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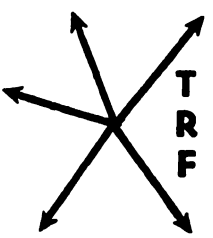

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Low Density Air Transportation in Developing Countries

*by Raymond A. Ausrotas**

TRANSPORTATION — the movement of people and goods from one place to another — constitutes a large portion of national expenditures. In the United States, which has a highly developed transportation infrastructure, the transportation industry accounts for about 20% of the gross national product. In developing countries where the infrastructure is not yet in place, transportation deserves careful analysis, for a large return on investment may be obtained by rational planning of the transportation system.

However, there is a problem. Investment in transportation for economic development purposes is not the only possible use of a country's resources. Although transportation planners, and even economists, know that the existence of a transportation system is a necessary ingredient if a country's economy is to grow, and that the lack of transportation can effectively retard development, the dimensions of the investment required and the resultant economic benefits are in general unknown. The usual input-output analysis is not totally applicable because transportation benefits more than one activity. What is clear is that transportation, in and of itself, will not cause miracles: "Where a nation is deficient in the factors conducive to growth, no amount of transport investment will create the economic dynamism that is so ardently desired."[1]

Assuming for the moment that the other factors (a proper mix of capital and labor, a market for the product, etc.) are present, and that investment in transportation is an appropriate policy for a nation to follow, there still remains the problem of what constituent parts to choose for the system. Ideally, the investment should be based on the following considerations:[2] (a) relative capital costs of alternative modes, (b) relative operating and maintenance costs of alternative modes, (c) volume of freight and passenger traffic to be carried (d) nature of the commodities to be transported, (e) distance that the commodities will be transported and, (f) relative demands of the alternative modes on the supply of foreign exchange available in country.

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However, a rational choice based on the above criteria is in practice almost never possible. First, few countries are fortunate enough to do their transportation system planning ab initio, and the vested interests of the existing infrastructure hold great power. Second is the problem of an adequate data base on which to make investment decisions. This lack of data (volume of traffic, maintenance costs, expected growth) greatly inhibits planners and consequently political rather than economical arguments usually win the day. (This is not to say that social costs should not be considered — but that economic costs be calculated as best as possible.)

Finally, particularly regarding air, there is the problem of myopia: when viewed on a macroeconomic scale, air transportation volume, especially cargo, is small compared to other modes. For example, Prest, on transportation in developing countries, notes:[3] "The relative unimportance of internal air travel . . . discussing present transport facilities in these countries one is covering the great bulk by concentrating largely on road and rail." Thus, air as a viable transportation mode tends to be more or less ignored by higher level government planners.

Despite the obstacles noted, air enthusiasts have had some success in making governments aware of the potentialities of their mode and investments therein have been made — although these successes have come where air was not only competitive with other modes, but where it appeared to be the only choice — usually due to terrain difficulties. Here, air requires considerably less capital requirements than surface systems. In low density areas, especially, where passenger and cargo volumes are small, the savings available due to lower infrastructure costs compensate for the higher operational costs associated with air. Finally, once investment in air is decided upon, there is great flexibility of investment between capital intensive and labor intensive factors, such as expensive jets and large airports and cheaper, slower propeller-driven planes and small strips, etc. These cost trade-offs are extensively discussed elsewhere.[4,5]

Conversely, almost magical powers have occasionally been [illegible] air transportation:

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A common feature of these emerging nations is the lack of any kind of good ground transportation . . . But they are going to want their share of the world's trade and goods, without having to wait too long for it . . . Many countries can jump right into the jet age. There are large areas of Africa and Latin America where a few strategically placed airports could open up a new life for millions of people.[6]

It is extremely unlikely that economic activity can be created solely by flying aircraft into previously isolated regions. In fact, the mere creation of a transportation link of any kind does not mean that it will necessarily be used. A more realistic assessment of the value of air transportation in low density areas, aside from the movement of people and goods, is that it serves as a communication device and increases national unity by linking a scattered population.

