CHAPTER 7

Technology Transfers in Commercial Aircraft Support Systems

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Technology Transfers in Commercial Aircraft Support Systems

INTRODUCTION

The Middle East has been one bright spot in the generally depressed worldwide commercial airline industry in recent years. Sales to the region of large commercial aircraft and related services required to support airline operations grew dramatically in the 1970's and have continued into the 1980's, despite the recent depressed condition of world air transport. This was due to both increased oil revenues and to the increased transport needs of the Middle East during their decade of dramatic business expansion. The airlines of the Middle East have the newest fleets in the world, with the average age of jet and especially non jet aircraft considerably lower than the world average.[1] The number of passengers carried by Saudia alone increased from 1.3 million in 1974 to 10 million in 1982. From 1980 to 1981, Kuwait Airways ranked second in the world in growth rate of scheduled revenue tonne-kilometers performed.[2] According to International Civil Aviation Organization (ICAO) statistics, scheduled air passenger traffic in the Middle East region will increase by 10 percent annually up to 1992. This represents the most dynamic growth pattern of any region in the world.[3]

While the Middle Eastern countries may have the financial resources necessary to purchase aircraft, operations and maintenance require substantial ongoing efforts. Whether commercial airlines are mere symbols of national prestige or important components of economic and technological development depends on the extent of technology transfer, particularly in aircraft support systems.

Commercial aircraft support systems cover a wide range of capabilities which include: 1) airport design, construction, and management; 2) basic airplane ground support including fueling and loading/unloading of passengers, baggage, and freight; 3) routine maintenance/inspection of aircraft; 4) major aircraft (airframe and powerplant) overhaul; 5) passenger reservation and cargo routing operations; 6) air traffic control flight operations; and 7) in-flight operations including piloting and avionics control/communications. Each of these areas requires specialized equipment, which entails training in its use and continued maintenance. The emphasis in this chapter is on large commercial (mostly international) operations although the discussion touches smaller civil aircraft, and civil helicopters. Aircraft sales to the region are covered, particularly as they relate to technical services, training, and spare parts availability and to U.S. policy issues such as official financing and export controls. Military aircraft sales and servicing are explicitly excluded, but the analysis does clarify the limited utility of commercial aircraft and related services for military uses.

Compared to other technologies covered in this study, technology absorption has been extensive in the commercial aircraft support sector. Operating statistics of these airlines (including safety) are comparable to those of major international airlines. This chapter analyzes the reasons for this comparative success.

[1]The average age of non jet aircraft in the Middle East is 5.0 years, compared to 1:}. 7 years for such aircraft worldwide. For jet aircraft, the number is 8.2 years, and the world average 9./i years

[2]The sum of the products obtained by multiplying the number of tonnes (1 tonne 1,000 kg) of revenue load carried by the flight distances measured in kilometers is the number of revenue ton ne-k ilometer performed, Separat [j calculations are made for passengers (including baggage). freight {including express), and mail.

[3]Robert Bailey, "Hoeing Strikes Back," *Middle East Economic Digest*, Feb.3, 19H4, p. 35.

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The analysis makes it clear, however, that while indigenous personnel in the Middle East are increasingly operating commercial aircraft support systems, some airlines may never become fully staffed by nationals.

The United States is an acknowledged leader in avionics and aircraft engines, but adequate substitutes are increasingly available from other supplier countries. U.S. aircraft sales in the Middle East region, important to sales of auxiliary equipment and services, have been negatively affected by U.S. foreign policy controls on exports. The European Airbus consortium[4] on the other hand has expanded sales in the region, and, to prevent future loss of sales, has even considered recertifying the Airbus with British Rolls-Royce engines instead of its present U.S. origin Pratt and Whitney or G.E. engines in order to avoid possible delays arising from U.S. export licensing procedures. Some U.S. observers feel that U.S. companies are also disadvantaged by subsidies which the Airbus receives from its European partners, and by a comparative lack of high-level diplomatic support. This view, however, is not shared by the Europeans who feel that U.S. aircraft sales are subsidized by U.S. Export-Import Bank and indirectly by NASA research programs.

All Middle Eastern countries under study have national airlines, but few turn a profit. Some, such as Saudia, are presently heavily subsidized. In contrast, Gulf Air, a consortium of several Middle East countries,[5] has been profitable even during the recent recession period, despite its tragic crash in 1983.[6]

This chapter analyzes commercial aircraft support systems technology transfer to the Middle East. First, requirements for commercial aircraft support are identified and their status is surveyed in the six countries under study. The technologies include a broad spectrum of application and complexity, but tend to be well established and governed by international norms. Recipient perspectives are then reviewed, focusing on development plans in this technology sector and their absorption of the technologies. Most of the countries under study have placed great emphasis on transportation needs, particularly civil air transport (passenger and freight) requirements. Plans include construction of new airports, expansion of existing airports so that they can accept larger aircraft and international traffic, and increased personnel training facilities. Experiences with technology absorption have varied, but capabilities have been improved at a rapid rate over the past 10 years, particularly in in-flight operations and passenger reservation and cargo routing. Although aircraft routine maintenance and major overhaul work is increasingly performed by the airlines themselves, many of the workers are expatriates and, in Saudi Arabia and Kuwait, will probably remain so for some time. The chapter also analyzes competition among suppliers. Likely short- and long-term developments for the recipient nations and for the suppliers are then described, and finally implications for U.S. policy are given. One important issue addressed is the role of U.S. export controls in affecting competition among suppliers.

[4]Members are Aerospatiale of France (37.9 percent ownership), Deutsche Airbus of Germany (37.9 percent), British Aerospace (20 percent), and Construcciones Aeronautics of Spain (CASA) (4.2 percent).

[5]Bahrain, Qatar, Oman, and the UAE.

[6]The Gulf Air crash of a Boeing 737 near Abu Dhabi on Sept. 23, 1983, with a loss of 111 lives is still being investigated.

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS IN THE MIDDLE EAST

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS

Commercial air transportation systems consist of two interdependent components: first, airline operations (including maintenance and operation of aircraft); second, airport and aviation support services (e.g., air traffic control) provided by an outside agency, usually governmental. In both, equipment ranges from the simple to the very sophisticated.

Labor and capital requirements differ between the two components of the air transportation system. The operation of aircraft is highly capital intensive, with small flight crews operating very expensive equipment to serve large numbers of customers. Ground operations, by contrast, are far more labor intensive since they use less expensive equipment but employ large labor forces to service and turn around aircraft in the shortest time possible.[7]

The occupational structure of air transport is consequently very diversified. Airline personnel range from low skill level (clerks, baggage handlers) to very high skill level (managers, pilots, mechanics, air traffic controllers). Air transport requires labor mainly in the clerical, professional, craft, and service categories. One key occupational group is present in each category—namely, ticket agents, pilots, mechanics, and flight attendants. Each occupational group has its own very specialized training requirements.[8]

The operations of airlines also depend on the aircraft manufacturing industry. While none of the Middle Eastern countries under study have civil aircraft manufacturing facilities, Egypt is presently manufacturing military aircraft of U.S. design.[9]

The high costs of purchasing and operating modern aircraft are dominant factors in the financial positions of airlines; in the United States, direct flying operations, maintenance of aircraft, and depreciation makeup over half the total expense of airlines. A new McDonnell Douglas DC-10 in 1980 cost about $60 million,[10] and the ratio of the capital value of flight equipment to ground equipment owned by U.S. airlines was more than 4:1 in 1980.

These high aircraft costs affect labor requirements in two ways: first, flight operations themselves are very capital-intensive. With a trend towards larger aircraft in the 1960's and 1970's, there has been a tendency to use smaller flight crews serving larger numbers of passengers. Second, the high cost of aircraft on the ground puts a premium on rapid turnaround so as to keep the aircraft flying.

Labor represents the single largest cost item for airlines worldwide, with nearly 10 percent of the work force being cockpit crew.[11] In the airline industry, labor is highly skilled and must assume a high degree of responsibility.

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[7] According to the U.S. Civil Aeronautics Board, flying operations made up 39 percent of the expenses of the U.S. airline industry in 1980. Expenses for other subsectors included (in percent): maintenance-10,8; passenger service-9.4; aircraft and traffic servicing— 16.4; general and administrative—3.9; promotion and sales—12.l; and depreciation, amortization, other—8.4. See U.S. Civil Aeronautics Board, *Air Carrier Financial Statistics,* March 1980.

[8] In the United States, the occupational breakdown for the air transport industry includes: professional and technical, 19 percent (including pilots); clerical, 30 percent; craft workers, 20 percent (including aircraft mechanics); service workers, 14 percent; laborers, 4 percent; managers, 6 percent; operatives, 6 percent; and sales, 1 percent. U.S. Bureau of Labor Statistics, Washington, D. C., 1981.

[9] Mark Lambert, ''Egypt Rebuilds Its Aircraft Industry, *Interavia—Aerospace Reviews,* February, 1984, pp. 157-60.

[10] Aircraft prices vary considerably, depending on plane configuration and customer needs for training and spare parts. For example, a Boeing 747 in 1984 reportedly ranged in price from $77 million to $84 million (747-SP) to $91 million to $106 million (747-300 extended).

[11] ''Labor and fuel are the two largest cost categories in the industry worldwide. See William E. O'Connor, *An Introduction to Airline Economics (New* York: Praeger, 1982). Cost per gallon of jet fuel for U.S. air carriers increased from 12.7/gal. in 1973 to 57,8/gal. in 1979 to 104/gal, in 1981, and dropped slightly to 98. l/gal. in 1982. Cost of fuel as percent of cash operating expenses moved from 12.2 percent in 1973 to 28.1 percent in 1982. Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures— 1983/84,* Washington, D. C., July 1983, p. 86. Cost of fuel for airlines in the Middle East depends on refining capabilities and subsidies of the individual countries.

Major Components of Commercial Air Transportation Systems

A. Airline Operations

1. Aircraft operations (usually called "flying operations"): the actual flying of aircraft from one point to another. Consumes fuel and employs a flight crew (consisting of cockpit crew and cabin crew.
2. Maintenance: periodic maintenance of aircraft while out of service. Uses spare parts and maintenance facilities and employs aircraft mechanics and related personnel.
3. Aircraft and traffic servicing: servicing aircraft during operations; securing aircraft at arrival and departure, loading and unloading cargo. Employs trained personnel such as baggage handlers, tug drivers need to move the aircraft on the ground, and aircraft service personnel.
4. Passenger service: ticketing, information, passenger facilities at airports, food served to passengers in flight, and related services. Uses airport facilities and supplies and employs service personnel and support personnel such as food preparers (the latter often employed by an outside vendor rather than the airline).
5. Administration: general management, accounting, and related business functions. Employs management personnel and office support staff.
6. Promotion and sales: advertising, publicity, travel agent commissions, and other promotional activities. Employs public relations/advertising staff and support personnel.

B. Airport Operations

7. Airport facilities: construction, maintenance, and operations of airport facilities. Employs primarily service personnel, management and support staff. Construction of a new airport requires major commitment of design/planning and construction labor. Within airport operations are included many subsidiary businesses and concessions including restaurants, duty-free shops, and book stores.
8. Food service: provision of food for passengers and other customers, both in the airport and in flight (the latter being included above under "passenger service"). Employs food preparation and service personnel.
9. Hotel service: airports generally spawn a local hotel industry, both on the airport grounds and in the surrounding area. Hotels serve both passengers and airline personnel, and may also be conference centers.
10. Fuel service: provision of fuel for aircraft. This involves pipeline and storage facilities, management of the fuel system, and actual fueling of aircraft (the latter included under "aircraft servicing" above).
11. Ground transport: transportation of people and goods to and from the airport is a major aspect of airport operations. Personnel include taxi and bus drivers, rapid transit personnel, and support staff.
12. Air traffic control: generally handled by a governmental aviation authority and consisting of three sectors—control of movement of aircraft taxiing on the ground (ground control), control of takeoffs and landings (tower), and control of aircraft movement while in the air between airports (air traffic control). Requires very highly trained professional staff, operating sophisticated equipment (radar, computers, communications equipment).

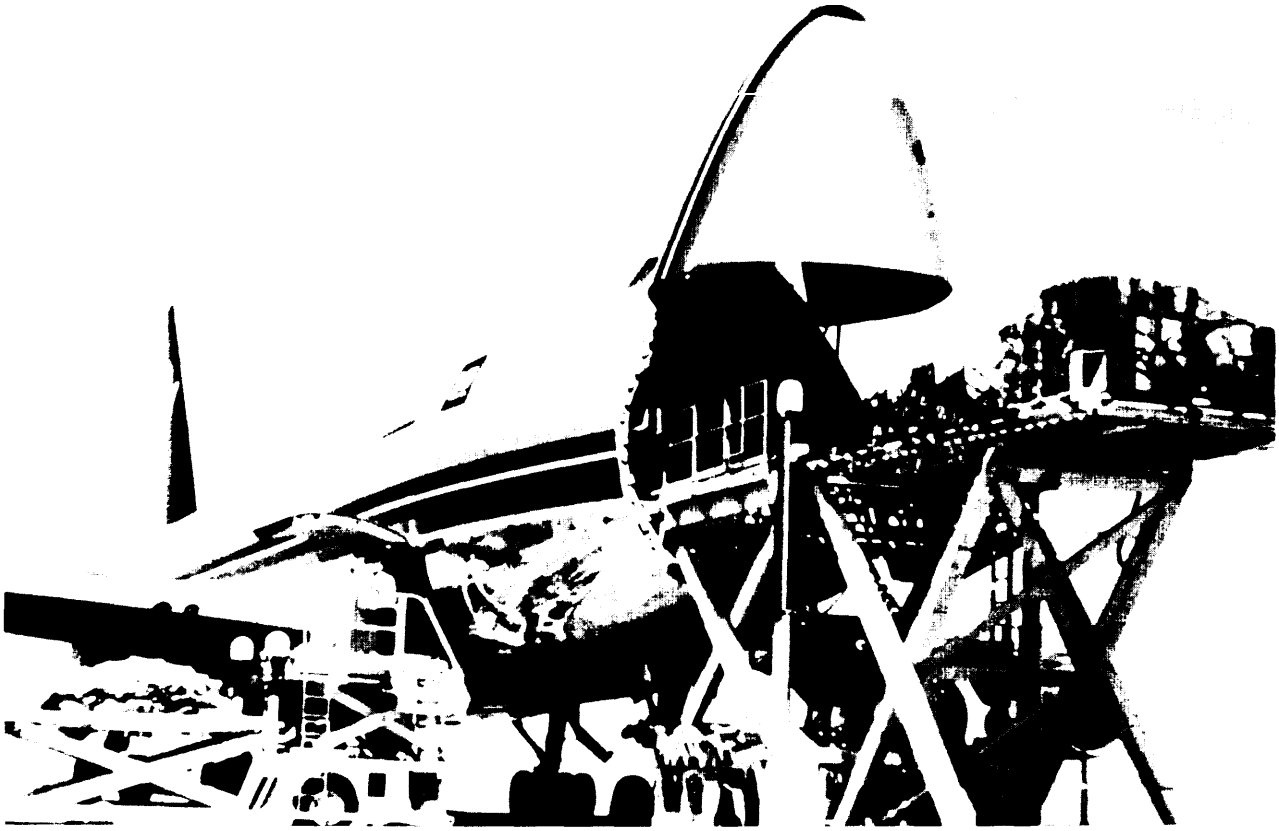


Photo credit: Saudi Arabian Ministry of Commerce

Ground-loading operations for Saudia Airlines

Strict standards in employee selection and training are essential.

Ground operations by the airlines also require considerable training. Aircraft servicing and maintenance require specific skills and training, as does passenger service to a lesser extent. Cargo and baggage handling may appear to be the least skilled aspect of ground operations, but in fact skill is required to safely handle shipments in international service which on average weigh 600 pounds. Security personnel are also a vital part of the ground operations since air cargo in storage and transit is particularly vulnerable to theft.[12] The pressure to turn aircraft around rapidly and the need to meet peak demands, add to the labor-intensity of the ground operations.

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS IN THE MIDDLE EAST: CURRENT STATUS

During recent years, the Middle East/Far East route with a load factor of 65 percent has experienced the highest passenger growth (22 percent) of all IATA (International Air Transport Association) route areas worldwide.[13] The Europe/Middle East routes remained at 1981 levels, however. Saudia ranked 17th in scheduled tonne-kilometers performed in 1982 of all 121 IATA members and had a 22.8 percent growth rate from 1981 to 1982. Kuwait Airways had a 20 percent growth rate in tonne-kilometers from 1981 to 1982. Saudia ranked 15th among the 121 IATA members in sched-

[12] O'Connor, op. cit., 1982, p. 126.

[13] The average load factor worldwide in 1982 was 64.2 percent.

uled passenger-kilometers[14] in 1982 with 12,277 million.[15] Saudia now ranks among the major international carriers, as shown in table 62. According to IATA and ICAO data, operating statistics for these six airlines in the Middle East such as revenue passenger load factor, average daily aircraft utilization, and safety are comparable in most cases to those of other national flag carriers operating internationally. Also shown in table 62 is the fact that these airlines increased operations during 1982 while several airlines from other regions of the world experienced decreased operations.

As another indication of the relative size of the airlines, table 63 gives employee totals for several airlines in 1982. Saudia airlines is by far the largest air carrier of the six study countries with total personnel numbering close to that of TWA or Japan Air Lines. The number of in-flight personnel of Saudia, however, is much lower than that of the non-Middle Eastern airlines listed. Iraqi Airways, with 4,863 total personnel, is the smallest airline included in the tabulation.

Table 64 includes airport traffic statistics for representative airports in the Middle East and the United States. Although not all international airports existing in these countries are listed in the table, relative traffic volumes can be noted. Bahrain, Qatar, and the United Arab Emirates (UAE) are included in the list since they carry significant air traffic in the region. Major international and domestic airports in the Middle East are shown in map 5.

Descriptions of the airlines of the six countries under study are given in more detail below. As a reference, relative sizes of several of the commercial airline fleets in the Middle East are given in table 65.

Saudi Arabia

Saudia, the national airline, has the greatest number of route miles of all national airlines covered in this study and has surpassed the beleaguered Middle East Airlines of Lebanon. Saudia has a fleet which includes 12 Boeing 747s, 17 Lockheed TriStar L-1011s, 9 Boeing 707s, 20 Boeing 737s, and 11 smaller planes. Saudia ordered 11 Airbus A300's to be delivered during May through September 1984.

TWA and Saudi Arabia have been associated in civil aviation since 1945 when President Roosevelt gave a DC-3 to Saudi Arabia's King Saud. The first contract was signed in 1946 between TWA and Saudi Arabia with subsequent ones through 1984. TWA participated extensively in the management and operations of the airline in the early period, but since 1979 its involvement has decreased markedly. With the new 1984 contract, the Saudis have taken over management of the airline. A successful program of training and upgrading of facilities and personnel led to gradual "Saudization" of the work force even while the company was expanding at a faster rate than any other national airline in the world. During the 1970's, Saudia had neither sufficient fleet nor personnel and facilities to accomplish the task of moving foreign workers in and out of the country. The main airports at Jeddah, and Riyadh especially, used aged facilities designed for the DC-6 era. Temporary airport buildings were rushed to completion within 18 months and by late 1976 the airline began to lease aircraft and integrate them into operations on a temporary basis. Some leased aircraft, mostly Boeing 747s and Douglas DC-8S, still are being used, usually during the annual Haj pilgrimage.[16]

Saudi Arabia is continuing its large-scale airport expansion projects which include both international and domestic airports. Eleven domestic airports will be upgraded to handle increased passenger traffic at a cost of approx-

"Scheduled passenger-kilometers is the sum of the products obtained by multiplying the number of passenger seats scheduled by flight distances measured in kilometers.

"International Air Transport Association, *World Air Transport Statistics*, No. 27, 1982.

"The Haj is the pilgrimage of Muslims from all over the world to Mecca, located in Saudi Arabia.

