeners (33,000 + 21,600 future checked baggage screeners), law enforcement officers, and FSDs

Lobby space will dramatically impacted by checked baggage screening's interim solutions

Bag rooms and other "back of the house" areas will be modified to accept in-line checked baggage inspection equipment

Airports will absorb O&M costs for baggage belt systems and the utilities to operate them

BIBLIOGRAPHY AND WEB REFERENCES

Knowledgeable discussions are limited due to the fact that much information on security programs and specific countermeasures is considered "Sensitive Security Information" defined and restricted by 49 CFR Part 1520 (formerly FAR Part 191).

"Security Considerations in the Planning, Design, and Operation of Airport Landside Facilities," Joan C. Zatopek and Peter B. Mandle, paper for ASCE, as yet unpublished.

"Get used to It: Airports Are Vulnerable," Brian Michael Jenkins, article, The Bergen County (NJ) *Record*, August 2, 2002

TSA website: http://www.tsa.dot.gov

American Association of Airport Executives (AAAE) security website: http://www.airportnet.org/security/

Aviation Security regulations (publicly available content) promulgated by TSA replace FARs 107, 108, 109, 191. They are now in 49 CFR Parts 1500 through 1550.

Congressional testimony by the DOT Inspector General can generally be found at http://www.tsa.gov/briefing_room

"Progress in Implementing Provisions of the Aviation and Transportation Security Act," statement of Alexis M. Stefani, Assistant Inspector General for Auditing, U.S. DOT, to Congress on August 7, 2002
http://www.tsa.gov/briefing_room/speech/speeches_08_2002.shtm

Opinion: Get used to it: Airports are vulnerable
By BRIAN MICHAEL JENKINS
The Bergen County (NJ) Record
August 2, 2002

AS WE CONTEMPLATE new measures to expand airport security, we need tokeep in mind some unfortunate realities.

First reality: It is very hard to protect public places. Doing so is costly and disruptive and creates new vulnerabilities.

Second reality: It is a mistake to create expectations about invulnerability that cannot be fulfilled. We could never make all locations invulnerable to attack. A determined killer could always move down the road to other public places.

We must make a distinction between security at airports and security for airports. There is justification to take extraordinary security measures at airports, but the calculations change when we talk about security for airports.

What we have now is security at airports deployed to keep weapons off airplanes. We do this because terrorists have focused their attacks on commercial airliners as national symbols. Airline sabotage can claim the lives of hundreds of passengers in a single incident. And, as we saw on Sept. 11, a hijacked plane can be turned into a missile that can kill thousands in a city below.

But the airport terminal itself is public space. Outside of the screening points, it is no safer nor more dangerous than most other public spaces.

Where do we draw the line? The government has publicized possible terrorist threats to national monuments, nuclear reactors, surface transportation, ports, power plants, bridges, high-rise buildings, movie studios, sports arenas, shopping malls, and public celebrations. Can we protect them all? And would even extreme measures stop attackers from taking innocent lives? A determined killer will always find a target. Someone determined to kill Jews will find it no more difficult than killing Catholics, Muslims, Buddhists, Hindus, or members of any other religious, ethnic, or national group.

Does anyone really believe, for example, that if airport security had been tighter, the Egyptian shooter at Los Angeles International Airport on July 4 would have traded his pistols for a picket sign and protested peacefully against Israel?

Security at Israel's main airport has been tight ever since May 1972, when three members of the Japanese Red Army - which had allied itself with the Popular Front for the Liberation of Palestine - attacked arriving passengers. Even Israeli officials concede the difficulties of preventing random attacks.

Because Israel's Ben Gurion Airport is surrounded by rings of security, suicide attackers instead target bus stops, shopping malls, hotel lobbies, and pizza parlors. The horror of these murders is not lessened by their distance from the airport.

Better security for airports is no small undertaking. The deployment of even a few additional armed uniformed and undercover officers at every terminal in every airport easily would involve

thousands of new security personnel. Shifting the screening checkpoints to the front of the terminal would simply create long lines of passengers on the sidewalks outside -- a new vulnerability and a tempting target for killers.

The question is not whether we can increase security for any category of public real estate. If we are willing to make the necessary investment and accept the added inconvenience, we can make it more difficult to carry out an act of violence inside wherever we establish the perimeter. The question is: How can we best allocate limited resources to reduce dangers to public safety overall?

All this doesn't mean we should do nothing more at our airports. We can on a random basis deploy additional police without pretending to provide full coverage. We can deploy additional surveillance cameras. And we can increase the efficiency of the check-in and screening process to move passengers into the secure zone more quickly.

Existing proposals to remodel airports or disperse check-in facilities to satellite terminals will provide valuable opportunities to explore new security protocols, but these are long-term improvements. With hard work, good luck, and clever strategies we may be able to come close to abolishing murder in the skies. But no society in history has been able to abolish murder here on Earth, and none ever will. Unfortunately, there is no security device that can X-ray people's souls to identify the killers among us.