Although it is impossible to generalize adequately about developing countries, certain common characteristics do exist. There are usually difficulties associated with, first, the geography of a country, i.e. aspects of topography, climate, and vegetation, and second, the economic state of a country, i.e. density of population, availability of capital, and size of per capita gross national product.

A look at a relief map of the earth indicates that a dominant feature of many developing countries is the presence of a large number of mountains and plateaus. For air transportation, this means that the aircraft used on these routes must not only operate from high altitude airfields, (whatever condition they may be in), but must then fly at yet higher altitudes (10,000 to 20,000 feet) in order to reach their destination, which is located beyond the mountain range. Thus a primary requirement for aviation imposed by the physical environment of developing countries is seen to be the capability to take off (without excessive loss of payload) from high, unprepared, short, and usually hot airfields.[7]

There are other climatic difficulties which occur often enough to be noted. Humidity can range from extreme dryness and dust storms in desert regions, as in North and Central Africa, to extremely high humidity in jungle regions, such as Brazil. Rain, thunderstorms, and floods follow the dry seasons in many countries, and aircraft must be suitable for use in these climatological extremes.

The airplanes must also be useful for more than one mission. The luxury of designing an aircraft primarily for passengers (or for cargo only) is not allowed the engineer who is attempting to meet the needs of under-developed areas. Given the fact that there is generally little competition, or help, from other transportation modes such as rail, highway, or ship, the range of missions that these aircraft must perform is very wide.

It must also be recognized that aircraft used on internal routes of a developing country are likely to have low utilization rates. The low utilization (which should also influence aircraft selection) is due to a number of factors: (a) lack of adequate navigational aids, both en route and at airports, limiting flights to daylight hours and high visibility conditions; (b) low demand, due to low population density and/or high cost of air transportation; and (c) short route segments.

The next two chapters will take a look in more detail at the state of air transportation in two developing countries in Africa, Ethiopia and the Sudan. These two countries have most of the general physical difficulties described above and provide typical examples of low density operations. They also provide a sharp contrast in the way authorities have viewed the role of air transportation in the respective countries.

CASE STUDY: ETHIOPIA

Ethiopia is the oldest independent country in Africa. It has been, until recently, almost an absolute monarchy under Haile Selassie. It lies in the northeast quadrant of Africa, occupying the so-called Horn of Africa, a total land mass of about 480,000 square miles (the size of Texas, New Mexico and Oklahoma combined). The country is bounded on the north and east by the Red Sea, on the west by the Sudan, on the south by Kenya, and the south and east by Somalia. It is the tenth largest country in Africa with a population (estimated) of 26 million, growing at a rate of 2.5 percent. The population is predominantly engaged in agriculture or stock raising (90%) and spread throughout the country, at a density of 53 people/square mile. The capital is Addis Ababa (population 700,000). Other major towns are Asmara (190,000), Dire Dawa (52,000), Harar (44,000), and Dessie (40,000).

Ethiopia has a complex topography. Its dominant feature is a high central plateau, which is split by the Great Rift Valley and has northern and western peripheries of hot, arid lowlands. The plateau ranges from 5,000 to 10,000 feet above sea level with mountains which reach altitudes of over 15,000 feet. Although it lies near the Equator (between 3° and 18° north latitude), in consequence of the altitude the climate is uniquely refreshing and mild with low rainfall and an advertised "Thirteen

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months of sunshine." The seasons are reversed with Spring commencing in September and the summer season running from January till June. It is an attractive country for tourism where many ancient historic Christian ruins exist and is now being advertised as the "Hidden Empire" in the U.S.A. and Europe.