Table 62.—Operating and Performance Statistics of Selected Airlines for 1982

Country	Airline	Passengers		Tonne-kms performed		Available tonne-kms		Load factor	
		000s	± change	Millions	± change	Millions	± change	Passenger	Weight
Saudi Arabia	Saudia	10,060	41.9%	1,478	22.8%	3,047	12.4%	64.2%	48.5%
Kuwait	Kuwait Airways	1,461	16.6	456	19.9	849	6.7	65.7	53.6
Egypt	EgyptAir	2,433	9.2	395	14.1	702	2.6	60.3	56.3
Algeria	Air Algeria	Not reported							
Iran	Iran Air	2,009	30.5	215	15.7	352	22.0	67.3	61.6
Iraq	Iraqi Airways	481	5.2	187	12.7	388	20.3	59.3	48.2
United States	TWA	17,854	–1.6	4,429	–1.5	8,149	–2.1	63.9	54.3
United States	Eastern Airlines	35,500	–1,4	4,334	–1.0	8,014	–2.5	57.7	54.1
United Kingdom	British Airways	14,838	–3.1	4,310	–6.4	6,827	–6.9	67.4	63.1
France	Air France	11,584	0.2	4,218	1.8	6,765	3.8	64.1	62.3
Federal Republic of Germany	Lufthansa	12,775	–1.5	3,746	4.4	6,317	8.5	59.6	59.3
Japan	Japan Airlines	13,329	–4.4	4,993	3.2	8,125	–4.6	62.5	61.4
Total[a]		384,610	–0.9%	87,529	0.4%	152,901	–0.3%	62.0%	57.2%

Note: ± is percent change from previous year data
[a]Total industry value for IATA Members in 1982 based on approximately 121 IATA member airlines

SOURCE: International Air Transport Association. *World Air Transport Statistics, No* 27 1982

Table 63.— Employee Totals for Representative Airlines, 1982

Country	Airline	Pilots and copilots	Other cockpit personnel	Cabin attendants	Maintenance and overhaul personnel	Ticketing and sales personnel	Traffic-handling personnel	All other personnel	Total Number	Total ± change over 1981
Saudi Arabia	Saudi	670	216	2,671	4,014	2,626	5,437	8,096	23,730	5.70/o
Kuwait	Kuwait Airways	174	76	487	1,808	1,139	734	2,113	6,531	4.9
Egypt	EgyptAir	251	81	633	1,981	—	—	6,537	10,731	4.2
Algeria	Air Algérie	Not reported								
Iran	Iran Air	193	81	721	1,378	882	2,253	4,027	9,535	–2.7
Iraq	Iraqi Airways	136	120	330	1,958	390	478	1,451	4,863	4.3
United States	TWA	1,802	971	4,905	7,051	3,752	7,739	3,024	29,244	–4.3
United States	Eastern Airlines	2,839	1,212	5,987	10,228	5,036	10,324	4,325	39,951	–0.7
United Kingdom	British Airways	2,104	447	4,375	9,009	3,376	8,943	9,700	37,954	–15.8
France	Air France	1,320	771	4,239	8,767	—	—	—	34,537	2.8
Federal Republic of Germany	Lufthansa	1,564	562	3,938	8,353	4,361	6,603	5,331	30,712	0.1
Japan	Japan Air Lines	1,355	646	5,132	4,951	3,575	3,449	2,632	21,740	0.9

SOURCE: International Air Transport Association, *World Air Transport Statistics, No 27, 1982*

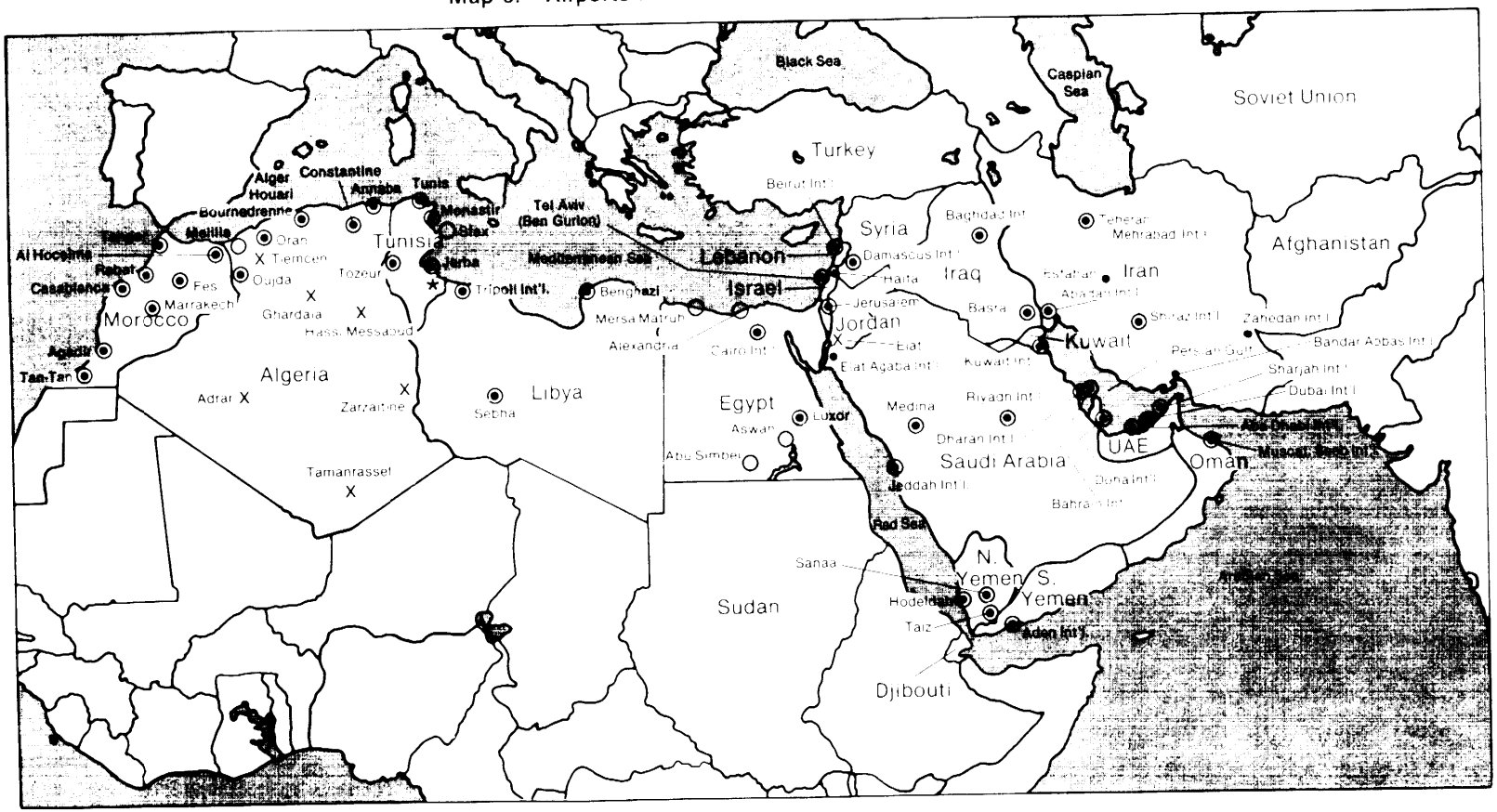
Table 64.—Airport Traffic Statistics for Representative Airports (1981 unless otherwise noted)

State City Airport	Aircraft movements (000) Commercial air transport	Passengers (000 embarked and disembarked) Total	 International	 Domestic	Freight (000 of tonnes) Total	 International	 Domestic	Mail (000 of tonnes) Total	 International	 Domestic
Saudi Arabia:										
Jeddah[a]										
Jeddah International ...	87.5[b]	7,505	3,499	4,006	478	350	12.8	NA	NA	NA
Kuwait:										
Kuwait[c]										
Kuwait International	273	2,376	2,376	0	55.1	551	0	2.2	22	0
Egypt										
Cairo										
Cairo International . .	518	5,239	4.741	498	568	563	05	NA	NA	NA
Algeria:										
Algiers										
Dar El Beida .,	401	2,870	1.520	1,350	32.2	28.4	38	NA	NA	NA
Iran:										
Teheran										
Mehrabad International	158	1,689	283	1,406	39.1	33.7	54	17	16	01
Iraq:										
Baghdad										
Baghdad International	6.3	618	618	0	16.7	167	0	05	05	0
Bahrain"										
Bahrain										
Bahrain International[a]	38.2	1,588	1,588	0	174	174	0	15	15	0
Qatar:										
Doha										
Doha International .,	156	662	662	0	16.7	167	0	0.5	05	0
U .A. E.:										
Abu Dhabi										
Abu Dhabi International[a] . .	347	924	899	25	261	NA	NA	NA	NA	NA
United States:										
Washington, D.C.										
Dulles International .,	29.2	2,133	377	1,755	23.2	114	118	179	2.3	157
United States:										
San Francisco, Cal If.										
San Francisco International .	2686	19.848	2!170	17.678	3179	NA	NA	1051	NA	NA
United States:										
Philadelphia, Pa										
Philadelphia International .,	255.6	9,009	468	8,540	933	8.9	843	459	05	455

NOTE Totals may not add up due to rounding
[a]1980 statistics. Complete data not available for the King Abdul Aziz airport but later 1981 data imply a rate of over 100.000 total commercial air transport movements per year
[b]1978 data point
[c]Kuwait as a city-state has no domestic air servlces
NA—not available

SOURCE International Civil Aviation Organization *Airporl Traffic– 1981 Digest of Statistics No 287 1982*

Map 5.—Airports in the Middle East and North Africa



Key

- ◉ Airports required for regular use by international scheduled air transport
- • Airports required for alternate use by international scheduled air transport
- X Airports required for regular use by international non-scheduled air transport
- ★ Airports required for alternate use by international non-scheduled air transport
- ○ Airports required for regular use by international general aviation

NOTE: The delineation of boundaries on this map must not be considered officially accepted. Geographic names or their spellings do not necessarily reflect recognition of the political status of an area.

SOURCE: Office of Technology Assessment, taken from *Air Navigation Plan, African-Indian Ocean Region*, Department of Commerce (CAO DOC 7474/23, August 1980) and *Air Navigation Plan, Middle East and Asia Regions*, Department of Commerce (CAO DOC 8700/13, August 1982).

Table 65.—Commercial Airline Fleets in the Middle East in Service as of March 1984 (on order as of March 1984 in parentheses)

Country	Airline	Boeing						Douglas	Lockheed	Airbus		
		707	727	737	747	757	767	DC8	L1011	A300	A310	A320[a]
Saudi Arabia	Saudia			9	—	20	12 — —		6[b]	17	(11)	
Kuwait	Kuwait Airways			7	4	—	4 —				(3)	3(5)
Egypt	EgyptAir	6		7			(3)[c]				8	
Algeria	Air Algérie		11	13							2[d]	
Iran	Iran Air			5	10	4	10				6	
Iraq	Iraqi Airways			3	6	3	4					
Bahrain, U. A. E., Oman, Qatar	Gulf Air			9					*8*			
Lebanon	Middle East Airlines	7[e]		3							*(5* plus 14 options)[f]	
Libya	Libyan Arab Airlines		4	10							(6)	(4)
Jordan	ALIA			5	6	3			5			
Syria	Syrianair		3		2							
Cyprus	Cyprus Airway s	4									*1 (2)*	*(4* plus 4 options)
Totals (existing and firm order)				50	45	59	35 0	(3)	6	30	16(20)	4(16)	(4)

[a] The development funds for the Airbus A320 were approved by the consortium in March 1984
[b] Leased from Overseas National and Icelandalr.
c These three *Boeing 767* extended range versions due to be delivered July 1984.
[d] Leased from Lufthansa.
[e] MEA previously had 18 707s (IATA, WATS 1982) but 6 were *destroyed and 5 extensively damaged in* the Lebanon Conflict
f These may have been canceled, although the contract has not been formally *abrogated, according to the M/dd/e East Economic Digcst,* Feb 3, 1984, p 35

SOURCE Taken from Exxon International Co , *Air World Survey—Turbine-Engined Fleets of thre Worlds' Airlines 1983.* Florham Park, N J and OTA communications with Boeing Commercial Airplane Co Ren.-ton, Wash , and Airbus Industrie, N.Y., March 1984, Note that "firm orders" for a particular jet and "options" in particular can be fairly volatile numbers The 707, 727, DC8, and L1011 are no longer in production.

imately $295 million. At five airports (Medina, Gassim, Gizan, Abha, and Tabouk) the expansion is designed to accommodate wide-body jets (Lockheed TriStar and Airbus) which will be equipped to meet the highest international navigational standards. At the smaller airports, the projects are designed to accommodate Boeing 737 aircraft instead of Fokker F28s. These airport projects in rural areas were originally tendered in 1983. However, in 1984 it was reported that the Presidency of Civil Aviation (PCA) was retendering these domestic airport expansion projects in order to economize on expenditures.[18]

Saudi Arabia's major international airports consist of: Dhahran International, Jeddah International, and Riyadh International. Presently, only Saudia calls at King Khalid International Airport (KKIA) at Riyadh, but KKIA will soon open to international carriers according to Civil Aviation President Sheikh Nasser Al-Assaf.[19] Pan American Airways and Saudia presently operate a joint service between New York and Dhahran. Saudia also now flies to New York from Jeddah. Foreign carriers which serve Jeddah or Dhahran include Alitalia, Air France, British Airways, Lufthansa, Middle East Airlines, and Iran Air. Some 44 airlines now fly into Saudi Arabia, and Saudia flies to major European, North African, Arab, and South Asian cities.

Riyadh's King Khalid International Airport was completed in 1983 at a total cost of about $3.2 billion. It began receiving commercial flights on December 5, 1983.[20] The airport was designed to handle 7.5 million passengers in its first year while it was still in the first stages of initiating its operations. The number will reach 18 million passengers annually by the year 2000.[21]

Servicing the pilgrimage, with its 800,000 visitors, more than 70 percent of whom travel in and out by air, is the second most important task for Civil Aviation, after supplying facilities for national needs. During the 45- to 60-day period preceding and following the Haj pilgrimage period to Mecca each year, the traffic density at Jeddah airport approaches that of some of the busiest U.S. airports, such as O'Hare in Chicago. Hundreds of charter flights, many by airlines not normally servicing the Kingdom, must be guided to safe landings and their airplanes serviced rapidly. It is a unique problem, and the Saudis have increased their use of modern computer techniques both to handle the aircraft and the pilgrims themselves. The Jeddah airport in its design and operations thus represents adaptation of commercial aircraft support systems to local requirements.

Egypt

Cairo is among the most active air centers in the Middle East and is served by a number of international air carriers. Egypt's one international airport is located in Cairo. Facilities at the Cairo airport are to be expanded to handle a projected fourfold increase in passenger traffic and rapidly increasing air freight tonnage. Alexandria's El-Nouzha Airport, located on the eastern outskirts of the city, resumed scheduled operations for domestic flights in late 1980. The airport has two operational runways, one of which will be lengthened to accommodate international flights.

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[18] "*Saudi Business,* Oct. 16-27, 1982, and Oct. 23-24, 1982; Saudi *Report, Nov. 29,* 1982.

"It is also believed to be the first case of a retendering prompted by King Fahd's recent decree that all government tenders must be announced publicly. "Airport Expansion Projects To Be Retendered, ' *Saudi Business and Arab Economic Report, No. 6,* May 28, 1983, reported in JPRS, Near East South Asia, June 30, 1983. I t is reported that Saudi Arabia may revise a portion of its ambitious airport modernization program because of anticipated cuts in government spending due to decreased oil revenues. This is not, however, expected to stop any of the large construction or upgrade plans included in the latest phase of airport modernization, but it may result in a scaling down of certain programs, such as those in the Eastern Province. See Jeffrey M. Lenomvitz, ''Slack Oil Funds May Force Saudis To Cut Airport Plans, " *Aviation iJeek and Space Technology,* May 21, 1984, pp. 41-45.

[19] Tony Odone, ''KKIA: Beginning a New Phase in Saudia Arabia, " *Middle East Economic Digest, Nov.* 11, 1983; *Saudi Report, Nov. 29,* 1982.

[20] "Jim Bodgener, "U.K. Airlines Battle for KKIA Rights, " *Middle East Economic Digest,* Sept. 11, 1983, p. 38; Jan. 27, 1984, p. 26.

[21] "'King Fahd Opens the King Khalid International Airport: A Tour Through Riyadh's New Airport, Which Is One of the Biggest in the World, " *Al-Majallah, No. 196, Nov. 12-18, 1983,* pp. 18-21, as reported in JPRS, Near East/South Asia, Jan. 30, 1984.

Photo credit. Aramco World Magazine

Haj Terminal, King Abdul Aziz International Airport, Jeddah, Saudi Arabia. The roof structure is evocative of bedouin tents

The national airline, EgyptAir, has six 707s (plus two more leased), seven 737s, eight Airbus A300s, two Fokker F-27s (leased), and two Cessnas." EgyptAir (formerly United Arab Airlines) has been operating since 1931. It provides flights to about 40 cities in Europe, Asia, Africa, and the Middle East. The airLine is considering the creation of an all-cargo subsidiary. A private cargo company, International Air Cargo Corp., was formed in early 1977."

Algeria

Algeria has a relatively good transportation network and is devoting substantial resources to its expansion and modernization. Algeria's international airports consist of Dar el Beida in Algiers, Annaba, Ain-el-Bey in Constantine, and Es Senia in Oran. Other major airports are located in Bechar, Hassi Messaoud, In-Salah, Tamanrasset, and In-Amenas. Fifty-five smaller airports are located across the country.

Air Algérie, the state-owned and operated airline, continues to expand its international services. At the end of 1981, Air Algérie was operating a record 250 scheduled domestic flights weekly, for cargo as well as passengers." Its fleet consists of 11 Boeing 727s, 13 Boeing 737s, and 3 Lockheed Hercules aircraft as well as 42 Beechcraft and Grumman aircraft for crop spraying, pipeline surveillance, and other purposes. Most of the equipment in Algerian civil aviation is made by U.S. firms," although Air Algérie leases two Airbus A300s from Lufthansa.

The leading foreign suppliers rank ordered by total sales in 1979-82 were the United States (aircraft and engines, $165 million), India, Belgium, and Hungary. By total expenditures since 1979, civil aviation projects ranked second for Algeria among the five technology sectors studied in this assessment ($265 million from 1979-82). This was a significant rise over the total value of contracts awarded during the 1972-78 period ($5.7 million). In addition, the absolute number of contracts approved in the later period was higher than the number approved in the earlier 1972-

22 International Air Transport Association, *World Air Transport* Statistics, No. 27, 1982; also personal communication, Airbus Industrie, New York, March 1984.

"U.S. Department of Commerce, *Overseas Business Reports, OBR* 81-31, "Marketing in Egypt," December 1981.

"U.S. Department of Commerce, *Foreign Economic Trends, Algeria 198.2,* p. 11.

' 'Information provided by` the U.S. Embassy, Commercial Section, Agiers, 1982.

78 period, reflecting the Algerian Development Plan's emphasis on transportation.

Kuwait

Kuwait, as a city state, has one international airport and no domestic airline routes. Its international airport has recently been expanded to handle 4 million passengers and 30,000 tons of cargo per year.[26]

Kuwait Airways, the national airline, has four 747s, seven 707s, four 727s and two Hawker Siddeley HS 125s. Kuwait Airways owns three Airbus A310s and has five more on order. Three Airbus A300s are also on order. This company has the fewest route miles of the six national airlines covered in this study. Kuwait Airways is an independent line item in the Kuwaiti budget; it is given a subsidy and capitalized as an extraordinary item. Operating losses in 1980 reached $33.3 million, reflecting the fact that flying expenses increased by 56 percent in 1 year, 1979-80, due partly to aviation fuel cost increases.

Passenger traffic grew between 1976 and 1980 by 45 percent, while freight traffic grew by 160 percent. The airline's capital has been substantially raised to permit purchase and amortization of the first six Airbuses scheduled to be delivered in 1984. In addition to Kuwait Airways, Kuwait is served by Gulf Air, Saudia, Iran Air, British Airways, Air France, KLM, and Lufthansa.

Iraq

Iraq's international airport is located in Baghdad. The first phase of the new Saddam Hussein Airport has now been completed, and as of 1980, work was underway on a new international airport at Basra. The present status of both these projects, however, is uncertain, due to the war with Iran. In the north, an international airport at Mosul is under design.[27]

Iraqi Airways presently has three 707s, six 727s, three 737s, and four 747s. Iraqi Airways ranked 44th out of 121 IATA members in 1982 international tonne-kilometers performed, but it grew 12.7 percent by the same indicator during the 1981-82 period.

Iran

Iran has international airports in Abadan, Esfahan, Teheran (Mehrabad International), Shiraz, and Zahedan. There are 36 major and secondary domestic airports open to civil aviation, Iran Air, the national flag carrier, was founded in 1962, taking over limited freight and passenger operations from two private companies. Its load factor grew appreciably, and in 1977 it served 25 different domestic airports and provided services in international routes to 24 different countries in North America, Europe, and East Asia. Iran Air has five 707s, ten 727s, four 737s, ten 747s, and six Airbus A300s. Iran Air ranked 50th out of 121 IATA members in 1982 scheduled tonne-kilometers performed and 49th in scheduled passenger-kilometers.

Regional Efforts

There are a number of regional efforts to develop commercial airlines and support systems in the Middle East. These include technical assistance programs, as well as one regional airline company, Gulf Air, which is jointly owned by four Middle Eastern countries.

Many technical assistance programs are being pursued with foreign participation. The U.S. Federal Aviation Administration (FAA), for example, is presently conducting technical assistance programs promoting the regional development of commercial aircraft support in the Middle East. These include assistance in design and development of the Kuwait International Airport, where the National Aviation System has two resident U.S. advisors. In Saudi Arabia, the FAA runs Saudi airman certification services for the Boeing 707/737/747 and the Lockheed L-101 1. During the period 1951-82 the FAA trained over 550 personnel in the six countries under

[26] U.S. Department of Commerce, *Overseas Business Reports*, OIIR-79-18, " 'Marketing in Kuwait. " June 1 979.

[27] Information provided by the U.s. Department of Commerce, 1 nternational Trade Administration, Feb. 10, 1983.

study in air traffic control, air navigation facilities, airport services, and flight standards.[28]

AACO (Arab Air Carriers Organization) has attempted to organize an aircraft spare parts pool similar to those in Europe such as the ATLAS (Boeing 747) and KSSO (DC-10), but the results have been mixed. Saudia is the holder of L-1011 spares at Jeddah, but Lockheed spares are also stored in Amman, Jordan by TriStar Parts Ltd.[29]

The IATA Program for Developing Nations Airlines (PDNA) assists airlines in developing countries in funding for individual or joint airline projects and in arranging and coordinating consulting and airline training services.[30] A training seminar, sponsored jointly by AACO and IATA, was held in Amman, Jordan in April 1983. The basic purpose was to determine the specific training needs and priorities of airlines in developing countries and to establish the foundation for a comprehensive PDNA training program in the future. In addition, initial steps have been taken to explore the possibility of conducting detailed feasibility studies for a Regional Airline Training Center in Amman.[31]

ICAO also promotes civil aviation in developing countries worldwide. A major instrument in this work is the United Nations Development Program. So far, most of the organization's work in this area has been directed toward the development of the ground services required for civil aviation and in particular air traffic control, communications, and meteorological services. [n the past few years, with the advent of larger and more complex aircraft, requests for assistance are increasingly in the more sophisticated fields of aviation. Assistance has been provided in the organization of government civil aviation departments and the location and operation of facilities and services, particularly personnel training. In Egypt and other Middle Eastern countries civil aviation training centers have been created or assisted.

Gulf Air is a joint venture between Bahrain, Qatar, the UAE, and Oman. Gulf Air was founded in 1950 as Gulf Aviation Co. and was nationalized in 1974 to become the flag carrier for the four countries.[32] It is now one of the region's largest passenger carriers, carrying numbers of passengers comparable to Iran, Air and EgyptAir. After rapid expansion in the 1970's, the airline plans to consolidate certain operations in the 1980's and must cope with problems such as the worldwide trend toward fare deregulation, and overcapacity due to increased competition on Gulf routes. Overcoming difficulties which included lack of infrastructure and competent personnel, Gulf Air realized a small profit in 1979 which steadily increased to $10 million in 1980, $19.4 million in 1981, and $34 million in 1982.[33] Gulf Air has recently expanded its network somewhat. In 1982, it started flights to Amman, Jordan and Larnaca, Cyprus, reopened a link to Athens, and inaugurated a London-to-Cairo service. By the end of 1982 it was operating a fleet of eight Lockheed L-1011 TriStars and nine Boeing 737s.[34]

Historically, the dominant airline in the region was Middle East Airlines (MEA) of Beirut. It was largely responsible for making Beirut the hub of international air travel to the Middle East. In 1979, Lebanon began a

[28] Quentin S. Taylor and J. Stuart Jamison, "FAA's International Training Programs, " *Journal of Air Traffic* Control, October-Dececember 1982, pp. 6-9.

[29] These spare parts generally include only airframe line replaceable units, with engine parts inventories held elsewhere. Information provided by TriStar Parts Ltd., January 1983.

[30] See for example International Air Transport Association, "Consultancy and Training Services Directory, " first edition, Nov. 1, 1981; "IA TA-Improved Productivity Through Common Effort, " August 1982; and "Wings for the Developing World, " 1982. As stated by IATA, the basic objective of the PDNA is "for member airlines to develop self-reliance, thereby strengthening the global commercial air transport system.

[31] IATA Annual Report and Executive Committee Report, 1983, p. 24.

[32] "'Gulf Air: Flying Against the Flag, " *Middle East Economic Digest Special Report,* September 1981, pp. 41-43; and Dudley Nigel, "Gulf Air: A Servant of Four Masters, " *Middle East Economic Digest, Mar. 21, 1980,* p. 10.

[33] Ibid.; and "Gulf Air's Profits Fly Against the Trend, *Middle East Economic Digest,* vol. 27,-Issue 4, Jan. 28, 1983, pp. 8-9, and "Gulf Air Posted 34 Million Dollar Profit in 1982, " An-Nahar Arab Report and Memo, vol. 7, Issue 27, July 4, 1983, p. 8.

[34] "'Arab Airlines: Co-Operation in the Face of Competition, " *Middle East Magazine–Aviation Survey,* August 1983.

$300 million program to expand and modernize Beirut airport, and in 1980 MEA announced its planned fleet expansion would include the purchase of five Airbus A310 aircraft, plus an option for 14 more. MEA survived the civil war of 1975 and the political instability in the late 1970's, but the 1982 war in Lebanon caused severe problems for the carrier. MEA lost six Boeing 707s and another five may be scrapped because of extensive damage. In addition, its ground facilities were damaged in the fighting. Insurance will provide only a small portion of the replacement costs, due to the restrictiveness of war risk coverage. The airline reportedly began to base its operations from Larnaca, Cyprus instead of Beirut. MEA does apparently plan to replace the aircraft lost and to continue its fleet modernization/expansion program based on the A310. The war has, however, eroded Beirut's position as a gateway, and MEA as a major factor in Middle East commercial aviation.

PERSPECTIVES OF RECIPIENT COUNTRIES AND FIRMS

Keeping an airline fleet operating is a technically demanding business. This section first outlines requirements for maintenance of commercial aircraft, reviews training programs associated with aircraft sales, and discusses the requirements such as airport design. Next, the experiences of six Middle East countries are analyzed in order to assess the extent of technology absorption and the significance of commercial airline support systems in their economic development programs.

Requirements for Commercial Aircraft Operation

Routine Maintenance.–Each aircraft model has a routine maintenance program for operation in scheduled service. Routine maintenance tasks consist primarily of inspection of the airframe, engines, systems and components to assure safety and satisfactory operation of the aircraft. Such routine maintenance is carried out by the individual Middle Eastern airlines.

Usually, these routine inspections or checks" are based on flight hours and are called Preflight, Transit, A, B, C, and Structural Inspection checks. The Pre-flight check is performed each morning prior to dispatch and anytime the aircraft is on the ground for more than 4 hours. The Transit check is performed before each flight, usually in a "walk-around" inspection. The flight crew can perform this check if maintenance personnel are not available. The A, B, C checks are called scheduled checks since they are performed at specific time periods. Each operator develops and obtains approval for his pattern of scheduled checks, but in broad terms the A check usually is performed approximately weekly (every 100 hours) with the B check interval four times that of the A (every 400 hours) and the C check interval four times that of the B.[36]

In order to avoid peaks and valleys in maintenance work and numbers of personnel, the checks are often combined into a "phase' check which consists of elements of all three checks, e.g., A + B/2 + C/8. There are many variations of these phases, normally established to correspond to a particular operational schedule.

Each inspection generates additional maintenance not part of the routine maintenance. A complete maintenance cycle includes these routine checks as well as major overhaul (structural inspection). Over the course of a complete maintenance cycle, nonroutine maintenance man-hours approximately equal the routine maintenance man-hours.

The number of personnel required depends on the type of check being performed and the

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"The maintenance check is defined as a maintenance action requiring thorough examination of an item, component, or system for general condition with emphasis on proper attachment, safety wiring, cotter pins, fasteners, clamps, latches, tubing, plumbing, electrical wiring and connctions, linkages, bearings, alignment, clearances, lubrication, obvious damage cracks, delamination, fraying, operating pressures, fluid leakage, excessive wear or play, corrosion, evidence of overheating, rubbing, aging, preservative coating or finish, cleanliness, and general appearances.

"The Structural Inspection (or airframe overhaul) is usually performed at intervals 10 times that of the C check, or, in the example noted— 16,000 hours. Major overhaul is discussed below.

length of time the aircraft is available for maintenance. The size of the aircraft also determines maximum crew size. The Boeing 747, for example, requires a maintenance crew approximately twice the size of that required for the 737. While a Pre-Flight or Transit check can be performed with as few as three to five people, a Phase (or C check) could require up to 50 people (for a 747) or 25 (for a 737).

Crews must include personnel skilled in airframe and systems, powerplant, electrical, avionics, sheet metal, and interiors. These personnel must include some who are licensed to work on and, particularly, to signoff work for release of the aircraft to operations. Crew composition for a scheduled maintenance crew should be approximately 50 percent airframe and system mechanics, 20 percent engine specialists, and the remainder equally divided among electrical/electronic, radio, instruments, sheet metal, interior, and quality control specialists. Additional specialists from the operator's maintenance shops are utilized on an "as-required" basis on airplane checks. The suggested ratio of licensed personnel to skilled is approximately 1 to 3.

Each operator, if purchasing an aircraft from a company such as Boeing or Airbus, receives information in the form of documentation, complete drawings and verbal briefings, as to the ground support equipment required to maintain the airplane. The specifications and/or engineering drawings of equipment required to maintain a particular aircraft model are supplied to the buyer as part of the sales package. The buyer can purchase equipment through the seller, from outside sources, or can manufacture the equipment. Availability of equipment or manufacture of equipment at a particular operator's maintenance base depends entirely on the industrial capabilities of the local area. In most areas in the world, there are local industries capable of manufacturing the required equipment. Provisioning of equipment, whether through the aircraft seller, or from other sources, is a separate negotiation. A potential customer can include these costs in the total package.

Photo credit Saudi Arabian Ministry of Commerce

Jet turbine engine repair

Maintenance provisions and their costs can be very important in making an aircraft sale. Equipment investment forecasts are performed regularly for presentation to potential customers, Since spares and ground support equipment investment and maintenance costs comprise about 20 to 25 percent of an airline's operating costs, improvements in methods of maintenance, extensions in maintenance schedules, and reductions in numbers of special tools and equipment required are factors influencing sales. Over the life of an airplane, spare parts sales can easily equal the purchase price of the airplane. Efficient management of spare parts inventories has become increasingly important, due to the high costs of maintaining excessive stock and the long leadtimes required for obtaining certain aircraft parts.

Major Overhaul.–Major overhaul is costly and technically demanding. A fleet of approximately 15 airplanes is normally required to justify establishing an overhaul center, but there are many other considerations such as fleet composition, age, and engine types. The only major overhaul center presently in the Middle East is in Saudi Arabia. Despite attempts to establish a regional center, such a facility has not been set up, and seems unlikely in the near future.

A major overhaul of an aircraft is usually considered to be a structural inspection, during which the airplane is moved into a hangar with built-in work stands (or docks) which allow ac-

cess to all areas of the airplane. The aircraft is lifted on hydraulic jacks high enough to allow landing gear retraction and extension. The interior furnishings (seats, galleys, and lavatories) are removed and interior wall and ceiling paneling and insulation are taken out. Components are removed, serviced, or repaired as required.

Personnel required to staff a major overhaul center include those skilled in engineering, training, production planning, quality control, spares planning and procurement, and shop personnel skilled in many different functions, such as electronics, welding, instruments, nondestructive testing, sheet metal, machining, and plastics repair. A total of approximately 450 people is required to staff such a maintenance base.

Guidelines for major overhauls in the United States are established by the FAA, and these guidelines are also used in the Middle East, region. Frequency of major overhaul depends on the operator's approved maintenance schedule and on flight hours. Boeing recommends a major overhaul at 16,000 flight hours for the 737 airplane. A structural inspection would be performed every 6 ½ years for an operator flying 7 hours a da-y, 2,500 hours per year. [38]

Many operator-s contract to perform all levels of maintenance including structural inspection for Middle Eastern airlines. The structural inspections are performed mainly in Europe or the United States, but there are facilities available in the Far East and other parts of the world. Normally, the operator determines where and how much contract maintenance will be carried out.

Training Programs Associated With an Aircraft Sale.— Through training, airlines seek to become self-sufficient in aircraft operation and maintenance. Training thus directly contributes to technology absorption. Generally speaking, the smaller the airline the greater the need for follow-on training as the pool of experienced personnel and trainers is smaller.

A comprehensive and professional training program is considered extremely important to the sale of aircraft. While a superlative training program will not win the sale, lack of such a training program can significantly contribute to loss of a sale. I n the competitive environment of commercial aircraft sales. this fact is well known, hence all suppliers stress training in their packages. Because of this, no one supplier has a significant advantage over competitors because of the training programs offered.

Personnel training associated with the sale of a commercial aircraft generally includes both flight operations and maintenance.[39] A typical training program offered by major aircraft manufacturers and included in the price of an airplane consists of: 1) flight operations, usually including complete training for a certain number of flight crews,[40] dispatchers, and flight attendants: and 2) maintenance training, usually including training in airframe and systems, electrical systems, avionics systems, corrosion prevention, and control, and post delivery practical maintenance training.

The three major U.S. aircraft manufacturers provide about the same level of flight operations training support. Of the three, Boeing is the most prominent in the commercial airline field, with Lockheed (maker of the L-1011) no longer producing commercial aircraft. (The McDonnell Douglas DC-10 jumbo jet is out of production except for a military version, but

[38] U .S Code of Federal Regulat ions, 1317, Federal A viation Administration, Title 11 Aeronautics and Space— Part 43, Appendix A Major *Alterations, Mojor* Repairs,. and Preventive *Maintenance, p. 624 ff.* Only *two systems for overhaul are used* i n the world, the [.S. f+'/\ A system and a British system, wit h the FA)1 system dominating worldwide. IATA and 1(' AO do n ot prom ulgate overha u l specifications

[38] For a Boeing 747 it is recommended that a major overhaul Occur a fter 20,000 hours H owever, the 747 normally flies longer flight segments Assuming 12 hours per day utilization, or 4, 400 hours per year, t he inspect ion would be performed ever y 4 . years

[39] Personnel trained for flight operations include: pilots, flight engineers, performance engineers. dispatchers, f] igh [att (,11(l ants, instructors supervisors, and load masters bo M m operat ors Personnel trained for maintenance include: electricians, airframe and systems specialists, avionics specialists, and in structors supervisors.

[40] The typical cockpit crew consist s of a pilot, first officer (copilot) and flight engineer. Some of the newer planes such as t 11(I Douglas M I)-80 or Boeing 767 require only t wo people, namely t he pilot and copilot This is due to improved instrumentation and more automatic features.

their MD-80 142- passenger airliner, previously called the DC-9-Super 80, is still being produced.) The amount, type, and technological sophistication of training techniques in courses offered by Airbus are roughly comparable to that offered by Boeing in both flight crew and line maintenance training.

Most airplane customers have a significant number of options with respect to brand names of equipment, control and functions of the avionics equipment and numbers of "systems" to be installed in their aircraft. Much of the avionics equipment is used by several different airplane manufacturers. The new integrated digital avionic systems introduced in the Boeing 757/767, McDonnell Douglas MD-80, and Airbus Industrie A310, for example, are expected 'to have an impact on air carrier operations equal to the introduction of radio navaids (navigational aids) and two-way voice radio half a century ago."[41] In this case, the entire collection of avionic sensors and subsystems has been designed to function as an integrated flight control and management system. This will enhance operational efficiency and flight safety and ease flight crew work load.

Aircraft companies generally provide training in the Middle East similar to programs provided to customers in other developing or developed regions. From a flight crew viewpoint, there is not much variance among operators arising from special qualifications required to fly a specific aircraft. At the request of the customer, courses can be extended to deal with language difficulties. All Middle Eastern students must, however, meet minimum requirements before attending maintenance training courses.

According to U.S. industry experts, training of personnel in aircraft maintenance and operation in the Middle East has proceeded successfully. From a flight operations viewpoint, Middle Eastern students generally are well educated and have sufficient knowledge of English to permit efficient and effective training. (Since all flight and maintenance classes are taught in English, training time and efficiency depend on the English fluency of the students.) Language problems in aircraft operations training are usually most noticeable in the case of ground support personnel.

Egypt and Algeria have the largest numbers of nationals maintaining their aircraft, while the Saudis and the Kuwaitis the smallest. Since being a mechanic is not a prized occupation in these latter two countries, reliance on Pakistani, Egyptian, Jordanian, and Palestinian mechanics will probably continue far into the future.

Airport Development. – In the Middle East, some of the world's newest and most technologically sophisticated airports have been built to accommodate expanded airline operations. Several of the newer, larger airports in the Middle East have been planned, designed, and sometimes constructed by foreign consultants and contractors.

The selection of a site suitable for a new airport normally depends on certain criteria which are also applicable to the expansion of existing airports. The location of an airport is generally influenced by the following factors: 1) type of development of the surrounding area, 2) prevailing weather conditions, 3) accessibility to ground transport, 4) availability of land for expansion, 5) presence of other airports in the general area, 6) surrounding obstructions, 7) economy of construction, 8) availability of utilities, and 9) proximity to urban centers. These factors vary greatly among the Middle Eastern countries.

The design of the passenger terminal complex must accommodate different types of users—passengers, visitors, airlines, airport operators, and concessionaires. Different design objectives, and consequently criteria, can be identified for the different users. The most

[41]"New Avionic Systems offer Efficiency, Safety Benefits,' Aviation *Week* and Space Technology, Apr. 19, 1982, p. 52. Training programs for the use and maintenance of avionics packages at the "line maintenance" (or systems) level are modified for each customer. The "shop level" (or test repair overhaul level) is not considered as critical, and courses generally teach ''typical configuration components to several customers at a time.

important evaluation criteria for passenger terminal planning are: 1) ability to handle expected demand, 2) compatibility with expected aircraft types, 3) flexibility for growth and response to technology changes, 4) compatibility with prevalent ground access modes, 5) compatibility with the total airport master plan, 6) potential for delay, and 7) financial and economic feasibility.

In addition to the passenger terminal, airfreight handling and storage facilities, control tower, powerplants, fuel storage, repair hangars, administration buildings, fire station, communications, concessions, parking, often hotels or residential facilities, and public safety facilities are needed. Airport planning and development is thus a complex architectural, engineering, and logistical task.

Air Traffic Control.–Air traffic control (ATC) requires various types of navigational surveillance and communication equipment (both in the cockpit and on the ground). The technologies involved, while widely used, are fairly complex, and training in their use, maintenance, and repair is not trivial. The equipment presently installed in the Middle East ranges from state of the art to outmoded.

Aids to aerial navigation can be broadly classified into two groups: 1) those that are located on the ground (external aids), and 2) those installed in the cockpit (internal aids). Some aids are designed primarily for flying over oceans; other aids are only applicable to flight over land masses; and finally there are aids that can be used over either land or water. Some aids are used only during the en route portion of the flight, while other aids are necessary in terminal areas near airports.[42]

The principal aids for ATC are voice communications and radar. English is the international language of ATC. The controller monitors the separation between aircraft by means of radar and instructs the pilot by means of voice communication.[43]

The Operation of Commercial Aircraft Support Systems in the Middle East

Designing airports, and operating and maintaining commercial airline fleets are complex and technically demanding tasks. Some Middle Eastern countries have effectively used these technologies. A major purpose of the discussion that follows is to analyze factors contributing to this comparative success in technology absorption.

Saudi Arabia.–The Saudi Arabian national airline, Saudia, is one of the fastest growing airlines in the world. Carrying 4,000 tons of freight in 1970, it grew to accommodate 100,000 tons of cargo and 9.4 million passengers in 1981. Saudia systemwide traffic increased 11 percent in 1983 to 11.1 million passengers, and the airline expects continuing expansion in 1984, particularly on routes to the Far East. The stated goal of the International Airports Project directorate under the Ministry of Defense and Aviation is "to plan and build airport facilities vital to the continued social progress and economic growth of the kingdom. "[44]

All three international airports in Saudi Arabia are undergoing or recently completed major expansions. Jeddah's new $6 billion airport (opened in spring 1981), the King Abdul-Aziz International Airport covers 104 square kilometers, making it in area the biggest in the world. Bechtel (U. S.) supervised construction while a Ralph M. Parsons/Daniel joint venture

[42]Rohert Horonjeff, *Planning and Design of Airports* (New York: McGraw-Hill, Inc., 1975). For further descriptions of alternative ATC systems, consult *Airport and Air Traffic Control Systems*, OTA-STI-175 January 19%2, and *Review of the FAA 1982 National Airspace System Plan*, OTA-STI- 176. August 1982, both publications of the U. S. Congress, office of Technology Assessment, Washington, D.C.

[43]There are two types of radar: primary and beacon. Primary radar shows reflections from the aircraft body as small "blips" on a radarscope. Beacon radar (sometimes referred to as secondary radar) consists of a radar receiver and transmitter on the ground that transmits a strong coded signal to an aircraft if that aircraft has a transponder. A transponder is an airborne receiver and transmitter which receives the radar signal from the g-round and responds by returning a coded reply to the interrogator on the ground. Most commercial aircraft carry transponders.

[44]"Saudia Continues Growth - At a Cost, " *Middle East Economic Digest*, Aug. 28, 1981, p. 29; Roy Allen, "Air Freight Business Zooms Ahead, " *Aviation: A Middle East Economic Digest Business Feature*, June 25, 1982, pp. 62-64; "Saudia Expects Traffic Rise to Continue, " *Aviation Week and Space Technology*, May 28, 1984, p. 37ff.