The gross domestic product (GDP) of Ethiopia is roughly $2 billion, or about $75 per capital. The country has great agricultural potential — it is said that Ethiopia could feed all of Europe if the proper investment in agriculture would be made and transportation links established. There has been some backhaul of fresh vegetables to Germany and England in wintertime by charter aircraft returning empty to Europe after delivery of tourists to East Africa. Currently agriculture and other pastoral pursuits account for 50% of the GDP, mostly in the form of subsistence farming by tenants on great feudal estates. Cereals like maize, wheat, and barley account for 70% of the sown area. Coffee is the most important cash crop ($90 million), with most of the exports going to the United States. Ethiopia has about 3% of the world market in coffee. There are 26 million head of cattle. Beef is cheap and plentiful internally, although the herds are not raised efficiently enough for export.

The country is deficient in road and rail transportation facilities. There are two narrow gauge rail tracks: one from the port of Djibouti in Afars et Issas (formerly French Somaliland) to Addis Ababa (486 miles); one from the port of Massawa to Asmara and Agordat (191 miles). The road network consists of 6900 miles of mostly gravel and some asphalt roads. There are roughly 38,000 cars and 13,000 commercial vehicles in the country.

There are 42 airports in Ethiopia identified by the Civil Aviation Administration at altitudes of 300 feet below to 9000 feet above sea level. Only four paved runways exist: Addis Ababa, Asmara, Jimma, and Dire Dawa. The runways at the international airports of Addis Ababa and Asmara are capable of B720 operations. Runway lighting and an instrument landing system are installed at Addis Ababa. At present there is no scheduled night flying in the country. A single VOR-DME exists at Addis, and several non-directional radio beacons are maintained elsewhere. Of the 42 stations, 19 have radio communications.

The typical internal airport is a grass field, sloping slightly. The runway is marked by piles of white stone. There is a small station house with scales for weighing baggage. Gasoline is sometimes available for emergency usage. Local police with Land Rovers provide security and passengers on all internal flights are searched as a precaution against hi-jacking. A local station agent sells tickets, collects air freight fares and supervises the loading and unloading of a wide variety of goods moving by air.

Ethiopian Airlines (EAL) was formed by Imperial proclamation in 1945 as the Ethiopian flag airline. Concurrently, a management assistance program was signed with Trans World Airlines. From this beginning, EAL now has a fleet of two Boeing 707's, three 720B's, three DC6's, and nine DC3/C-47's. EAL in 1972 had operating revenues of about $40 million and an operating profit of $2.5 million, while it performed 268 million, revenue passenger miles and carried 290,000 passengers.

At present there are nineteen TWA advisers in EAL management together with some senior career pilots who have stayed with EAL since its inception. Thus the airline is now essentially managed and operated by Ethiopians. The international services consist of Boeing 720B services to Europe, West Africa, Middle East, and Asia (including India and The People's Republic of China). The West Africa and Asia services are not profitable yet due to low load factors. However, the European services are profitable even at a 1973 average load factor of only 32%. (EAL operates in pool with all European carriers serving Ethiopia). This low breakeven point is in part due to low labor costs for the airline (an average salary of $4,110). The consistent profit on the European routes has allowed EAL to sustain the introduction of other new routes and to cross subsidize the domestic routes. A generally good profit record has also allowed EAL to purchase new aircraft by obtaining favorable commercial financing; EAL prefers commercial sources rather than the U.S. Ex-Im Bank which had financed the initial purchase of two 720's in 1962.

The domestic services consist of a set of daily, twice-weekly and weekly DC-3/C-47 and DC-6 services from Addis Ababa to remote points in the provinces to supply a communication link and to transport essential personnel and cargo. The average load factor on domestic routes is 46%. The domestic services are provided by EAL in the greater interest of providing a tie for the various regions of the country. This was a prime objective in 1945, and still is a strong goal of EAL management, as the airline remains an instrument of domestic and international policy.

Because of the long distance from U.S. and European aviation communities, EAL has made itself almost self suffi-

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cient in the areas of maintenance and overhaul. It is performing all of its own work on its various aircraft including the jet and piston engines, avionics and instrumentation. It is presently training its own mechanics in all the required skills. EAL also performs maintenance work for other African and Mediterranean airlines as well as for general aviation in the area.