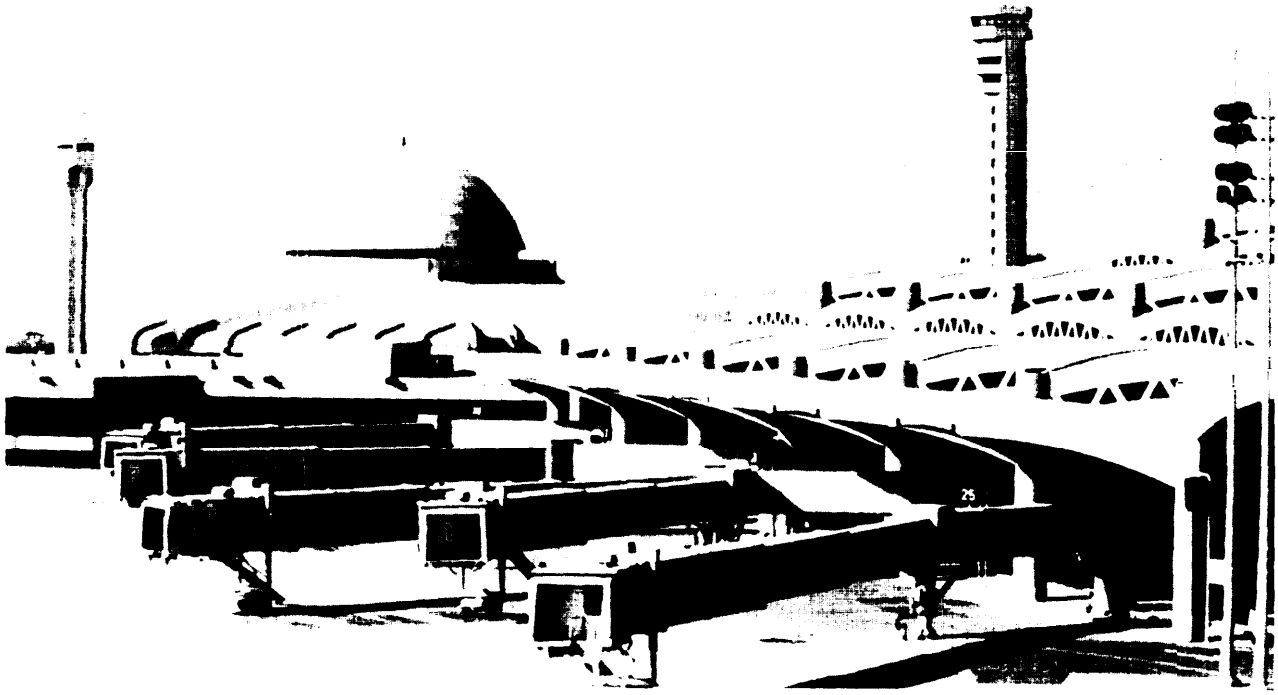

Photo credit: Saudi Arabian Presidency of Civil Aviation

New Riyadh Gateway— King Khaled international Airport is the new aerial gateway to Riyadh, capital city of the Kingdom of Saudi Arabia. Its four-passenger terminals are all served by air bridges The mosque, center left, rises 40 meters above the arrivals level roadway

operates it. The new Riyadh airport, which will exceed Jeddah's in eventual size, was also built by Bechtel, using more than 12,000 workers from 35 countries.[45] The third major airport is Dhahran International.

Saudia has had a predominantly U.S.-manufactured fleet until its latest purchase of 11 wide-bodied Airbuses for delivery in 1984. In order to service its large fleet, Saudia has established extensive maintenance facilities. Saudia completed a comprehensive maintenance facility in 1979 and can perform all of its own aircraft checks and overhauls. TWA has had a deep influence on Saudia standards and operating procedures, but European influences have also been felt.

Recruitment of personnel, both ground and flight crews, has been international in scope, Saudia now has over 600 pilots. Saudia expects 400 to be nationals by the year 1990. Until recently, training of Saudia pilots has occurred largely in TWA facilities in the United States. The suppliers of hardware (and software) for the computerized reservation system have also been involved in training of Saudia staff. Much of the training of staff, except for pilots, has taken place in the extensive Saudia facilities in Jeddah.

Training of Saudi nationals by both Saudia airlines and for the Presidency of Civil Aviation has been more successful, according to experts, than technical training in most other sectors of the Saudi economy. Faced with extremely high costs for expatriate labor, Saudia chose to recruit high school graduates and gave them in-house training. Most Saudia traffic agents are now Saudis and most middle and lower management personnel are also Saudis.

[45] Transport: Airport Facilities Keep Pace With Kingdom's Growth, *Saudi Arabia: Middle East Special Report*, John Whelan (ed.), Middle East Economic Digest House, London (August 1982), pp. 161-164. See also, Robert Bailey, "Countdown Begins for Jeddah Airport" *Middle East Economic Digest*, Apr 17. 1981, p. 42.

Photo credit: Trans World Airlines

Saudia's Boeing 737 Simulator

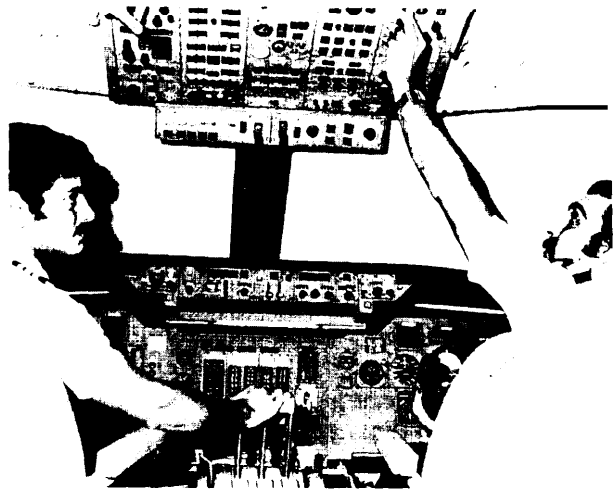

Photo credit: Trans World Airlines

Saudia flight training students in Saudia simulator

More than half of the flight crews are now Saudi nationals.

In certain technical areas and in the more complex maintenance of aircraft, Saudia still depends on foreign technicians. A drive to find, train, and retain Saudis in this field is now under way, but it will be several years before the majority of such technicians are Saudi nationals.

Saudia now performs all A, B, C, and D checks, and plans to carry out base checks (every 6.000 hours) on its Lockheed TriStars. Saudia can carry out major repairs and hot section maintenance on several types of engines. By 1984, Saudia plans to contruct and operate an entirely new maintenance base in Jeddah, which will meet projected maintenance requirements to the year 2015. Saudia has recently begun operations with a twin-cell civil engine test facility located in a new support area of Jeddah's King Abdul Aziz International Airport.

In a given year, more than 700 hangar visits will be made by Saudia aircraft for routine checks, modifications, and repairs. Saudia uses its own Automatic Test Equipment, a computer-controlled laboratory facility, to diagnose problems in electronic equipment so that airplanes can be put back into service with the least possible delay. The Saudia Metrology Laboratory tests and calibrates the equipment used in the aircraft to ensure proper performance. Their MEMIS (Maintenance and Engi - neering Management Information System) is particularly useful in time control. and in the issuance of purchasing and repair orders. Self-sufficiency in maintenance is thus rapidly being realized within Saudia, and maintenance training courses are being expanded to include more and more key personnel.

The Bendix Corp. (U.S.) is engaged in a 15-year agreement which aims to eventually staff Saudi Arabia's airports with Saudi nationals.[46] In a separate award, Bendix's technical services subsidiary, the Bendix Field Engineering Corp., won a $337 million, 5-year air traffic control contract. It will supervise 31 airports in operations, systems engineering, and maintenance. Six hundred Saudi staff will be needed; 500 of them will be managers and technicians.[47]

Saudia thus eventually expects to operate without a major expatriate work force. on the

[46]"Turning Point for U.S. Commission," *Middle East Economic Digest*, Special Report on Saudi Arabia, July 1981, p. 18. See also "Saudis Seek Technical Self-Sufficiency," *Aviation Week and Space Technology*, May 14, 1984, pp. 68-70.

[47]"U.S. Company Wins Air Traffic Contract," *Middle East Economic Digest*, Aug. 15, 1980, pp. 29-30.

other hand, one reason why the airline has operated at a loss over the past few years is its massive investments in training, computerized systems, and flight simulators, as well as new aircraft and other capital investments.[48] In 1980 alone, official subsidies for Saudia Airlines amounted to almost $75 million. The airline is determined to eliminate subsidies gradually through higher fares and increased efficiency. The government, through accounting and financing procedures, is attempting to provide incentives to operate the airline as a profit-seeking enterprise. Saudia's airfreight business has been an important component of its growth and Saudia is considering modifying its A-300s on order to a combination passenger-freight configuration. Aiming to make the new airport at Jeddah the hub for airfreight traffic to the Middle East, the airline plans to increase its airfreight business and enhance profitability.

Saudia, which tries to restrict recruitment to nationals, expanded its training budget in the late 1970's: the budget grew by 164 percent between 1977 and 1981 to $47.7 million. In 1977, there were 4,261 trainees; the figure projected for 1981 was 9,149.[49] Approximately 1,200 Saudi nationals are being-trained by Saudia at its $42 million institute in Jeddah. Some Saudi nationals are also studying in the United States.[50] Saudia courses include flight crew training, computer programing, marketing, and technical and managerial skills. World Wide Languages (United Kingdom) computerizes translations and typesets manuals dealing with installation, operations, and technical specialties. Indicating the international nature of Saudia operations, the manuals are reproduced in Arabic, Russian, French, Spanish, Chinese, and English.[51]

The key to the long-term objective of "Saudilation," says Ibrahim Serage, Saudia's training director, is giving trainees sufficient incentives and "opportunities for promotion. This means we are not training people simply for jobs, but for career development."[52] In 1980, the company recruited 700 employees, of which 200 became Saudi flight crew.[53] The ratio of Saudi pilots to nonnational pilots fell from 1975 (75:25) to 1980 (50:50) as the demand for flyers grew rapidly. The goal is to raise the ratio to the 1975 level by 1985. To that end about 100 pilot trainees are recruited each year. Some observers have pointed to the tragic fire on the Lockheed TriStar L-1011 on August 19, 1980, as an indication that Saudia may be growing too fast.[54] Nevertheless, Saudia has a good maintenance record and its pilots are generally considered capable.

The strides being made by Saudia are very impressive; complete staffing by Saudi nationals, however, will not occur in the near future. Successful technology absorption in several aspects of commercial aircraft support systems has come as a result of lengthy experience, and a strong commitment to training. Saudia is a comparatively independent operation and can offer technicians exceptional housing and other perquisites and has, therefore, been able to recruit and retain educated blue-collar technicians. Training programs have been costly, but they have contributed significantly to the high quality of operations and maintenance of Saudia.

[48] Roy Allen, "Air Freight Business Zooms Ahead," op. cit., pp. 62-64.

[49] Edmund O'Sullivan, "Saudi Arabia–Bridging the Labour Gap," *Middle East Economic Digest,* May 22, 1981, p. 53.

[50] The Sierra Academy of Aeronautics located at Oakland International Airport, Oakland, Calif., will use a computerized, multi-engine aircraft simulator to train pilots from Saudi Arabia. The training features the 99 instrument approaches used at King Abdul Aziz International Airport, Jeddah International Airport, King Khalid International Airport, Riyadh International Airport, Dhahran International Airport, and airports in 15 other cities in the Kingdom, "Courses for Saudi Pilots Added to U.S. Program," *Saudi Report,* Jan. 24, 1983, p. 3.

[51] Saudi Arabia Continues Growth," op. cit., p. 30.

[52] Quotation cited in "Saudi Arabia–The Manpower Controversy," *Middle East Economic Digest,* Apr. 24, 1981, pp. 40-41. See also "Saudis Seek Technical Self-Sufficiency," *Aviation Week and* Space *Technology,* May 14, 1984, pp. 68-70.

[53] Saudi Arabia Continues Growth," op. cit., p. 29.

[54] John Whelan, "Airline Safety Questions Follow Riyadh Disaster," *Middle East Economic Digest,* Aug. 29, 1980, p. 35. The official declaration of cause for the accident which killed 14 crew and 287 passengers was a fire of undetermined origin in the cargo compartment. Factors contributing to the fatal results were listed primarily as pilot error in not making a maximum stop landing and immediately evacuating upon landing and not properly utilizing the flight crew during the emergency. Information provided by the National Traffic Safety Board, Washington, D. C., March 1984.

Kuwait.–Kuwait's aim to become a regional center and a hub in East-West air traffic has been the driving force in civil aviation policy and the growth of Kuwait Airways during the past two decades, Kuwait Airways is unusual among world-class airlines in that it has no domestic air service. Yet Kuwaitis probably travel more by air than people from almost any other nation. The airline, however, cannot make up in receipts on international air travel for the lack of domestic air service. In addition, heavy losses due to increased operating costs in the past 3 years, and the fact that longer range aircraft make stops in the Middle East less necessary than before, have changed the likely future growth pattern of the airline and probably will modify the need for building a new airport.

The Kuwait Airways Corp. (KAC) has been expanding the range of services it offers using eight-seat aircraft that fly up to 6 hours nonstop. Air taxis to the Persian Gulf and parts of Europe were initiated in 1982. The goals of the new service are said to be to reduce the use of private planes and to increase sagging revenues of the company. Another tactic to boost profits is the goal of increasing KAC's market share on Gulf flights. To do so, however, fares were reduced by 35 percent for trips within the area in order to make the airline more competitive.

Kuwait Airways has placed a ceiling on further hiring, and the management intends to cut the substantial losses of the past few years through emphasizing profitable routes, such as the one to New York, and perhaps by offering less frequent service or canceling some routes. Politically, however, it maybe difficult for Kuwait to withdraw from certain routes while continuing to serve others.

Kuwait's sole airport, Kuwait International, was built in the 1970's. In the 1970's the British firm Frederick Snow designed a runway which an Italian contractor was unable to build in the very hot climate of Kuwait. A Japanese architect, world-famous in this field, solved the problem: huge slabs had to be sawed in two at great expense. This remains a well-remembered example to Kuwaiti planners of the need to monitor technology transfers.[55]

An airport development plan completed in 1975 has been largely ignored, and the present Civil Aviation Department has authorized a new conceptual study by Aeroport de Paris to cover requirements to the year 2000. An IATA team has prepared another report on the subject. Both reports identify coordination between military and civilian airport needs as a major factor in determining whether or not a new second airport can or should be built. Another key issue is Kuwait's future importance in regional and international air traffic. Studies indicate that the existing airport, with a design capacity of 4 million passengers per year, will have to cope with about 5 million passengers by 1990. This compares with 2.8 million in 1981. Like Algeria and Egypt, Kuwait is thus anticipating a growth in air passenger traffic beyond its present physical and service capacities.

The aircraft support industry in Kuwait is heavily staffed with nonKuwaitis. Even prior to the completion of expansion plans, efforts were made to expand recruitment. For example, in August 1980 airline pilots (as well as employees of the fire department) were exempted from military conscription. The overburdened airport traffic controllers were to be "stretched" by upgrading automated controls. A computerized radar system was put into effect in September 1980 at a cost of $3.7 million. Chief executive officer of KAC Ahmad al-Mashari announced in June 1981 that an in-service training system for Kuwaiti and other Arab engineers and technicians had been started.[56]

Staff training is included in the $775 million contract between KAC and Airbus Industrie

[55] "Pacific Consultants, the Ballast Nedem (the Netherlands), and Soleco (Italy) were all involved in the building of the airport. Minor parts of the present airport system, including the jetways, were designed or furnished by U.S. firms. The airport development plan was drawn up by the Netherlands Airport Consultants.

[56] "KAC Plans Major Projects, Middle East Economic Digest, June 12, 1981, p. 28.

for purchase of 11 aircraft.[57] Some say that the Boeing 767 had the technical edge over the Airbus A310; moreover the U.S. company had the advantage of having provided the rest of KAC's fleet. Boeing reportedly lost this award for political reasons. The Airbus was reportedly selected because the political positions of major consortium participants, particularly France, were seen as more acceptable." Political considerations in aircraft sales in the region are covered in more detail in a following section.

The political importance attached to having a national airline should not be overlooked in explaining Kuwait's strategy. In the future, KAC's expected increase in services and assets will result in expanded requirements for skilled manpower, even with more extensive use of automation. Two points should be noted. First, there is no indication that the work force will be primarily Kuwaiti. Dependence on expatriates must be increased to carry out these plans. Secondly, although training is included in the plans, it is not clear whether the planned training is sufficient in view of the physical expansion.

Egypt.–Expansion of Egypt civil aviation sector has been uneven during the past few years, despite projections which show large future increases in passengers. While financing problems have not postponed construction of airport facilities and telecommunications improvements, EgyptAir has had to retrench plans for major aircraft purchases.[59] Redefinition of its market segment, competition, and management problems have contributed to the slowdown in expansion of the state-owned air carrier.

Passenger traffic through Cairo is expected to rise rapidly from the current level of 4 million passengers per year, possibly at a rate of 15 percent annually.[60] The airport at Cairo will be expanded according to designs by Aeroport de Paris. The first annex will raise overall capacity from 5 million to 10 million passengers annually when it is completed in 1984. Another 5 million may be accommodated by a second annex to be built by 1987. The airport plan allows for completion of further annexes as necessary.

A complete overhaul of the air traffic control system for the whole country is underway. Thompson-CSF (France) will build and equip the Cairo air navigation center- as well as seven radar stations in other parts of the country, linked together by microwave. Air traffic controllers will be trained on the SIMCAT simulator to be supplied by Thompson-CSF. The French Government is helping the Egyptian Government to finance the package–worth $72.5 million. The French officially subsidized financing was reportedly a critical factor in the decision to choose the French company.

Regional airports at Alexandria, Aswan, and Luxor are being improved. There has also been discussion of building two new international airports in the northern Delta area. These would be located at Alamein and Ameriyah and would tie into industrial development schemes for the region.[61]

EgyptAir has been redefining its relationship with the government over the past few years. Ali Gamal al-Nazer, Tourism and Aviation Minister, announced in November 1980 that the company was doubling its capital to $72 million through investments from the National Bank of Egypt and the Misr Insurance Co. Independent observers noted that EgyptAir had been permitted to exercise increasing autonomy and had been commercially successful, recording operating profits of $17.4 million for 1979.[62]

Nonetheless, planned investments have been scaled back. Orders for four McDonnell

[57] *Middle East Economic Digest. vol.* 25, *May* 29, 1981, *p 26.*

[58] "*Pro-Arab Stand 'Wins Airbus Deal', "Middle* East Economic Digest, July 11, 1980, p. 34. The number of aircraft given in the 1980 announcement of the contract award was six but the 1981 figure was revised to 11.

[59] Alan Mackie, "EgyptAir Trims Expansion Plans, " *Middle East Economic Digest,* Sept. 5, 1980, pp. 3-4.

[60] "Robert Bailey, "Safety First at Cairo Airport, " *Middle* East *Economic Digest,* June 12, 1981, p. 24.

[61] "Northwest Development Planned, " *Middle East Economic Digest,* July 3, 1981, pp. 7-8.

[62] Mackie, op. cit.

Douglas (U. S.) DC-10/30 aircraft were canceled in August 1980. Refer-ring to the purchase of three Airbus Industrie A300s, the Tourism and Aviation Minister said that the new investments could not all be made simultaneously.[63] The company decided to forgo the long-haul market, for which the DC-10s were ordered, concentrating exclusively on the medium-range market. Further planned investments were being limited. Discussions focused on either canceling or reducing in size by 75 percent the planned maintenance center to service the Airbuses at Cairo Airport.

The government, nonetheless, affirmed its support for EguyptAir virtual monopoly as it protected the company from potential competition from a newcomer. Arabia (Arab International Airlines) was incorporated in December 1978 with $15 million in capital owned 60 percent by pritvate Egyptian and 40 percent by Saudi Arabian investors. Its staff of 150 were all Egyptians.[64] But after operating for less than 6 months, it was forced to terminate operations, It was not permitted to fly on lucrative international routes, which would bring it into direct competition with the state-owned company. Closely restricted domestically, Arabia finally succumbed to price-cutting tactics. Further evidence of the government commitment is the fact that of the $226 million allocated for civil aviation in fiscal year 1981-82, EgyptAir was to receive $103 million.

The Egyptian labor profile, which includes an abundance of labor and a large professional contingent, is well suited to air transport. Specific vocational training programs are required, however, for each occupational category (the four major areas being aircraft pilots, flight attendants, ticket and station agents, and aircraft mechanics). Skilled labor occupations such as mechanics may present the greatest difficulties in terms of availability of labor, while training flight attendants and ticket agents does not present a great problem.[65]

Algeria. -Algeria is simultaneously expanding airports, purchasing aircraft, and planning for increased demand for trained staff due to the forecasted increases of 3 million to 5 million passengers annually in passenger air traffic during the 198084 development plan period.[66] Two of the fundamental criteria involved in the plan are to decrease charter freight and to upgrade the fleet in the face of growing air traffic.

The Algerian 5-Year Plan mentions allocations for a potential fleet of 54 aircraft. However, because aggregate investment levels are not specified, it is unclear how much expansion beyond present levels will actually occur. The 1980-84 development plan aims to provide international coverage for the southern part of the country and to expand facilities in the north to meet increasing demand. Approximately 00 airports are to be built or upgraded, 20 of which are located in the south. These will be used primarily for short-haul stopovers en route to points in west, central, and southern Africa.

Contracts for design and construction of two of these airports were recently won by the state-owned international Airport Authority of India. The turnkey contracts for the airports at Batna and Setif are reportedly valued at $100 million.[67]

Despite deliveries in May 1982 of two Boeing aircraft, a 737 and a 727, Airbus Industrie appears to be gaining ground in negotiations. One attractive feature of Airbus proposals has been broad sales and leasing packages that take manpower needs into consideration. For

[63] "Egypt Cancels 1)('-1 (.)s, *Middle East Economi* A ug. 29, 1980, p. 1 x; M ackie, op cit.

[64] Jenab Tutnj i, "Arab Wings: Flying the Charter Way," *Middle East Economic Digest*, June "26, 1981, p. 26.

[65] Egypt's acquisition of milit ary aircraft technology (through licensed assembly and military procurement) may improve technical capabili ties u seful t o the commercial aircraft sect or. See Clarence A. Robinson, Jr., "Egypt Seeks Technology Transfer," *Aviation Week and Space Technology*, Aug. 15, 198~). p 129ff.

[66] Michael Frost, "Algeria Plans Major Airport Expansion," *Middle East Economic Digest*, Aug. 28, 1981, p. 7.

[67] *Middle East Economic Digest*, July 2, 1981, p. 4; "Indians Sign Airport Contracts," *Middle East Economic Digest*, N ov. 5, 1 982, p 13.

example, Lufthansa (West Germany) will train Air Algérie crews on A300s at the Frankfort/Sieheim base of Lufthansa.[68] This arrangement is part of the terms of a lease for two Airbus Industrie medium-range passenger planes. Eight Air Algérie maintenance teams will also receive technical training. Until the Algerians are fully able to take over operations, Lufthansa itself will provide crew and maintenance technicians.

According to some estimates, Algeria may need up to 25 Airbus Industrie A300s in the next 15 years.[69] Although the comparable Boeing 757 is less expensive, Airbus is said to have the edge. In this case the French have offered to train Algerian engineers and aircraft mechanics at Airbus' factories in Toulouse. Moreover, the French proposed to setup complete maintenance facilities for Air Algérie at El-Djazair within 3 years.

A civil aviation school for pilots and technicians is planned as a step towards implementation of the current development plan.[70] The school, to be located in Constantine, will be modeled on the Ecole Nationale d'Aviation Civile in Toulouse." Its estimated value as a turnkey package is from$115 million to $230 million. Funding of $818,800 has been provided through the United Nations Development Program while the Algerian Government has allocated some $68.2 million. The Enterprise Nationale d'Exploitation Meteorologique et Aeronautique, within the Transport Ministry, is in charge of the project. Tractional (of Belgium) is carrying out preliminary studies for the proposed 636-student institute.

Algeria plans to purchase sophisticated equipment for use in training and research. For example, Algerian leaders have been discussing the purchase of flight simulation equipment from Latecoere (France). The simulators would be used for testing the physiological effects of flying on the flight crews as well as for testing aeronautical equipment.[72] Algeria has plans to purchase a research aircraft with the help of a $7 million loan from the Arab Fund for Economic and Social Development (AFESD). It will be used for testing ground control equipment by some African and all Arab countries.[73]

If Algeria proceeds with its planned fleet expansion, investment on the order of $55 million could be required and an additional 1,000 workers could be needed. It appears that the overall composition of the national labor force could support the annual levels of growth planned in airline-related occupations, given adequate vocational training in the specific occupations required.

Serious attempts are thus being made by Algeria to develop manpower apace with increases in air traffic and airport expansion. Airbus Industrie, with its multigovernment support, is said to offer attractive training arrangements and financing terms. Thus Airbus is said to be favored for large purchases of aircraft in the coming years.

Iraq.— Iraqi Airways uses Lufthansa service for its aircraft maintenance but performs its own routine maintenance (A and B checks). Plans have been laid to build new airports in most provinces with a view to expanding and improving Iraqi Airways services. There are plans to expand the domestic network through airports to be built at Arbil, for which the design contract has already been let, and at Amara, Kirkuk, and Najaf.[74] Decreased oil revenues and the strains of the Iran-Iraq War, however, make delay of these plans likely.

Iraqi Airways has experienced impressive growth, especially since 1977, and considerable investments have been for new airports, both international and domestic. Foreign contractors from a wide variety of nations have

[68]"Air Algérie Leases Airbuses," *Middle* East Economic Digest, May 22, 1981, p. 8.

[69]"Airbus Looks to Air Algerie. *Middle* East Economic Digest, Oct. 15, 1982, p. 6. It presently has no Airbus or Boeing aircraft on order, however.

[70]F'rest, op. cit.

"*Middle East Economic Digest,* Feb. 27, 1981, p. 8.

[72]"Aviation Contract Discussed, " Middle East Economic Digest, Apr. 11, 1980, p. 22. The contract was valued at $45 million.

[73]Middie East Economic *Digest,* Aug. 8, 1980. pp. 15-16.

"Information provided by U.S. Department of Commerce, International Trade Administration, Feb. 10, 1983.

participated. Pacific Consultants of Japan won contracts for airport design studies in 1976 and 1978. The major construction contract for the Baghdad International Airport (valued at $900 million) was awarded in 1979 to the French company Spie-Batignolles and Fougerolle. The major Basra Airport construction contract was awarded in 1980 to an Austria-West Germany consortium of Universal Hoch and Treflou and Bil Pinger. In 1978 Scott, Brownringy and Turner of the United Kingdom received a contract of unspecified amount for design of passenger terminals; another British group, Kirkpatrick and Partners, received an airport consultancy contract in 1982. In conjunction with the contract, Pakistan's Feedai Agency is supplying labor for this construction.

The primary suppliers of passenger aircraft and parts have been U.S. corporations. Three Boeing 727s and 747s, at a cost of $183.6 million, were sold in 1981. Three other 727s were sold in 1980. In 1975, two 747s, three 727s and one 737 were supplied by Boeing at a cost of $150 million.

The State Organization for Civil Aviation has plans to build a comprehensive training institute. Programs in operation and maintenance of airports, aircraft, air traffic control, and radar equipment will be offered. Pilots and cabin crew will be trained in a broad range of skills, including foreign languages. [75]

Iraq has been active in developing specialized manpower for its commercial aviation sector. Now that women as well as men are being admitted to train as pilots at the Takrit air force academy, the pool of skilled labor that could be eventually drawn from military to civil aviation may be expanded once the Gulf war is ended.[76] This move is indicative of national policy to expand the indigenous labor force.

The government is not waiting for domestic facilities to be completed before intensifying training activities. In October 1981, British Airports International won a $1.3 million contract to train over 400 Iraqis in airport electronics." The courses to be given in the United Kingdom will include both classroom study, at universities and technical institutes, and hands-on training at airports and at centers of aviation equipment manufacture. A similar contract worth $530,000 to train Iraqi air traffic controllers in the United Kingdom was awarded at the same time.

British firms thus have been particularly successful in the Iraqi aviation training market. Some companies have had long-time working relationships with Iraq, such as the Lancer Boss Group which has been dealing with Iraqis for 20 years, Non-British firms have made inroads in this market. For example, in January 1982 an airport staff training contract worth $1.4 million was awarded to the West German firm Flughaven Frankfort am Main.

The national airline of Iraq continues to operate despite the war with Iran. Under present circumstances, however, it is unlikely that Iraq would divert capital investment or occupational training (pilots and aircraft mechanics) from the military in order to build up the commercial airline industry.

Iran.– Iran Airways presently handles most of its own routine maintenance, with the assistance of technical specialists from other countries. Major overhauls are carried out abroad. Iran's Fifth Development Plan, (1973-77), under the Shah's regime, called for expansion of existing airports and the construction of new airports, including the new Teheran airport scheduled for completion in 1980. Authoritative information on the current status of these projects and of Iran Air is unavailable, although it can be assumed that military capabilities have been given priority over commercial aviation in the air transport sector.

As of 1982, Iran Air was reported to have a labor force of 5,500 trained technical personnel. Iran carried on negotiations with Australia to set up a training program for Iran Air.

[75] *Middle East Economic Digest,* Apr. 10, 1982, p. 28.
[76] *Middle East Economic Digest,* Apr. 9, 1982, p. 5.
[77] *Middle East Economic Digest,* Oct. 16, 1981, p. 28.

About 150 commercial pilots of the national airline would be involved in the program.

Iran reportedly has budgeted some $33 million over the next 5 years for building a new international airport south of Teheran. Design and preliminary construction were completed prior to the Shah's overthrow. Plans have been scaled down from an annual capacity of 20 million passengers to 7½ million. Total cost is now estimated at between $100 million to $200 million. Despite the political situation, Iran's commitment to the airport project suggests that the government expects more internationa-1 visitors and is willing to provide modern facilities for them.[78]

Regional Efforts.–The expansion of air traffic in the Middle East over the last few years has seen considerable cooperation among regional and national carriers. One official, speaking about joint provision of air services between the Middle East and North America, summed up the general situation quite succinctly: "At the moment we do not have the equipment, the machinery, or the manpower to do it [cover demand for services] individually. The idea is for a pooling of resources to benefit every body."[79]

In 1980 a technical consortium was formed that included Middle East Airlines, Saudia, Kuwait Airways, Gulf Air, and ALIA (the Royal Jordanian airline). The consortium also held discussions with other members of the Arab Air Carriers Organization (AACO), but none have yet joined. Programs being considered or actually underway include shared services (especially telecommunications) and unified training.

Shared Services.–Sharing electronic equipment and technical services may be an attractive option for Middle East carriers. Highly specialized electronic and telecommunications may cost as much as 20 percent of the total sum required for a new airport. Elements typically included in a turnkey package are radar, telecommunications, navigational aids, and lighting. Multinational corporations or consortia of suppliers of equipment and services generally offer to install, maintain, and staff the airport.

In order to limit the number of expatriate workers who form the largest proportion of the technical staff in most cases, airlines in the Middle East have the option of automating operations. Keeping the labor component to a minimum while at the same time developing regional capabilities requires coordination in telecommunications services. Perhaps the most impressive effort is the joint computerized reservation system. "" Based in Bahrain, it will handle an estimated 10 million reservations a year for the 10 airlines involved: ALIA, Domestic Yemen Airlines Co. (South Yemen), Gulf Air, Kuwait Airways, Libyan Arab Airlines, Middle East Airlines, Saudia, Sudan Airways Corp., Syrian Arab Airlines, and Yemen Airways (North Yemen). At present only Gulf Air has its own computer reservation facilities; the rest lease services from outside the region. Iraqi Airways did join the group because it has a central computer judged to be adequate.

Another labor-intensive service that could be performed more cheaply through a regional center is the calibration of instruments. Among the Arab countries, only Saudi Arabia has such capabilities. A regional air traffic control system may be attractive from an economic perspective, but there is overlap between the military and civilian control networks so that such cooperation may not be politically feasible. Aircraft maintenance centers and joint catering services are under discussion.

Unified Training.—Royal Air Maroc's experience with training Moroccan nationals for technical flight staff shows how expensive training can be.[81] In 1980, the airline announced its goal of complete staffing with Moroccan nationals by 1982. The 1980 defi-

[78] *Middle East Business Intelligence,* vol. 2, No. 13, Aug. 15, 1983.

[79] 'Arab Airlines Plan Atlantic Route, " *Middle East Economic* Digest, June 20, 1980, p. 16.

['] 'Robert Bailey, "Airlines Plan Computer Reservation Centre, "Middle *East Economic Digest,* Apr. 11, 1980, p. 19. The project is estimated to cost $30 million to $40 million.

[81] 'David Hawley, ''Royal Air Maroc . . . Facing the Competition, " *Aviation: A Middle East Economic Digest Business Feature,* vol. 26, June 26, 1982, pp. 62-63,

cit of $2.6 million (up from $1.9 million the year before) was attributed largely to training costs totaling $3.8 million in 1980. As of June 1980 approximately 60 percent of the technical staff was Moroccan. Nevertheless, the airline has expanded its role in regional training. The At-ah Civil Aviation Council has considered promoting Morocco as a base for a civil aviation high technology institute.[82] The Royal Air Maroc center in Casablanca is training some African airlines students (e. g., from Air Mali, Air Zaire, and Air Mauritania) in addition to Moroccan nationals.

The AAC() has met with some success in joint training of management-level staff. The Douglas Aircraft Co. (subsidiary of McDonnell Douglas Corp., U.S.) organized a popular seminar for the 18-member AACO in August 1981. This was followed the next year by a marketing course offered to 25 executives from the group. Sessions included fleet planning, aircraft financing, performance assessment, and forecasting.[83]

In September 1981 the chairmen of several Arab airlines met to consider a unified training system as well as the joint building of a large airport hangar. The airlines involved were Kuwait Airways Corp., Saudia, Middle East Airlines, Gulf Air, and ALIA. There has, however, been no reported progress in these ventures.

There is general agreement that cooperation among Arab airlines is economically desirable and perhaps necessary to reduce staff requirements of individual carriers. The AACO is the most comprehensive organization, but various smaller groups of countries have participated in joint programs, The notable achievement has been the development of the Bahrain-based, centrally computerized reservation system, Joint provision of other telecommunications, maintenance, and training services has been discussed rather more than implemented.

[82]Bailey, "Airlines Plan Computer Reservation Centre," op. cit., p. 19.

[83]"Arab Airline Chiefs Discuss Cooperation," *Middle East Economic Digest*, Sept. 11, 1981, p. 4.

PERSPECTIVES OF SUPPLIER COUNTRIES AND FIRMS

Commercial aircraft support systems comprise a variety of equipment and services needed to operate and maintain local airlines in the Middle East. As discussed earlier, they fall into two groups: the goods and services needed to operate aircraft, and those needed to operate airports. The former are usually supplied by other airlines, aircraft and aircraft engine manufacturers, and aircraft maintenance firms. The latter are supplied by a diverse group of communications, aerospace electronics, and airport construe'ti(jn firms.

The diversity of products exported to be parts of airports and air navigation traffic control systems, and the large services component in aircraft maintenance and operation preclude any simple analysis of trade flows. While most equipment for aircraft and aircraft engine maintenance is exported as aircraft parts (SITC 7349), a large portion is linked to the original aircraft purchase.[84]

A multitude of equipment manufacturers often coordinated by construction management firms, provide the various airport systems components. For example, Bechtel was has the construction manager for the new Riyadh airport, but the equipment installation and construction was handled under a number of separate contracts. The French firm

[84]The major equipment items in this sector are listed according to Standard Industrial Classification (SIC) and Standard Industrial Trade Classification (SITC) code numbers

Commercial Aircraft Support Systems Equipment Classifications

SIC code		SITC	SITC (revised)
3662	Air Traffic Control Systems Aircraft Control Systems Electronic Flight Simulators Instrument Landing Systems (Airborne and Ground) Inertial Guidance Systems Electronic Navigation Equipment Radio Equipment Radio Antennae Radio Telephone Equipment	724, 7248	764,7648
3721	Aircraft	7841	792
3724	Aircraft Engines and Parts	7114	7131
3718	Aircraft Parts and Auxiliary Equipment Instrument Panel Mockups Training Aids (except electronic)	7349	7925, 7929
1611	Airport Construction		

Thomson-CSF is supplying air traffic control and navigation systems. Firms from the United Kingdom are also active, particularly in Saudi Arabia. Germany's major presence has been in Iraq, while U.S. firms are primarily involved in Saudi Arabia. Some recent commercial aircraft support system contracts awarded in several Middle East countries are shown in appendix 7A in tables 7A-1 to 7A-5.

Aircraft maintenance and support are performed by the local airline, by foreign personnel employed by the local airline, or by foreign airlines and maintenance firms on a contract basis. The contracts in the Middle East (and elsewhere) cover a 3- to 5-year period. This is done to spread the nonrecurring costs over a broader base, thus lowering the person-month rate.[85] As mentioned previously, after the initial aircraft sale, there is a substantial amount of follow-on training for flight operations personnel, especially for smaller airlines which do not have their own training program. Crews and performance engineers are trained and previously trained personnel are brought up to instructor qualified level. There may be a significant amount of follow-on maintenance training in the more specialized areas, such as rigging and composite repair.

The degree and magnitude of the follow-on spare parts business is determined by many variables, including.

1. The amount of spare parts initially purchased from the manufacturers and suppliers prior to delivery of the first aircraft.
2. The degree of customer expertise in airplane maintenance and repair of parts removed from aircraft.
3. The number of airplanes of a particular make the customer has in operation. For example, the same quantity of certain high-cost repairable spare parts is sufficient to support one or several aircraft. As a general rule, however, the larger the fleet, the more spares that are needed over time.
4. Daily utilization by the customer of the fleet and the route structure. The higher the utilization rate of the aircraft, the more spares are needed in inventory at the main base and at those locations included in the route.
5. The extent to which a customer participates in pooling of inventory with operators in the same region.

Fleet homogeneity assists in maintenance since the publications, training, ground support equipment, and spare parts needed reflect only the differences between early aircraft and later model aircraft of the same model. Maintenance capabilities can be pooled, but usually these capabilities and services are contracted. There are, however, several consortiums whose members perform maintenance for each other. These usually do overhaul work for the consortium. For example, one operator may do engine and auxiliary power unit work; another hydraulics; another airplane structures. Regional airline spare parts pooling agreements are administered and controlled by the airlines-prime manufacturers are not participants. Most Middle East customers currently participate in the International Air Transport Pool (IATP).

Competition Among Suppliers in Technical Assistance and Commercial Aircraft Sales

The factors which affect competition among firms supplying technical assistance to airlines in the Middle East are, not necessarily in order of importance, fleet compatibility, geographical proximity/route compatibility, historical ties, and commitment to service. Fleet compatibility, or capacity for type-specific maintenance and support, and geographical proximity are more prerequisites than competitive factors. Historical ties have been an important determinant of technical support relationships, but they must be reinforced in order to remain influential. Underlying historical ties with foreign airlines are bilateral political relations. With the exception of MEA and Trans-Mediterranean (all cargo), Middle Eastern airlines are government owned, heightening

[85] "'Person-month rate is the cost of employing a person for 1 month including salary, benefits, and general overhead.

the importance of political factors. While the contracting of maintenance services is not necessarily a long-term commitment, combined with other technical services and assistance it is an important aspect of airline operations and is unlikely to be entrusted to an airline of a country with poor or faltering political relationships. Price, which is always a factor, is sometimes not as important a consideration as quality and efficiency of service combined with commitment. It is costly and disruptive to have aircraft grounded; airlines have been willing to pay for reliability in service.

Sales of large commercial aircraft lead to sales of auxiliary equipment and services. Table 66 shows the large U.S. export value of sales of large commercial aircraft. In 1982, sales to the Middle Eastern region were surpassed only by sales in the European and Asian regions.

The Boeing Commercial Airplane Co. hopes to sell aircraft valued at $600 million to $800 million to Middle Eastern customers in 1984 alone. According to projections from Boeing, the world market for commercial jet aircraft between 1983-95 will be worth about $185.1 billion at constant 1984 prices. Of this, 3 and 4 percent will come from the Middle East and Africa, respectively, representing total sales of $12.9 billion.[86] Middle Eastern sales may be an important indicator for sales in the rest of the world. Whether carriers in the Middle East will invest in brand new aircraft, or refurbish or buy used planes in order to meet their expected growth, is a major question for supplier firms.

The chief rival of Boeing and McDonnell Douglas is Airbus Industrie, a multinational group of companies that are wholly or partly owned by European governments. Members of Airbus Industrie are Aerospatiale of France (37.9 percent ownership), Deutsche Airbus of Germany (37.9 percent), British Aerospace (20 percent), and Construcciones Aeronautical of Spain (CASA) (4.2 percent).[87] Airbus Industrie was formally constituted in December 1970. Its first plane, the A300, a short- to medium-range twin-engine wide-body transport, went into service in May 1974. A smaller Airbus, the A310, was delivered to customers beginning in the spring of 1983.[88]

[86] Robert Bailey, " 'Boeing Strikes Back," *Middle East Economic Digest*, Feb. 3. 1984, pp. 34-35.

[87] The French Government owns more than 97 percent of Aerospatiale, the British Government holds 48.3 percent of British Aerospace's shares with the rest held privately. CASA is wholly owned by the Spanish Government. Deutsche Airbus is a subsidiary of two commercial companies that are in the process of merging.

[88] "Richard C. Schroeder, "Troubled Air Transport Industry," *Editorial Research Reports*, vol. 1 1 , No. 20, Nov. 26, 1 982, p , 882.

Table 66.—U.S. Exports of Commercial Transport Aircraft (33,000 lb and over airframe weight, 1978-82)

	1978	1979	1980	1981	1982
Total *number exported*	111	200	237	255	121
Canada	4	20	22	25	13
Latin American and Caribbean	14	19	31	35	13
Europe	36	68	109	108	31
Middle East	17	17	9	21	13
Asia	24	60	53	34	25
Oceania	6	6	7	19	8
Africa	10	10	6	13	18
Total value *(millions of dollars)*	*$2,558*	*$4,998*	*$6,727*	*$7,180*	*$3,834*
Canada	132	373	299	584	294
Latin America and Caribbean	187	423	640	1,027	301
Europe	906	1,601	2,670	2,528	938
Middle East	541	582	236	841	699
Asia	478	1,722	2,467	1,405	1,096
Oceania	118	149	179	559	234
Africa	196	148	236	236	272

SOURCE Bureau of the Census U S Exports Schedule B Commodity by Country." Report FT 446 (annually), in Aerospace Industries Association of America Inc.. Aerospace Facts and Figures 1983/84 Washington, D C July 1983 p 133

Commercial aircraft, however configured, are costly, as shown in table 67. Enormous capital outlays are required for developing and producing new models of large commercial aircraft. A new airline program can cost $2 billion to $3 billion before deliveries even begin.[89] This figure may exceed the company's entire net worth.[90] There is no guarantee that even a best-selling plane will be a major revenue earner. Of 23 models of commercial jet-powered transports produced, only two are believed to have been profit-earners–the Boeing long-range 707 and the medium-range 727. (over 1,800 727s have been delivered.) Lockheed's L-1011 lost $2.5 billion by the time it was canceled, after approximately 200 were delivered. The supersonic transport Concorde, developed by the British and French, was a technical success but a major financial failure; only 16 were produced.[91]

Boeing's newest planes are both twin-engine jetliners with new, fuel-efficient engines. The 767, a twin-aisle wide-body, smaller than the 747, began flying commercially in the United States in September 1982. It has seven seats across with a capacity of 211 passengers. The 757, under delivery beginning in 1983, is a short- to medium-range jet with 186 seats.

Some observers note that, until recently, no aircraft available on the market had 150 seats to accommodate a smaller number of passengers. This perceived gap in the market led aircraft manufacturers in the United States and Europe to begin work on a smaller airplane. This size is desired by airlines for its fuel economy.