In 1971, the World Bank commissioned a study of tourism and aviation in Ethiopia[9] which forecast favorable economic results for an investment program in new hotels, aircraft, and airports along a so-called "Historic Route" from Asmara to Addis Ababa. The tourist would be able to travel by air from Asmara to Axum, Lalibela, Gondar, Bahar Dar, and then Addis, stopping overnight along the way to visit churches and other tourist sites. The complete tour package would involve four or more days, and provide a focus for advertising and promotion of tourism in Ethiopia. The Ethiopian Tourist Organization was to build the hotels, the Civil Aviation Association four new airports with help of a loan from the World Bank and EAL was to provide air transport services. The air travel portion of the tour package exists currently but the DC-3 services and the hotel capacity need expansion due to high demand. The airports are still under study, as are the hotels.

EAL is currently initiating a study of its domestic services aimed at changing the patterns of service and procuring modern short haul aircraft like the HS 748 and DHC-7 to replace or complement the DC-6B and DC-3 aircraft. To compound EAL's problems, Ethiopia is embarked on a new five year plan for the improvement of its road system. As these roads are established air travel may decline due to cheaper alternative transport costs. Thus, if new aircraft are purchased for regional service, the DC-3 service may be radically changed from the current one of a daily round trip from Addis Ababa, to a feeder ("hub-and-spoke") pattern where smaller aircraft bring passengers to regional hubs. Higher frequencies may be required to produce adequate traffic along routes where roads will provide competition. These traffic demand predictions are very difficult, however. The problem of making investment decisions in the face of large uncertainties is a basic problem facing internal air transportation system planners in developing countries.

In general, Ethiopia represents a successful application of air transportation for low density operations because the government has consistently given high priority to its development. The air service has tied a mountainous country of diverse social groupings to a central government, thereby helping to create and maintain a sense of national unity and allowing governmental assistance in economic development. While it cannot be quantified, air transportation has been an obvious important factor in Ethiopia's progress in the past thirty years.

CASE STUDY: THE SUDAN

The Democratic Republic of Sudan, henceforth the Sudan, is the largest country in Africa. It is also situated in northeast Africa, and is bounded by Egypt on the north, Libya, Chad, and the Republic of Central Africa on the west, the Congo (Kinshasa), Uganda and Kenya on the south, and Ethiopia and the Red Sea on the east. The Sudan covers an area of nearly one million square miles, approximately the size of Western Europe, while the population of about 16 million is that of the Netherlands. By virtue of its geographical position, it forms the link between the African civilization in the south and the Arabic civilization in the north of Africa and the Middle East.

At the beginning of 1956, when the first census was taken, population was 10.3 million; in 1972 it was estimated at 16.0 million with an annual rate of growth of 2.8 percent a year. Over half the population is under twenty years of age. About half the people live in fourteen percent of the country. In 1956 Khartoum, the capital, together with the adjoining towns of Omdurman and Khartoum North, had a population of 246,000. In 1972 it was 69,200. Other towns include El Obeid (76,000). Wad Medani (79,000), Port Sudan (116,000), Kassala (86,000) and Atbara (58,000).

The people are part Arab, part Negro and part Nubian. Those of the six northern provinces are mainly Arabised and Moslem. Those of the three southern provinces — Upper Nile, Equatoria and Bahr el Ghazal — are mainly Negro and pagan, but with small Christian groups. Arabic is the official language, but 48 per cent of the population speak other languages; English is widely understood.

High heat and the change of climates from south to north are the dominant features of the Sudan's climate. In the northern region conditions are those typical of the Sahara desert: very high daily maximum temperatures (126°F.) and no rainfall. In the south, rainfall is equatorial. As rain decreases northwards, the rainy season (February-October in the South) contracts to July and August. North of Khartoum no rainy season as such exists, although

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road and rail links are occasionally washed away by freak storms.