Boeing disputes that the 150-passenger aircraft need must be filled by a completely re-

[89]See ch V I, "The Economics of Large Transport Development, Production, and Operation in the [Tnited States," *A Competitive Assessment of the U.S. Civil Aircraft Industry*, U.S. Department of Commerce, Industry Analysis Division, Office of Industry Assessment, March 1984.

[90]"The decision to build a new jetliner has been referred to as "}NIL ting the company.' See John Newhouse, *The Sporty Game* (New York: Alfred A. Knopf, 1982).

[91]Annabelle May, "Concorde—Bird of Harmony or Political Albatross: An Examination in the Context of British Foreign Policy," *International Organization*, vol. 33, No. 1, 19'79, pp. 481-50H.

Table 67.—Typical Configurations and Purchase Prices of Various Competing Commercial Aircraft

Manufacturer/country	Model	Year available	Seating[a] (seating range)	Cost[b] (millions 1984 dollars)
Airbus Industrie				
France, United Kingdom, Federal Republic of Germany, Spain	A300	1974	260 (250-260)	50
	A310	1983	210 (200-210)	45
	A320[c]	1988	150 (134-174)	24
Boeing				
United States	737-200	1968	**115**	16-20
	737-300	1984	**(122-149)**	23-25
	737-400	under review	(134-161)	NA
	747-SP	1976	331	77-84
	747-200	1971	452	86-101
	747-300	1983	496	91-106
	757-200	1983	186	38-42
	767-200	1982	211	48-54
	767-300	1986	261	56-61
	7-7[d]	late 1980's	—	—
McDonnell Douglas				
United States	MD-80	1980	140(133-155)	**23-24**

[a]Number of seats depends on seat pitch (spacing) used. First number is for a typical layout
[b]Costs are highly variable and are given as a reference only Aircraft configuration customer needs provision of spare parts and other factors make exact numbers for aircraft or cost comparisons between companies difficult
[c]The Airbus A320 project received final go ahead funding from the consortium in March 1984
[d]The Configuration of the 7-7 is unknown it will probably make greater use of Composites and may use a lighter Weight metal skin.

SOURCES The Air War Boeing Airbus Fight for Jetliner Contracts All Around the World." *Wall Street* Journal, Mar. 20, 1984; information provided by Boeing Commercial Airplane Co. Airbus Industrie and McDonnell Douglas Corp., March 1984

designed (and hence very expensive) airplane. Their 737-300 model can accommodate a maximum of 149 seats. [fl)] Under study are a 737-400 configuration (a stretched version of the 737-300) with 134 to 161 seats, and a shortened version of the 757-200 (presently 186 seats). Boeing has recently reached agreement with the Japanese for development of a new plane, presently termed the 7-7, which could end up being in the 150-seat range.[j)]

The Douglas LID-80 has 142 seats and might be stretched into the 150-seat range. The MD-80 series plane is already selling well in the United States and elsewhere, with three models in production (the Super 80, MD-82, and MD-83 seating up to about 155 passengers). This makes the aircraft already an effective rival in the 150-seat market.[94] McDonnell Douglas is now studying a new version, the MD-88, which would seat up to 164 passengers and use the projected new international V2500 engine being developed by the multinational International Aero Engines consortium.[95] The latter powerplant is being developed by a group of seven companies in five countries, with Pratt and Whitney of the United States and Rolls-Royce of the United Kingdom the project leaders. The engine is expected to be available around 1988 and probably will also be used in the Airbus A320.

The need for a new 150-seat jetliner was a major concern in the deliberations leading to approval of funding for the A320 by the separate members of the Airbus consortium.[96] The production go-ahead for Airbus Industries A320 Transport program (which will cost a total of over $2 billion) was endorsed by European governments under the condition that the consortium work to improve its profitability and more equitably distribute equipment contracts among participating countries. The 150-seat aircraft is expected to make its first flight in February/March 1987. Certification and start of deliveries are planned for spring 1988.[97]

Government Roles in Aircraft Sales

Competition between Boeing and Airbus is already intense and will probably become more so once the 150-seat A320 is introduced in 1988. Each company complains that the other enjoys unfair marketing advantages. Boeing argues that Airbus is subsidized by the participating governments, allowing it to provide preferential financing. Boeing also contends that nationally owned European airlines naturally prefer Airbus planes. Airbus refutes this by pointing to sales of the Boeing 757 to British Airways. As a response to charges by U.S. aircraft manufacturers, Airbus states that aerospace research undertaken by the U.S. National Aeronautics and Space Administration (NASA) and made available to American manufacturers, constitutes a subsidy for U.S. companies. Airbus also states that the U.S. Export-Import Bank devotes an inordinate amount of its resources to financing overseas aircraft sales. Boeing has the largest exports of any U.S. company, as shown in table 68.

One of the reasons given by the Europeans for their government support of Airbus is that European industry faces a fundamental problem in its lower volume of production in comparison to U.S. manufacturers. According to this view, long production runs give the U.S. manufacturers, particularly Boeing, economies

[94] Germain (’ham bost, "Boeing's 737-300: A Step Into the 150-Seat Market, " *Interavia-Aerospace Review*, March 1984, pp. 240-241.

[95] "Boeing, Japan Sign Work Share Pact for 7-7, *Aviation 11'e('k* and *Space Technology*, M ar. 19, 1984, p. 32.

[96] Michael Dixon, "McDonnell-Douglas Studying MD-80 Airliner Derivative," *Financial Times*, Mar. 16, 1984, p. 6.

[97] Ibid.; *Aviation Week and Space Technology*, Mar. 19, 1984, p. 31.

[fl)] During deliberations by the British, Margaret Thatcher was quoted as saying, " I don't want another Concorde. Where is the market'? (Peter Ridden, " U K Aid for Airbus - I Don't Want Another Concorde." *Financial* Times, Mar 7, 1984). The British Government finally approved 250 million pounds in launch aid to British Aerospace for its share of the A320 project in early March 1 984. British Aerospace argued that the A 320 was not a technological breakthrough into an untested market like (’oncorde hut an updated and improved version of the existing European Airbus project which would replace existing *medium*-range aircraft. Firm orders and options for the A320 number approximately 100, It is estimated that 600 must he sold for break-even, or more than 700 for the British Government to earn a reasonable return on its investment, (Ibid, Riddell.)

[j)] Jeffrey M. Lenorovitz, "I+; uropeans Endorse A320 Production,' *A viation Week and Space Technology*, Mar. 19, 1984, p. 29-30.

Table 68.—Ten Leading U.S. Exporting Companies

Rank	Company	Total sales[a] (in billions)	Exports[a]	Percentage of sales
1	**Boeing**	**$ 9.78**	**$6.10**	**62.40/.**
2	General Motors	62.69	5,72	9.1
3	**General Electric**	**27.24**	**4,34**	15.9
4	Ford Motor	38.24	3.74	9.8
5	Caterpillar Tractor,	9.15	3.51	38.3
6	**McDonnell Douglas,**	**7.38**	**2.76**	**37.5**
7	**E. I.** du Pont de Nemours	22.81	2.64	11.6
8	**United Technologies**	13.66	2.63	19.2
9	IBM	29.07	1.85	6.3
10	Eastman Kodak	10,33	1.80	17.4

[a]For 1981, as reported by *Fortune,* Aug. 9, 1982, p. 68
Boldface denotes companies that are engaged wholly or partly in aircraft manufacture
SOURCE Richard C Schroeder, "Troubled Air Transport Industry." Editorial *Research Reports,* vol. 11, No. 20 Nov. 26, 1982, p 883

of scale which are extremely difficult for the Europeans to match unless they can secure a sizable share of the huge U.S. airplane market.[98] They note that out of 353 A300/A310 Airbuses ordered to date, a total of only 36 have been ordered by two U.S. airlines.[99] Viewing Airbus investments as very speculative, these observers argue that the bulk of the funding has to come from their governments.

For their part, U.S. aerospace industry leaders point out that U.S. aerospace companies fund a substantial amount of research and development (R&D) themselves. A National Science Foundation (NSF) analysis of industrial R&D shows that the aerospace industry's R&D funding far outpaces the average for all U.S. manufacturing industries. In 1981 aerospace company funding of R&D (civil plus military) was 4.2 percent of net sales, compared to 2.0 percent for all U.S. manufacturing industries. Total aerospace R&D funding (company plus government) was 15.3 percent of net sales while the comparable all-industry percentage was 2.9.[100] Figure 14 shows the Federal and company funds spent on aerospace R&D (civil and military) from 1970 to 1983 in current and constant dollars.

The issue of subsidization becomes more complex if one examines only the component of U.S. Government support for commercially oriented aeronautical R&D. The Federal Government, through NASA, devotes roughly $300 million **a year** to these commercial aeronautical R&D projects.[101] NASA supports long-term R&D in some areas that may be underfunded by private firms, such as aircraft noise and safety. Other programs support the development of more fuel-efficient and better performing aircraft, goals for which some feel private incentives may be adequate. On the other hand, some believe that there are no grounds for favoring this industry over others also facing international competition but receiving little R&D support. Advocates of NASA's support argue that reductions in these programs could have a negative effect on the international competitiveness of the U.S. civilian aircraft industry.

The federally supported U.S. Export-Import Bank (Eximbank) lends money at subsidized interest rates to foreign purchasers of U.S. products. The industries benefiting most from Eximbank's subsidized overseas lending in the last decade have been manufacturers of com-

[98]"The Airbus Example," *Financial Times,* Mar. 5, 1984.
[99]Michael Donne, "U.S. Airbus Protests Arouse Little European Sympathy," *Financial Times,* Mar. 22, 1984. The Europeans also note that Airbuses have approximately 30 percent [J. S. content by dollar value.
[100]Aerospace Industries Association of America, Inc., *Aerospace* Facts *and* Figures 1983/84, Washington, D. C., July 1983, p. 109.
[101] *Reducing the Deficit: Spending and Revenue Options,* a Report to the Senate and House Committees on the Budget–Part 111 (Washington, D. C.: U.S. Congress, Congressional Budget Office (CBO), February 1984,) p. 173. CBO listed elimination of NASA commercially oriented aeronautical R&D programs as one way to reduce nondefense discretionary spending. This one change. if adopted, could generate savings of $1.9 billion over the 1985-89 period, according to CBO estimates.

Table 70.—Export-Import Bank Summary of Commercial Jet Aircraft Authorizations for Loans[a] and Guarantees[b] (fiscal years 1957.82, values in millions of dollars)

	Number of jets		Export value		Number of credits		Gross authorizations	
Year	Loans	Guarantees	Loans	Guarantees	Loans	Guarantees	Loans	Guarantees
New authorizations:								
1957[c]-68	322	53	$2,572	$ 331	92	58	$ 1,520	$ 274
1969	55	23	451	207	23	18	197	111
1970	142	1	1,749	3	44	38	598	79
1971	126	9	1,539	40	58	49	481	363
1972	145	2	1,334	9	44	29	475	183
1973	129	4	1,729	25	60	23	690	191
1974	189	—	2,195	—	79	22	895	133
1975	136	1	2,070	5	64	10	691	64
1976	77	6	1,017	139	34	11	398	87
1977	31	25	330	902	16	14	138	294
1978	29	5	479	253	18	5	189	77
1979	118	7	2,938	317	35	10	1,399	239
1980	136	21	3,975	901	36	24	1,693	1,088
1981	121	18	4,568	637	26	17	2,550	533
1982	13	7	441	113	5	2	199	78
Cumulative new authorizations	1,784	187	27,603	4,064	640	333	12,208	3,853
Transfers and reversals	—	—	(8)	—	4	—	(24)	(20)
Cumulative gross authorizations (net of transfers and reversals	1,784	187	27,595	4,064	644	333	12,184	3,833

NOTE: Detail may not add to totals because of rounding.
[a]Loans are commitments for direct financing by the Export-import Bank to foreign buyers of U.S. equipment and services, including direct credits and loans authorized under the Cooperative Financing Facility (CFF) until the termination of the CFF program in 1981, but excluding Discount Loans, which are made by the Export-Import Bank to commercial banks and which subsequently may be guaranteed by the Export-Import Bank, in which case the value of the loans is included with Guarantees.
[b]Guarantees by the Export-Import Bank provide assurances of repayment of principal and interest on loans made by private lending institutions, such as Commercial banks, for major export transactions
cFirst year of commercial jet aircraft authorizations.

SOURCE: Export-Import Bank of the United States, in Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures 1982/84,* Washington, D. C., July 1983, p. 137

grounds that they give an advantage to some firms over others, and create income transfers from taxpayers in the United States to assisted firms and also to foreign buyers.

These issues are complicated by the fact that complex buyback arrangements are not uncommon in jet airliner sales. The manufacturers do not disclose details of individual deals, but Boeing is understood to have an inventory of approximately 50 aircraft (including jets of other manufacturers) that it has either already bought back, or has agreed to acquire at a future date, in order to win new sales of its own jets. In another case of competition for sales in Kuwait, it was reported firms were proposing to buy back jets manufactured by their competitors and not yet delivered in order to win sales.[103]

High-level supplier government economic diplomacy has frequently been employed. The sale to Egypt of three Boeing 767-200 ER (extended range) worth $163 million was a par-

[103]Michael Donne, "Why Boeing is Buying Airbuses to Win Key Orders, " Financial *Times,* Feb. 2, 1984, p. 5. These buybacks are reportedly sometimes at above market rates. In the battle between Airbus and Boeing for a Thai Airways International order for two planes, which Airbus eventually won, Boeing offered to purchase three old DC-8s from Thai Airways International at $5 million each. Airbus offered $5.1 million for each with spare engines. The market value for DC-8s is presently $2 million to $3 million. See William M. Carley, "The Air War: Boeing, Airbus Fight for Jetliner Contracts All Around the World, " Wall *Street Journal,* Mar. 20, 1984, p. 1.

mercial aircraft and heavy equipment, including power generators. The large share of loans for commercial jet aircraft exports from the Export-Import Bank is shown in tables 69 and 70. Table 69 lists total Eximbank authorizations of loans and guarantees as well as separate exports for fiscal years 1974-82. In the years 1979, 1980, and 1981, aircraft exports represented 37.3 percent, 41.8 percent, and 50.3 percent of total loan authorizations. This percentage, however, fell dramatically in 1982 to 7.8 percent of a much smaller total loan authorization of $3,104 million. Total authorizations for loans in support of aircraft exports in 1982 were less than one-tenth that of the previous year. Some of the reasons for the decrease were the soft market for aircraft sales during the worldwide air transport recession, lower total Eximbank funds, and questions as to which U.S. planes truly were up against unfair competition.][102] Table 70 gives a summary of commercial jet aircraft authorizations and the number of jets involved. The number of jetliner exports covered by these loans and guarantees fell sharply from 1981 to 1982.

Supporters of the Eximbank program maintain that it is a necessary response to the sometimes "predatory" policies of foreign competitors offering advantageous financing terms to attract and retain buyers. They also feel that export programs stimulate U.S. employment and promote development of technology. Critics contend that such programs are inappropriate interference in the free market causing economic inefficiency. They also criticize the programs on the

[102]The Export-Import Bank determined that loans would only be provided in cases where U.S. exporters faced direct competition from foreign suppliers.

Table 69.—Export-Import Bank Total Authorizations of Loans and Guarantees and Authorizations in Support of Aircraft Exports (fiscal years 1974-82, millions of dollars)

		Authorizations in support of aircraft exports[a]			
Year	Total authorizations	Total	Percent of total authorizations	Commercial jet aircraft	Other aircraft[b]
Loans: [c]					
1974	$3,981	$ 946.2	23.8%	$ 894.6	$51.6
1975	2,701	710.4	26.3	691.2	19.2
1976	2,285	421.9	18,5	398.4	23.5
1977	747	139.0	18,6	137,6	1.4
1978	2,927	195.2	6.7	189.5	5.7
1979	3,825	1,427.7	37.3	1,399.4	28.3
1980	4,087	1,710.1	41.8	1,692.6	17.5
1981	5,079	2,555.0	50,3	2,550.3	4.7
1982	3,104	241.4	7,8	199,1	42,3
Guarantees: [d]					
1974	$1,594	$ 154.0	9.7%	$ 132.9	$21.1
1975	1,574	84.5	5.4	64.0	20,5
1976	1,661	107.6	6.5	87.2	20.4
1977	1,021	307.5	30.1	293.9	13.6
1978	589	97.6	16.6	77,2	20,4
1979	908	261.4	**28.8**	239.3	22.1
1980	2,510	1,131,9	**45,1**	1,088.1	43.8
1981	1,513	562.6	**37.2**	533.4	29.2
1982	727	104.2	**14.3**	78,4	25,8

alncludes complete aircraft, engines, and Parts
blncludes business aircraft, general aviation aircraft, helicopters, and related goods and services
c Loans are commitments for direct financing by the Export-Import Bank to foreign buyers of U.S.equipment and services including direct credits and loans authorized under the Cooperative Financing Facility (CFF), until the termination of the CFF program in 1981, but excluding Discount Loans, which are made by the Export-import Bank to commercial banks and which subsequently may be guaranteed by the Exporf-import Bank, in which case the value of the loans is Included with Guarantees
d Guarantees by the Export-import Bank provide assurances of repayment of principal and interest on loans made by private lending institutions, such as commercial banks for major export transactions

SOURCE: Export-Import Bank of the United States, in Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures 1983/84* Washington, D C July 1983, p 136

Table 70.— Export-Import Bank Summary of Commercial Jet Aircraft Authorizations for Loans[a] and Guarantees[b] (fiscal years 1957-82, values in millions of dollars)

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1978	29	5	479	253	18	5	189	77
1979	118	7	2.938	317	35	10	1,399	239
1980	136	21	3,975	901	36	24	1,693	1,088
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NOTE: Detail may not add to totals because of rounding
a Loans are commitments for direct financing by the Export-Import Bank to foreign buyers of U.S. equipment and services including direct credits and loans authorized under the Cooperative Financing Facility (CFF) until the termination of the CFF program in 1981, but excluding Discount Loans which are made by the Export-Import Bank to commercial banks and which subsequently may be guaranteed by the Export-Import Bank in which case the value of the loans is included with Guarantees
b Guarantees by the Export-Import Bank provide assurances of repayment of principal and interest on loans made by Private lending institutions, such as commercial banks for major export transactons.
c First year of commercial jet aircraft authorizations.

SOURCE Export Import Bank of the United States in Aerospace Industries Association of America, Inc., Aerospace *Facts* and Figures 1982/84 Washington D C July 1983 p. 137

grounds that they give an advantage to some firms over others, and create income transfers from taxpayers in the United States to assisted firms and also to foreign buyers.

These issues are complicated by the fact that complex buyback arrangements are not uncommon in jet airliner sales. The manufacturers do not disclose details of individual deals, but Boeing is understood to have an inventory of approximately 50 aircraft (including jets of other manufacturers) that it has either already bought back, or has agreed to acquire at a future date, in order to win new sales of its own jets. In another case of competition for sales in Kuwait, it was reported firms were proposing to buy back jets manufactured by their competitors and not yet delivered in order to win sales. ""

High-level supplier government economic diplomacy has frequently been employed. The sale to Egypt of three Boeing 767-200 ER (extended range) worth $163 million was a par-

[109] Michael Donne, "Why Boeing is Buying Airbuses to Win Key Orders," *Financial Times,* Feb. 2, 1984, p. 5. These buybacks are reportedly sometimes at above market rates. In the battle bet ween Airbus and Boeing for a Thai Airways International order for two planes, which Airbus eventually won, Boeing offered to purchase three old DC-8S from Thai Airways International at $5 million each. Airbus offered $5.1 million for each with spare engines. The market value for DC-8s is presently $2 million to $3 million. See William M. Carley, "The Air War: Boeing, Airbus Fight for Jetliner Contracts All Around the World," *Wall Street Journal,* Mar. 20. 1984, p, 1.

ticularly difficult one. Between the initial agreement in September 1983 and formal contract signing on January 12, 1984 (for delivery in July and August 1984), the governments backing Airbus reportedly instructed their ambassadors in Cairo to lobby Prime Minister Fuad Mohieddin to persuade EgyptAir to choose Airbus.[104] In a final but unsuccessful effort to thwart the Boeing sale, Aerospatiale's chairman, Henri Matre, was said to have offered Egypt a role in producing the airliners.[105]

It thus appears that both U.S. and European manufacturers of commercial aircraft are being subsidized–but the extent of the subsidies, either direct (through subsidized loans) or indirect (through R&D programs or diplomatic support) are difficult to gauge. Both sides see the growth of government assistance as a response to the "unfair" practices of the other players. Boeing Commercial Airplane Co., as a private, for-profit business, must compete against Airbus, an essentially state-run business which is predicated on other factors in addition to turning a profit.

Because of continuing disagreements over subsidies, a special aircraft sector agreement was established in 1981 between the United States and major European countries to set clearer rules of the game in financing exports of commercial aircraft. This common-line agreement (subject to renewal every 6 months) sets a minimum interest rate and maximum cover for government agencies. Thus, in the past few years progress has been made to ensure that supplier governments adhere to similar rules of the game in financing exports of commercial aircraft.

Aircraft Engine Suppliers

Aircraft engine manufacturers have been involved in maintenance facilities in the Middle East. General Electric, for example, recently assisted Egypt in setting up an engine maintenance facility. This is a limited modular facility capable of expansion, but it is not now conducting major overhauls. Similarly Rolls-Royce is providing Saudi Arabia with engine overhaul equipment. The engine manufacturers play an important role in supplying equipment for local maintenance bases, but much of this equipment can be supplied by other types of firms involved in aircraft and engine maintenance. Chief among these are the major airlines.