The first settlers appeared in the Sudan around 5,000 B.C. It has a long history going back to what was known as Nubia, ending with the Anglo-Egyptian Condominium, under which the British ruled the Sudan from 1899 to 1956 when the Sudan became an independent republic. A series of coups, largely bloodless, have since marked Sudanese politics, caused by stagnating economy and the civil war with the non-Moslem South which raged from 1967 to 1972. Since 1969 the Sudan has been led by Colonel Nimeiry who finally succeeded in arranging peace with the South in 1972.

The economic structure of the Sudan is typical of a country in the early stages of economic development. It is one of the twenty-five least developed countries in the world. Per capita gross national product in 1972 was $117; the manufacturing sector of the GDP was 9%; literacy rate was estimated at 10-15%; the percentage of students enrolled in school of the five — nineteen age group was 14%.

The Sudan is basically a one cash crop economy — cotton. Cotton brings in about 60% of total export earnings. The remainder comes from gum arabic (in which the Sudan has practically a world's monopoly), ground nuts, hides and other agricultural products. The Sudan too has vast agricultural potential, as has Ethiopia: nearly one third of the country's surface could be used for farming. The Sudan is virtually self-sufficient in basic foods.

Little has been done to exploit the country's mineral potential, although it is believed that rich deposits of copper, iron ore, manganese and chromites exist. This can be traced to a lack of risk capital, as well as an inadequate transport infrastructure.

Sudan Railways operates 3,000 miles of rail [narrow (3'6" gauge)]. Cotton and other goods must be transported by rail and volume during the harvesting season is particularly heavy. Freight traffic was estimated at 2.8 million ton-kilometers in 1970, vs. 1.6 in 1960. The railway is the fourth largest in Africa.

Sudanese roads, of which 300 miles are paved (basically in and around Khartoum), are inadequately developed as the government has chosen to improve and expand the railway first. For the most part the roads are dirt tracks, usually impassable after rain. Land Rovers and similar four-wheel-drive vehicles are the only feasible way to get about the country, although trucks, buses, and trucks converted to buses travel between towns. Nile river traffic is also important and the existing river fleet is being expanded and improved.

The first passengers and mail arrived by scheduled air service in the Sudan in 1931. The service was provided by Imperial Airways and flying boats were the mainstay of the route, landing on the Nile throughout the trip. Short "C" class flying boats (28 passengers, 140 knots, range of 850 miles) provided thrice weekly service from Southampton from 1937 until the outbreak of World War II, taking about 50 hours for the trip to Khartoum.

No internal air service existed until 1947 when Sudan Airways was established by the authorities, with management assistance provided by a British firm, Airwork Ltd. The original idea behind Sudan Airways was that it would provide air taxi service to meet the needs of the local administration. For this purpose four DeHavilland Doves were bought. Airwork was responsible for technical matters, and Sudan Railways for providing financial backing and management.

Promotion was the first order of the day for the airline, and free flights were offered to show that a plane could complete a three day camel journey in a half-hour. Traffic grew steadily from this beginning, and the Doves were replaced by DC-3's.

Sudan Airways restricted itself to intra-Sudanese operations until 1954. Then routes expanded: to Cairo with DC-3's, and then with Viscounts and Comet 4Cs to London. While the aircrews for these international flights consisted of British expatriates, Sudanese gradually took over the domestic routes. As the DC-3 was phased out, the airline acquired F-27's and Twin Otters for domestic service.

In 1967 Sudan Airways was reorganized as an independent state-owned corporation with its own management team. Its charter was to provide service on a profit making basis, dropping those points that the government was not willing to subsidize. After the 1969 revolution, however, management of the airline was taken over by a Productivity Council (16 members), with Sudan Airways representation a minority (6) and the bulk of the council, as well as the Chairman, being political appointees from various Ministries. Since late 1972, however, the pre-1970 management of Sudan Airways has been returned to the helm.