Commercial aircraft engine manufacture and sales is a separate realm of competition. Ten years ago, the situation was fairly simple: Pratt and Whitney (U. S.) dominated the market and each plane model was matched with a specific engine from a specific company (almost always Pratt and Whitney). Today, the Pratt and Whitney Aircraft Group (a division of United Technologies Corp.) has two strong competitors: Rolls-Royce (U. K.) and the General Electric Aircraft Group (U.S.)[106] G.E. also has a joint venture called CFM International with the French corporation, Snecma.

Today, each of the new, more efficient airplanes, the Boeing 757 and 767 and the Airbus A300 series, can be fitted with engines from at least two of the manufacturers. In addition, a multinational consortium, International Aero Engines, is now developing the V2500 engine which will be able to power the A320 now under development (the A320 can also be powered by the CFM International CFM56-4). The fact that an airliner can now be built with engines from different manufacturers is important on two counts. First, it intensifies competition among the engine makers who may be willing to make concessions in order to win contracts for particular planes. Second, if an aircraft manufacturer feels that its sales may suffer because it carries a particular engine (e.g., U.S. controls on exports of U.S. engines

"['Robert Bailey, "Boeing Strikes Back, " Middle *East* **Economic** *Digest,* Feb. 3, 1984, pp. 34-35.

'[' Ibid., also David Marsh, "France Offers Egypt Airbus Work in Bid to Beat Hoeing, *Financial Times,* Dec. 6, 1983.

'['Worldwide projected market shares for jet engines in the 1982-86 period are projected as Pratt and Whitney (36 percent); G.E. (30 percent); CFM International (23 percent); Rolls-Royce (9 percent); and other (2 percent), according to Forecast Associates, Inc. See Agis Salpukas, "Aircraft Engines: Stiff Rivalry Pratt Loses Its Big I.cad, The New *York Times,* Jan. 21, 1983, p. D1.

prevented sales of Airbuses to Libya), the company may opt for another engine which does not present those risks.

Competition among engine manufacturers, particularly in fast-growing markets such as the Middle East or Asia where an entry in the lucrative market is desired, has been hard fought. In competing for sales of the two new jetliners for Thai Airways International, the aircraft manufacturers and engine manufacturing groups that initially teamed up to bid later shifted sides.[107]

Airbus Industrie is becoming increasingly cautious about using U.S.-origin engines in their airframes. U.S. export controls reportedly delayed the sale of Airbuses to Libya.[108] The Airbus consortium therefore considered using engines made by Rolls-Royce as a way to circumvent the U.S. ban.[109] A study was carried out in 1983 by Airbus Industrie to determine what components would have to be changed on the A300 or A310 in order to export these aircraft to Libya.[110] The study indicated that Airbus aircraft include more than 30 percent U.S.-built content by dollar value (much of this due to U.S. engines), and that with such a high percentage of U.S.-built equipment, the aircraft are effectively under the restrictions imposed by U.S. export controls. Although the new A320 being developed may not be free of these restrictions since both available engines are partly U.S.-built, the Europeans talk of reducing U.S.-built content as much as possible so as to limit [J. S. influence on Airbus export sales.[111]

The Airbus A320 will be powered by engines produced only partly in the United States– the CFM International CFM56-4–or the V2500 under development by the multinational International Aero Engines consortium. These engines are nevertheless subject to U.S. export controls. The fact that the V2500 falls into this category is of great concern to Rolls-Royce of the United Kingdom, one of the members of the engine consortium along with Pratt and Whitney of the United States. The U.S. Government has agreed to working-level discussions concerning the control of exports of the V2500 engine once it has been certificated. In return, Rolls-Royce has indicated that it will abide by U.S. export control restrictions on the engine.'" As a result, the U.S. Department of Commerce issued export license authorization for the program on March 9, 1984. The British, however, are still concerned that U.S. export controls that may be administered in an extraterritorial manner. Rolls-Royce officials have stressed that their agreement was not a government-to-government one, and that they agreed to abide by U.S. export controls on the understanding that there will be serious negotiations on how the rules will be applied to the V2500 engine. "

Airport Systems

Airports in the Middle East are being expanded to accommodate increased air traffic in the region. Saudi Arabia recently completed airports at Jeddah and Riyadh and is planning another major development for Dhahran, as well as a number of regional airport projects.

[107] See William M. Carley, '"The Air War—Boeing, Airbus Fight for Jetliner Contracts All Around the World, *Wall Street Journal*, Mar. 20, 1984, p. 1 The real winner of this contest may have been the customer-Thai I nternational. Thai Senior Vice I 'resident, Mr. Lumholdt, was quoted as saying, "We got a wonderful deal with all the concessions, we figure we got one $50 million airplane for free,

[108] David White, " Airbus Deliveries to Libya Delayed," *Financial Times*, Aug. 9, 1982

[109] "Libyan Airlines Negotiates Airbus Lease," *Middle East Economic Digest*, vol. 26, No. 47, Nov. 19, 19H2.

[110] *Aviation Week and Space Technology*, Apr 4, 1983, p. 29, and Mat-, 19, 1984, p 31, See also Michael Donne, "Air hus I ndustrie S t i l l H opes To S e l l Libya A300s, " *Financial Times*, Lad. 26, 1 984, p. 7.

[111] "U I S. Tries to Stem Airbus Business Loss," *Aviation Week and Space Technology*, Mar. 19, 1984, p. 31. (Crawford F. Brubaker, Deputy Assistant Secretary of Commerce for aerospace who visited with government and aerospace-industry officials in Europe in March 1984, said he would not like to see a reduction of U .S. participation in the A320 program. However, he stated that there appeared to be a growing trend toward " de-Americanization, or, put the other way, the Europeanization of the A 320. See also Jeffery M. Lenorovitz, " Europeans Endorse A320 Production, " . 4 *viation Week and Space Technology*, Mar. 19, 1984, p. 29.

[112] "2R0115 Signs V2500 Export Plan, " . 4 *viation Week and Space Technology*, Mar. 19, 1984, p. 32, See also .'\ *viation Week and Space*, Nov. 7, 1 983, p. 30.

[113] Ibid.: *Aviation Week and Space Technology*, Alar. 19, 1984, p. 32. see also " A irbus orders for Rolls- Royce," *Financial Times*, May 1 7, 1984, p. 8; and Keith F. Mordoff, "Airbus To Offer \2500 option on A320," A *viation Week and Space Technology*, May 21, 1984, pp. 33-34.

Abu Dhabi recently opened a new airport, and major work has been underway in Cairo and Baghdad. Algeria has more modest plans for upgrading and expansion.

Airport development in the Middle East has relied extensively on technical assistance and equipment from the West. This has been provided by a variety of firms including airport consultants, architects, airlines, construction firms, civil aviation authorities, aerospace manufacturers, and a multitude of equipment manufacturers. This scattering of activity among so many different types of firms makes it extremely difficult to analyze the factors determining commercial success in supplying and transferring the technical skills for the development of airport systems. Bechtel (U. S.) had the role of construction manager for the Jeddah airport project. The firm was responsible for up to 60 primary contracts at any given time since 1978. Some of these contracts involved extensive subcontracting; one reportedly involved 1,500 subcontracts with equipment suppliers. Yet public information on most of these contracts is not generally available. The bulk of the primary contracts are said to have gone to non-U. S. firms, but there is no way to document this. Although much of the actual equipment orders sourced through subcontracts reportedly have been won by U.S. firms, there is no way to verify this.

The civil aviation authorities of Western countries have been a major source of technical assistance in airport planning. France, the United Kingdom, and the United States have been the most active in this respect. Traditionally, such services were provided largely on the basis of colonial and historical ties, but today these links are less important. France actively seeks technical assistance relationships, and often assumes the costs under foreign aid. The United States responds to requests for assistance, which has been on a fully reimbursable basis since 1967. The United Kingdom pursues an approach similar to the United States, although it does occasionally assume the cost of technical services.

The actual implementation of airport development projects, such as those in Saudi Arabia, is normally carried out by groups of firms with separate contractual responsibilities. U.S. construction firms, Bechtel and Parsons, in joint venture with Saudi firms, are providing construction management services at Riyadh and Jeddah. The actual work and equipment contracts have gone to a multitude of firms from several countries, as mentioned above. In contrast to this type of multicontract international division of labor is the French approach of providing a comprehensive package which includes planning and design, construction, equipment installation, and even financing. This approach has reportedly enhanced the positions of French firms, as illustrated by the Cairo airport modernization work. This project began with a feasibility study by Aeroport de Paris in 1978, which included design of the terminal and construction supervision. Thomson-CSF supplied and installed the electronic equipment for the air traffic control system, and terminal construction was carried out by a French/Egyptian joint venture. Some financing was also made available through official export credits. This size of package would not have been sufficient to accommodate projects such as those in Riyadh or Jeddah. This approach does, however, allow for coordination of all facets of project development and implementation, which the French foster through this type of consortium.

Technical support in the operation and maintenance of airport systems is provided by a wide variety of firms. The Dhahran airport is operated by a services division of the Boeing Co. In other areas, technical assistance is provided by affiliates of airlines such as British Airports International, which has been active in the Gulf States, diversified aerospace companies such as Lockheed, which had a contract for the first phase of Saudi Arabia's air traffic control system, and equipment manufacturers. In Saudi Arabia, the major responsibility for operation and maintenance of the air traffic control system is handled by Bendix under a 1980 contract from the Presidency of Civil Aviation (PCA).

The case of the Bendix air traffic control contract illustrates factors influencing competition. Bendix won a contract in 1980, replacing the U.S. firm Lockheed. Bendix has overall responsibility for the air traffic control system, including staffing, equipment maintenance, training, and advising on new equipment for expansion. Logistical arrangement of the system is an important component of the contract, due to the variety of equipment types installed and the need to replace parts from many different countries. Bendix manages a training center in Jeddah, which has mockups of all the major systems in use. The major aim of the contract is to train Saudi Arabian nationals for eventual takeover. However, due to the shortage of qualified personnel, complete takeover by the Saudis is still a long time in the future, Bendix has over 1,000 foreign nationals under contract in Saudi Arabia, but some portion of these are in support services such as housing, transportation, etc.

Bendix did not have a proven track record in managing similar operations in other countries, but the firm did have 20-years experience with NASA projects in the United States, Its principal competition was from Lockheed and SEL, a German equipment manufacturer. Bendix had done extensive work in Saudi Arabia, for the navy and army, and was well known to the PCA. Primary factors affecting the contract award were reportedly price and the efforts of a well-placed Saudi agent. Bendix was the low bidder on the project, and also set forth an institutional arrangement and contract proposal which satisfied PCA's concerns about logistical functions and internal decisionmaking. Bendix met these concerns by establishing an autonomous division in Saudi Arabia capable of handling the logistical and other responsibilities. Bendix also emphasized training Saudi nationals as controllers and system managers.

The most important factors influencing airport systems contract awards appear to be a proven track record in the technology or technical management area, a demonstrated willingness to train nationals, the effective use of local agents or joint venture partners (especially in Saudi Arabia), historical relations with a country or firm, perhaps including the involvement of the civil aviation authority, and price/financing. In different countries, these factors are of differing importance: Saudi Arabia, for example, has been comparatively less concerned with price and is increasingly attempting to diversify suppliers.

Air Traffic Control/Avionics

Air traffic control (ATC) in the Middle Eastern countries under study ranges from Saudi Arabia's state-of-the-art system to Egypt's visual sighting. ICAO periodically publishes a status report for airport ATC throughout the world which lists requirements for raising major airports to ICAO international standards. In this publication, Middle East airports rate, as expected, from excellent to poor. Upgrading recommendations are generally for airfield lighting, markings, radio navigational aids, AFTN (Aeronautical Fixed Telecommunications Network), and AMS (Aeronautical Mobile Service-approach control). New aircraft such as the Boeing 757/767 and Airbus 300/310 come with the state-of-the-art ATC compatible equipment—but these are of no use if the airport does not have adequate ground ATC equipment, such as is the case in Egypt. Improved ATC enhances airline efficiency and safety and is thus a priority in airport modernization. Raytheon (U.S.), Bendix (U.S.), and Thompson-CSF (France) are major competitors in ATC equipment.

Aircraft avionics encompasses both ATC functions and aircraft systems monitoring. Collins Avionics (a subsidiary of Rockwell International) and ARINC (Aeronautical Radio Inc.) are leaders in aircraft monitoring equipment. Delco and Litton Industries, also from the United States, are the leaders in general inertial navigation systems with Honeywell specializing in laser-gyro based inertial reference systems. Major competition for U.S. firms comes from Thomson-CSF and Aerospatiale ATEC equipment, which supplies the Airbus. New digital equipment also is being manufactured by France's Sfena in coopera-

tion with Great Britain's Smiths Industries and Germany's Bodenseewerk Geratechnik for the Airbus. Although. avionics seems an ideal entree for Japanese electronics technology, Japanese firms have not yet entered into this field. Color cathode-ray tubes for crew alerting systems are made by Toshiba and Mitsubishi, and Japan Aviation Electronics Industry, Ltd., is developing a laser-gyro inertial reference system for use in the Kawasaki XT-4 trainer. It is generally assumed that the Japanese will soon take significant steps into avionics, particularly digital systems.

Avionics will become dominated by digital systems (as opposed to analog) in the next few years, much as turbine engines largely replaced piston engines in large commercial transports. Digital systems are more expensive but more reliable (two to three times the mean time between failures) than analog systems. However, when they do malfunction, highly trained personnel with sophisticated equipment are needed to service them. Manpower requirements will thus shift even further to highly skilled technicians. At present, digital equipment manufacturers often give 3-year warranties which cover microprocessors and software modification. After that period, investing in spare parts for the equipment may be less expensive than developing digital maintenance expertise.

Aircraft simulators can cost up to $7 million each, $400 per hour to operate, and require highly trained personnel. However, when compared to the cost of actually flying a plane, the lifecycle cost savings are significant. Presently simulators are available for 13 commercial transport types and an equal number of smaller regional/corporate aircraft. Helicopter simulators are also available, although they are not as numerous. Major manufacturers of civil aircraft simulators include CAE Electronics, Ltd., of Canada, Conduction (U.S.), Curtiss-Wright (U.S.), Thomson-CSF (France), Redifon (U.K.), and Singer-Link (U.S.). Demand for simulators will grow as simulator "fidelity" (likeness to real-life) continues to improve.'"

[114] See ICAO *Bulletin Special Issue: ATC and Flight Simulators, vol. 37, No. 5,* May 1982, for six articles on aircraft simulators.

Private Aircraft and Helicopters

In addition to private travel within and outside some Middle Eastern countries, general aviation is used in air photography for oil and minerals, mapping, spraying, servicing of remote construction sites and drilling rigs, and for light freighting. Ownership of executive aircraft is concentrated in the Gulf area.

The use of private aircraft is limited by local problems. Many airports have a limited capacity for dealing with private aircraft, which will be expanded as airports are improved. In addition, because of security considerations, some governments have restricted registration of civil aircraft and individual aircraft movements.[115]

Among the smaller aircraft used by corporations, the Gulfstrearn, British Aerospace, Canadair, Falcon, and Lear models dominate the Middle Eastern market.

Helicopters are used to service oil derricks in the Gulf, worksites for fire control and first aid, such as at pilgrimage sites. Helicopters have been used to offload cement and steel pipe at Saudi ports and to lay pipe in the interior. Major suppliers in Saudi Arabia include: Agusta (Italy) primarily for military use, Bell Helicopter (U.S.), and Kawasaki (Japan).

Helicopter sales to the Middle East fell in 1982, although the downturn in world sales was sharper.[116] Nevertheless, the demand for helicopters in the Middle East has been fairly bouyant. It is estimated that 95 percent of the helicopters sold in the Middle East are for military uses. The largest helicopter sales at present in the Middle East are in Iraq (primarily due to the Iran-Iraq War) and Saudi Arabia.

[115] This assessment is found in "The New World of the Executive Jet, *Middle East Magazine—Aviation Survey,* August 1983.

[116] "Market Survey, Saudi Arabia," U.S. Department of Commerce, ITA, May 1981; "Building Up the Helicopter Fleets," *Middle East Magazine–Aviation Survey,* August 1983; "Saudis Expand Kawasaki KV-107 Helicopter Fleet," *Aviation Week and Space Technology.* May 21, 1984, pp. 150-151.

U.S. Export Controls

At the end of 1981, sale of Airbuses to Libya was restricted by U.S. foreign policy controls.[117] The sale of ten aircraft were blocked because they were to have General Electric engines, Six of the aircraft were not built. Four completed Airbuses destined for Libya reportedly remain at the Airbus production headquarters in Toulouse, France.

Table 65 shows the fleets of Middle Eastern airlines, including aircraft on order. While there is a preponderance of Boeing and Lockheed aircraft, reflecting the historical U.S. dominance in commercial aircraft, most aircraft on order are Airbuses. Indeed, Boeing has sold only three of its new generation aircraft (757 and 767). Airbus has made almost all sales of twin-engine, wide-bodied aircraft sales in the Middle East.

Opponents of foreign policy controls believe that these controls have strongly contributed to U.S. market losses in commercial aircraft sales in the Middle East. Potential buyers include countries designated as supporters of terrorism—currently Libya, Syria, and the People's Democratic Republic of Yemen—as well as other countries in the region that may turn to non-U. S. suppliers out of resentment of controls used for political purposes. Kuwait, for example, has urged other Gulf States to seek alternative suppliers of aircraft, in direct response to U.S. antiterrorism controls. The U.S. Department of Commerce cites such reactions as a partial basis for the reduction in sales of U.S. aircraft and avionic equipment in one of the largest and fastest growing markets in the world.

In testimony before the House Foreign Affairs Subcommittee on International Economic Policy and Trade on March 19, 1981, Mr. Harry Kopp, Deputy Assistant Secretary for Economic and Business Affairs in the Department of State, stated that:

> In no other area of the world were the successes of the competition so spectacular and our own sales performance so dismal as in the Middle East last year. Jet aircraft sales in the region climbed to $1,977 million, of which U.S. suppliers won only $259 million, or 13 percent, as compared with U.S. sales of over $1.5 billion the year before. Airbus, in contrast, selling $1.7 billion, captured 87 percent of the Middle Eastern market. . . . [Our] regional civil air attache in Tunis notes that the enormous decline in U.S. fortunes was not likely due to technical considerations, a lack of effort on the part of our manufacturers, not even to the quality of the airbus (sic). Rather, pivotal factors most mentioned by his contacts were: financing, political considerations, including foreign policy controls; high-level political support for Airbus; and the U.S. Foreign Corrupt Practices Act.

New orders for large U.S.-origin transport aircraft destined for the Middle East dropped from a peak of $1.1 billion in 1979 to $186 million in 1980,$380 million in 1981, and $89 million in 1982 (through September). On the other hand, Airbus orders for the same countries were $289 million in 1979, $1.2 billion in 1980, $484 million in 1981, and $661 million in 1982 (through September). Airbus orders for the Middle East totaled $2.3 billion during the 1980-82 period, compared with $655 million for U.S. aircraft.

Undoubtedly, various factors explain this shift in market sham, including differing availabilities of export finance as well as a desire in the Middle East to diversify sources of supply for civilian aircraft. Because U.S. export controls in this area were uniquely restrictive, they contributed to the decline in the position of U.S. firms. The U.S. embargo of spare parts sales to Libya, especially, further added to the reputation of the United States as an unreliable supplier. For Middle Eastern countries whose positions differ with the United States on issues such as the Palestinian problem, such controls present a real potential risk that they may be denied access to U.S.-produced aircraft.[118] The recent modification of controls

[117] David Marsh. "Airbus Components Plans Face Protests From U.S.," *Financial Times*, Mar. 21, 1984, p. 1.

[118] A Saudi manager recently said: "Another element [for Airbus selling so well in the Middle East Persian Gulf area] is the political climate these days. Many Middle East countries want to reduce their reliance on the U. S, This should not be underestimated in evaluating Air buses sales success in the re-

by U.S. officials to permit sales to scheduled airlines represented an effort to mitigate the adverse impacts of these controls.

Summary of Supplier Perspectives

Sales of large commercial aircraft are important both for the large dollar volume of aircraft sales and for the sales of auxiliary equipment, which includes testing and maintenance equipment, avionics packages, and spare parts. Planning, building, or operating airports, air traffic control, and navigation systems in the Middle East normally entail consulting or management contracts, a major area of strength for U.S. firms.

U.S. firms have led in commercial aircraft, avionics, and airport management. However, the stiff competition afforded by West European firms in each of these subsectors indicates that U.S. firms cannot count on continued technical superiority as the key to effective sales. Other factors such as low-cost bids, on-site support, and reputation for long-term supplier reliability may be critical in contract awards.

The main competition for aircraft sales in the Middle East presently is between the Airbus 310 and the Boeing 767. Industry experts note that neither one has a clear technical advantage over the other. While Airbus Industrie claims an edge in its avionics (aviation electronics), Boeing claims superior fuel efficiency. Both planes compete in the medium-range market, covering flights of 1½ to 5½ hours, which account for about 37 percent of departures worldwide. In the Arab world, this sector is expected to be worth $20 billion over the life of this generation of aircraft.119

Commonality of aircraft and engine type within an airline fleet is an important but not overriding consideration. If the price and financing terms offered by suppliers are similar, and future availability of spare parts is not a problem, in most cases airlines assemble mixed feets.