At the current time, international services are provided by Sudan Airways on two B-707s wet-leased from British Midland, which is providing pilot training for Sudan Airways as well. In July of 1974 Sudan Airways will take possession of two B-707-320 C's, which are

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being financed by the U.S. Ex-Im Bank. The initial plan submitted to the Ex-Im Bank (prepared in cooperation with Boeing) was for two B-737's as well, which were to replace the F-27's on some routes. However, only the 707's were approved. In the meantime, Sudan Airways is attempting to sell two grounded Comet 4-C's which it owns.

Although load factors on Sudan Airways are very high (80% on domestic, over 50% on international), so are costs. One reason for the high load factors may be that government employees travel gratis. Also, there had not been a fare increase for twenty years until August of 1973 when a 20% hike was allowed. Sudan Airways pays landing fees, foreign currency transfer charges, and custom duties on its parts. The engines are overhauled overseas.

The major equipment problem facing Sudan Airways is the F-27 replacement. The F-27's have been in service for fourteen years and are now flown in a thirty passenger configuration due to gradual engine power loss. The Twin Otters are flown in a sixteen passenger configuration.

The fleet of Sudan Airways has very low utilization due to lack of light and communications throughout the interior. The pattern of service is a morning trip from Khartoum to the provinces and return in the afternoon, similar to that of Ethiopia. Because of the distances and the slow speed of the aircraft, the trips can be accomplished only once per day, with no departures possible in the afternoon because of the uncertainty of the location of the outbound airports after dark.

It is hard to compare airlines of developing nations that have long links overseas, a large domestic network, and provide service to a low density population, with airlines in the United States. The difficulties are pointed out by the following statistics. Sudan Airways performed 158,000 rev-passenger kilometers in 1972, about the same as Quebecair, a regional Canadian carrier. But Sudan Airways carried 130,000 passengers (about 50% domestic and 50% international) vs. 360,000 passengers for Quebecair and the length of its scheduled network was 31,000 miles vs. 726 miles for Quebecair. Sudan Airways employed a total of 1,500 people vs. 500 people for Quebecair. Sudan Airways serves seventeen internal points, as well as thirteen points outside the country.

The major issue in the Sudan has been, and continues to be, lack of an adequate infrastructure. Only one airport can handle jets: Khartoum. Even so, most jet departures and arrivals are during a window which lasts from the late evening to early morning (10 P.M. to 8 A.M.) while the heat of the day is not too intense. Only two other airports are paved and have towers (Juba and Port Sudan), while, as previously noted, only Khartoum has lights.

The most immediate need appears to be lighting at other domestic airports. This would allow Sudan Airways to vastly improve service internally through increased utilization of equipment. The next important need is for telecommunications at airports to avoid needless trips to outlying stations to determine the cause of aircraft breakdowns. Finally, there is definitely need for airfield improvement, especially if plans of Sudan Airways to introduce jet aircraft on some of the internal routes proceed.

One planned capital expenditure which has been on the drawing boards for over two years appears to warrant review: the construction of a new Khartoum international airport, at a cost that will be in excess of $30 million. A feasibility study has been awarded to a group of Italian airport consultants, but financing has not been arranged, although World Bank help and foreign loans are anticipated.

The current airport is more than adequate for the traffic it handles and is close to downtown Khartoum (about a ten minute taxi ride). The reasons given for the relocation of the airport to about fifteen miles northeast of the city are: (1) The land on which the airport is located now has become valuable because of the growth of the city and the government would benefit by closing down the airport and re-zoning the area; (2) the saturation of the existing airport by 1980. While the rest of the country's airports need basic navigational aids and telecommunication equipment, as well as lighting, the construction of a new international airport appears to be a second-order priority.

It appears that Sudan Airways has the potential to be a profitable airline and provide a valuable domestic communication network as well if it concentrated its energies upon regional service, rather than international, and if the government would provide an adequate infrastructure for aviation in the Sudan — which it has not done to date. Given the size of the country and the poor alternative means of transportation for light volume and traffic, Sudan Airways is ideally situated to perform as a low density operator if the government becomes aware of its potential.

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