In airport systems development a multitude of equipment manufacturers provide the various system components, often coordinated by construction management firms. For example, Bechtel has the construction management contract for the new Riyadh airport, but the equipment installation and construction is being handled under a number of separate contracts.

Supplier firms such as Thompson-CSF of France have special strength in supplying ATC and navigation systems. The United Kingdom is active in the Middle East commercial aircraft systems market, particularly in Saudi Arabia. West Germany's major presence has been in Iraq. The United States is primarily involved in Saudi Arabia.

Official diplomatic support (involving the use of official negotiating leverage to influence contract awards) is a factor in commercial aircraft support systems. However, relations among airlines such as the 30-year TWA-Saudia relationship, or the previous Pan Am-Iran technical assistance agreements, may carry more weight. The importance of government support has some relevance in airport systems contracts, but strong links are often established through technical assistance provided by civil aviation authorities.

Technological differentiation is limited among firms supplying equipment and services for commercial aircraft support systems. The technologies and equipment are fairly standard; many firms from several countries can provide adequate support. The basic technologies (although constantly improved) are relatively mature and well dispersed among the major industrial countries and even some newly industrializing countries such as Hong Kong (aircraft overhaul) and South Korea (airport construction). Indeed, India and Pakistan have been involved in airport construction in the Middle East (see tables in app. 7A). The standing and experience of the supplier firm is sometimes important, although aircraft operation and maintenance relationships are based more on initial provision of aircraft.

gion, " quoted in "Middle, Near East Airlines Increase A300/A310 Use, " Aviation *Week and Space Technology*, May 14, 1984, pp. 47-49.

[1] ""NO Holds Barred in the Airbus—Boeing Battle, " *Middle East Magazine-Aviation Survey*, August 1983.

The use of local agents is an important, sometimes required, means of winning aircraft support contracts throughout the Middle East. This has been especially the case in Saudi Arabia and Kuwait. While in the past, local agents have been used solely to garner political influence in bidding contracts, their role has generally expanded to involvement in assuring contract performance and maintaining continuing client relationships. Hiring well placed agents has been an important means of penetrating new markets for firms with little prior experience in a country.

Price is important in aircraft operation and maintenance, because of the routine nature of these services and the fact that the-y are current, not capital expenditures. Price and financing are becoming more important in the traditional oil-surplus countries, as the extensive development plans conceived in the 1970's progress into implementation while surpluses from oil revenues have diminished. Pricing and particularly financing arrangements have been important in commercial aircraft sales. Stiff competition for aircraft sales in the Middle East and the large future stakes believed to be involved have led suppliers to use, along with attractive financing, purchase incentives. These include buy-back of competitors' planes, package agreements for spare parts, training, or engine maintenance centers, or promises of assistance to the buyer's aircraft or even non-aircraft industries. These purchase incentives seem likely to continue in aircraft sales in the Middle East.

The expansion of foreign policy controls on U.S. exports of aircraft along with other types of export controls and regulations on U.S. business, have affected U.S. exports negatively. West European governments have subsidized the Airbus consortium; at the same time, the U.S. Export-Import Bank has supported sales of U.S. aircraft with loans. What distinguishes the policies of supplier governments is the absence of export controls in Western Europe, and their greater use of high-level economic diplomacy.

FUTURE PROSPECTS

In the short-term, the recipient nations will continue to carry out their commercial aircraft plans incorporated in their 5-year plans. For Iran this may be difficult; for Iraq, almost impossible. Saudi Arabia has the most ambitious plans and can be expected to complete its present airport infrastructure goals without major problems. Algeria has a fairly well-developed airport system, and its needs are more in the area of modernization and expansion than building new airports. Kuwait, with one major airport, will continue to consider a second airport. Egypt, despite major financing difficulties, will attempt to improve its existing airports and ATC systems.

In the long-term the world airline industry is expected again to prosper, and increased airline traffic worldwide in general and in the Middle East in particular, will provide a climate conducive to improved profitability. Freight transport in particular is expected to increase dramatical. All of this will place increased demands on Middle East air traffic control, airport management needs, and aircraft service. The Middle East countries will build on their positive experiences with technology transfer in this sector, and will eventually fully staff their commercial aircraft support systems with indigenous workers.

U.S. firms can be expected to maintain their leadership in the civil aviation sector in certain countries in the Middle East for the near term—however, U.S. firms can no longer rely on technological superiority. Aviation technology is becoming increasingly international.

IMPLICATIONS FOR U.S. POLICY

The importance of supplier reliability is especially evident in commercial aircraft support systems due to spare parts compatibility and training needs. The United States has gained the reputation of being an unreliable supplier, in large part because of U.S. export controls. U.S. export controls govern sales of commercial aircraft, in that sales can be restricted if countries are seen as supporting terrorist activities. These controls are used to impose sanctions on countries supporting terrorist acts. The military applicability of civilian technologies is, however, limited.

Equipment that can be used directly for military purposes includes radar capability, troop transport airplanes (e.g., C-130 S), dual-use runways, and fuel storage and maintenance facilities. Concerns have been raised regarding applicability of commercial aircraft maintenance to military aircraft maintenance. However, maintenance, diagnostic tools, and training are vastly different for military aircraft that are not derivatives of commercial aircraft. While it provides a general base of knowledge in maintenance and repair, commercial aircraft training is not directly applicable to nonderivative military aircraft such as the General Dynamics F-16 air combat fighter or the Northrop F-5G. Military equipment, as compared to civilian, is built to different standards and requires different spare parts, and different maintenance training. Civilian helicopters are not easily used as military equipment, except for simple surveillance and transport. Thus, technically, there is little overlap between civil and military technologies and equipment. Some aircraft, however, do have both civilian and military uses, such as the U.S. C-130, or can be modified for military use.

Subsidies for manufacturers of commercial aircraft exist for both the United States and European rivals, either in the form of support for aircraft development, or subsidized loans. Diplomatic channels are often pursued by the Europeans in the form of trade missions by high-ranking government officials in order to promote sales, a route the United States does not often pursue.

Boeing and Airbus are engaged in intense competition, as illustrated by the Thai case mentioned earlier. In the Middle East, where many major purchasers of aircraft are less constrained by financial considerations than most developing countries, political factors have been particularly important in influencing sales. While it is often difficult, if not impossible, to identify the precise effects of politics on a particular sale, it is clear that the Europeans have in some instances benefited from their political support for Arab States. In contrast, strong U.S. support for Israel and the use of foreign policy export controls has undoubtedly served as an irritant to potential buyers in the Middle East. As a result, competitors are able to argue that the United States maximizes politics above trade, and recipient governments can point to purchases of comparable aircraft from non-U. S. firms as evidence of support for Arab positions.

The Airbus Industrie consortium, in its short 14 years of existence, has become a significant supplier. Although the consortium wants its aircraft to be profitable, motivations other than profits (employment, diversification of supply, technology development, prestige) are important, thus ensuring their continued support even if investors do not realize a favorable rate of return. U.S. policymakers must recognize that competition between Airbus and U.S. aircraft manufacturers, when carried out on fair terms, can be a good thing (for the companies and consumers alike). Enhancing, or even maintaining, U.S. market presence in commercial aircraft and aircraft support in the Middle East will be increasingly dependent on cost, financing arrangements, diplomatic support, and especially, consistent policies regarding export controls.

SUMMARY AND CONCLUSIONS

Each of the countries under study has a civil passenger airline (Kuwait Airways Corp., Saudi Arabian Airlines Corp., EgyptAir, Air Algérie, Iraqi Airways, and Iran Air) with the longest route miles being covered by Saudia and the shortest by Kuwait Airways. Operating statistics of these airlines (e. g., revenue passenger kilometers flown, revenue passenger loads, and average daily aircraft utilization) are comparable, in most cases, to those of other national flag carriers operating internationally.

The airlines of the Middle East have a preponderance of Boeing aircraft (707, 727, 737, and 747 in several variations), a smaller number of Lockheed L-1011s, and an increasing number of Airbus A300s and A310s. The airlines also have smaller planes such as the Fokker F-27, De Havilland DHC-5, and Hawker Siddeley 748. The average age for Middle Eastern jet aircraft is much lower than the world average for nonjet planes. All air carriers can perform routine maintenance and checks at their own facilities. Saudia, which had a comprehensive maintenance facility completed in 1979, can perform major overhauls as well. Aircraft engines for large commercial aircraft are manufactured by Pratt and Whitney, General Electric, Rolls-Royce, and CFM International.

All of the airlines rely on expatriate labor to some extent, with Kuwait and Saudi Arabia being the most dependent and Egypt and Iran being the least. The airlines are making efforts to reduce expatriate labor (e.g., Saudia has been successful in making one-half of its pilots Saudi nationals) but in the near term complete self-sufficiency will be difficult if not impossible to achieve-particularly among maintenance and overhaul personnel needed for Saudi Arabia's and Kuwait's airlines. Thus, Middle Eastern airlines will continue to need technical support in aircraft maintenance and operation from foreign sources.

The six countries under study have carried out significant airport development, with the efforts of Saudi Arabia being the most ambitious. Most major new airport construction is complete or near completion. Future plans emphasize upgrading existing airports rather than initiating new, expensive projects. Upgrading of a regional airport to handle international (wide-body jet) flights is planned for Saudi Arabia, Algeria, and Iraq. Upgrading of air traffic control is also planned for all but the newest airports. Major airport designers/prime contractors are all from the West and include Bechtel, Aeroport de Paris, and Hochtief. Actual construction work is, however, increasingly done by Korean firms. Future work will emphasize improvements in freight handling, airport access, runway expansion and strengthening, and construction of maintenance facilities.

Commercial aircraft support thus involves fairly well-defined, well-established technologies and technological processes which can, and have been, increasingly performed by indigenous personnel in the Middle East. The fact that the process of training indigenous personnel takes so long demonstrates that, even for moderately complex systems, technology absorption can be difficult and requires considerable efforts on the part of both recipients and suppliers. Despite the moves towards self-sufficiency in this sector in the Middle East, in some countries all aircraft operations may never become fully staffed by nationals. This is, however, not due to lack of capability on the part of local workers, but to a shortage of indigenous manpower willing to perform certain tasks, such as engine maintenance in Saudi Arabia or Kuwait. These two countries should be able to complete the expansion of their commercial aircraft support systems but will have to continue to use foreign workers at some levels. For Algeria, Egypt, Iraq, and Iran, the local labor force could support an expansion of commercial aircraft systems. Attention will have to be paid to the training of aircraft mechanics, in particular. Civil air traffic expansion is unlikely in Iraq or Iran while their war continues. Technology absorption in the commercial aircraft support systems sector can be expecte to be-

come more extensive in the years ahead, due to expanded facilities and training programs currently underway.

The fuller absorption of commercial aircraft support systems technology by the recipient Middle Eastern countries compared to other technologies in this study stems mainly from three factors: 1) a commitment on the part of the recipient governments to develop this technology for transportation infrastructure needs and for prestige; 2) the fact that training and performance in this sector are well defined by international standards; and 3) the relatively long experience with these technologies which are in some respects not as demanding as nuclear power or certain types of telecommunications systems.

Commercial aircraft support worldwide is becoming increasingly sophisticated and will require more highly trained personnel in the future. The heavy responsibility which comes with commercial airline support services with regard to human lives, invested capital, and reputation is a continued impetus to maintain high standards. The increased complexity of avionics systems, simulators, and air traffic control will ensure expansion of training throughout the world, not just in the Middle East.

Airline operations in the Middle East are generally on a par with internationally accepted standards except for air traffic control. Egypt is considered to have one of the least effective ground ATC systems in the world although it is now being improved. The ATC system of Iraq is also poor. Increased passenger and freight traffic will require modernized systems to maintain and improve airline efficiency in the Middle East.

Airport planning and construction has been performed primarily by expatriates, both working for private firms and international organizations such as ICAO and IATA, Construction has been managed by Westerners, with construction crews often from the Far East. Airport management in the Middle East has often been performed by nonnationals, particularly in the Gulf States where U.S. firms have been active. Indigenous personnel are being trained and will increasingly take over these operations.

The United States is generally acknowledged as a leader in avionics and aircraft engines. Increasingly, however, adequate substitutes are available for U.S. technology. The United States has recently been perceived as an unreliable supplier in the Middle East due to U.S. export controls, and more Middle Eastern countries are attempting to diversify suppliers. The Airbus, for example, uses U.S. engines and hence deliveries to Libyan Arab Airlines have been delayed due to U.S. foreign policy controls on exports to Libya. The Airbus consortium was considering recertifying the Airbus with Rolls-Royce engines (despite the considerable cost) in order to avoid such delays. That the new Airbus A320 will contain less U. S.- manufactured equipment appears certain, partly in response to concerns about U.S. export controls.

A major concern for U.S. aircraft manufacturers is the inroads the Airbus 300 (and potential inroads of the Airbus 310 after 1984) have made in the Middle Eastern market. The new fuel-efficient Boeing 757 and 767 have not been purchased extensively by buyers in the Middle East. Some say this is not because of the technical superiority or better after-sale service of the Airbus, but because the United States does not support aircraft sales financially or politically in the manner that the French sell the Airbus consortium. Through U.S. Government support for aerospace R&D in the form of export credits, however, the U.S. aircraft industry has been promoted.

U.S. export controls are also often cited as a reason for lack of new U.S. sales of aircraft in the Middle East region. Future sales of U.S. civil aircraft, and perhaps of aircraft engines in the growing Middle Eastern market are hindered by these controls, despite the aggressive sales techniques of U.S. manufacturers and the high quality of their products. Sales of export aircraft, plus their long-term attendant support services and spare parts, are a significant factor in the U.S. balance of trade and

in U.S. employment. Other large markets which may eventually develop in Latin America and Africa could also be affected by the fear of potential purchasers that they might be subjected to future controls. While supporters of export controls see them as a means to exert pressure on countries supporting terrorist activities, policy makers must also take into account the commercial costs and the evidence that foreign policy controls do not appear to have by themselves resulted in change in the policies of foreign governments. Modification of present U.S. foreign policy control policies concerning commercial aircraft sold to foreign commercial airlines deserves serious consideration.

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APPENDIX 7A: COMMERCIAL AIRCRAFT SUPPORT SYSTEMS: SELECTED RECENT CONTRACTS IN THE MIDDLE EAST

Table 7A-1.—Selected Recent Commercial Aircraft Support Systems Contracts in Saudi Arabia

Supplier country	Year	Supplier	Description	Amount (millions of dollars)
United Kingdom	1976	International Aeradio	Establish civil aviation training center at Jeddah	$ 30.0
Canada	1979	Air Canada	Maintenance contract for Saudia's Lockheed Tristars	2.0
United States	1980	Bendix Field Engineering Corp.	To supply system engineering, maintenance services and staff as well as operating air traffic control equipment and facilities at 31 airports. Also, supply training, automated data processing and recruitment services	337.0
United States	1979	Trans World Airlines	Technical assistance agreement to supply technical personnel to maintain Saudi aircraft and train Saudi nationals. Involved approximately 150 TWA personnel. Ran from May 1979 to December 1983	NA
United States	1984	Trans World Airlines	A continuation of the technical assistance agreement above. Runs from Jan. 1, 1974 to September 1986. TWA personnel involved begins at 150 and is gradually reduced to zero by the end of the contract.	NA
United States	1979	CRS Design Associates and Metcalf & Eddy	Design aircraft support facilities project managment site planning construction documents.	10.9
France	1979	Union de Transports Aeriens Industries; Societe de Etudes Techniques and Enterprises Generales; Dumex-Batiment; Joseph Paris	Airport hangar construction and maintenance for royal family aircraft at Jeddah	
South Korea	1980	Dongsan Construction & Engineering Co., Ltd.	Construct telecommunications building, air cargo building, public safety complex, catering and central kitchen, fire station and other facilities at Riyadh International Airport.	205.0
Saudi Arabia	1980	Saudi Tarmac Co., Ltd.	Build terminal links to connect the four main terminals at Riyadh International Airport.	84.1

SOURCE: Office of Technology Assessment.

Table 7A-2.—Major Projects and Sources of Investment, 1971-81: Commercial Aircraft Support in Egypt

Source of funds	Project	Foreign nations involved	Contractors	Produce	Year started	Level expenditures	Comments
—	Cairo airport expansion	–				$150 million	Not a U S company
World Bank	Luxor airport	—	—	Study	—	–	.
—	Imbaba airport (Cairo)	United States		Upgrade to international capability			USAID feasibility study requested
—	EgyptAir engine shop	United States	General Electric	Overhaul aircraft engines		$14 million	Turnkey project
French government 8-9°0, 10-year term	Commercial aircraft radar system	France	Thomson-CSF	Radar control system	1981		Expected to be signed soon
U.S. foreign military sales credits	Benha Factory (No. 144)	United States	Westinghouse	TPS-63 military radar	—	—	Licensed production under discussion

SOURCE Off Ice of Technology assessment

Table 7A-3.—Major Projects: Civil Aviation in Algeria, 1979-82

Description of projects	Clients	Contractor	Location	Value of contract	Year
1. Design of pilot training centers	Ste. Metal-urgique Rias-Bajas	Tractional (Belgium)	Thenia	Not stated	1981
2. supply of Boeing 737s and 727s with Pratt and Whitney engines	Air Algérie	Boeing Co. (United States)	—	$35 million	1981
3. supply of six C-130 Transport aircraft	Air Algérie	Lockheed (United States)	—	$100 million	1981
4. Design of airport with 3,000 meter runway	Air Algérie	Uvaterv (Hungary)	Tiaret	Not stated	1981
5. supply of three Hercules L100-300 aircraft	Air Algérie	Lockheed (United States)	—	$30 million	1981
6. Turnkey contract to design and build airports	Air Algérie	International Airport Authority (India)	Setif and Batna	$100 million	1982

SOURCE Off Ice of Technology Assessment

Table 7A-4.—Selected Recent Commercial Aircraft Support Systems Contracts in Iraq

Supplier country	Year	Supplier	Description	Amount (millions of dollars)
[illegible] West [illegible]many	[illegible]	Universal Hoch and Tisfbou/Bilpinger and Berger and Strabag Bau	Construction of Basra Airport	$586.0
France	1979	Spie Batignolles and Fougerolle	Construction of Baghdad International Airport	900.0
Japan	1976	Pacific Consultants International	Study and design airport extension	4.3
Pakistan	1981	FEEDIA Agency	Supply of foreign labor for airport construction	NA
United Kingdom	1981	British Airports International	Provision of training courses	1.3
United Kingdom	1981	International Aeradio	Provision of training courses	0.53
United States	1981	Boeing	Supply three Boeing 727s and two Boeing 747s	183.6

SOURCE: Office of Technology Assessment.

Table 7A-5.—Selected Commercial Aircraft Support Systems Contracts in Iran

Project's main characteristics	Total investment size	Year established	Domestic partners	Foreign partner(s) and other details
1. Aircraft refueling vehicles	316,000	1970	Iran Air	British firm—to provide lightweight aircraft refueling vehicles and trailers
2. Boeing 737s	$ 18.5 million	1970	Iran Air	3 Boeing jets
3. Concordes		1972	Iran Air	Preliminary order for 2 British-French Concordes
4. Boeings	$ 19.6 million	1973		2 planes (707, 737), with Eximbank loan of $7.45 million
5. Boeings—for oil	$ 60.0 million	1973	Government	Six 707s to be purchased and paid for by Iran in oil. Eventually canceled
6. Boeing jets	$103.0 million	1974	—	Purchase of three 727s, two 747s. Partially financed from a $45.3 million loan by Eximbank
7. Cargo and passenger jets	$ 99.0 million	1975	—	Contract for six 747s, two adapted for cargo and passengers
8. Boeing 747s	$ 49.5 million	1975	—	Three additional jets
9. Concordes		1975	—	Order for two British-French Concordes. Eventually canceled prior to delivery
10. Boeing	$200 million	1977	—	Aircraft provided by Boeing
11. Boeing 747s	$250+ million	1978		Five 747s (4 747-100Bs, 1 747 SP)
12. Airbus jets	—	1978	Iran Air	6 Airbus A-300s, to be delivered between 979 and 198 Two leased
13. Airport Lighting	$100,000	1978	Government	Runway lighting systems for Mehrabad Airport Tehran Provided by Sylvania division of GTE
14. Boeing Commercial Aircraft Corp.	—	—	Government	Airport maintenance, training, and airport construction
15. Other airport support systems	—	—	Government	Northrop, Grumman, Sperry Univac, Hughes, Ford, E-Systems, Teledyne, Pan American, Rockwell Int., DH Canada, British Aerospace (Hawker Siddeley), United Technologies, Fokker, Lockheed, McDonnell Douglas
16. Pan Am—Iran Air Technical Assistance agreement	—	963-78	Iran Air	Pan American World Airways; Ongoing technical assistance agreement to provide training and personnel for maintenance and operations of Iran Air fleet
17. Suppliers of light aircraft to Iran	—	—	—	Piper Aircraft (U.S.), Cessna Aircraft (U.S.), Beechcraft (U.S.), Hawker-Siddeley, Ltd. (U.K.)
18. Suppliers of ground avionics equipment	—	—	—	Hallicrafter Co. (subsidiary of Northrop (U.S.)), Collins Radio Corp. (division of Rockwell International (U.S.)), Stancil-Hoffman (U.S.), Marconi Electronics, Ltd. (U.S.), Harland-Simons (division of Simons Engineering Ltd., (U.K.)), Standard Telephone and Cables Ltd. (U.K.), Siemens (FRG), Redifoss Ltd. (division of British Electric Tractron Co. Ltd. (U.K.))

SOURCE: Office of Technology Assessment