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Traffic Planning
Scientific Paper
U.D.C. 656.025.2:656.7(430)
Accepted: Mar. 2, 1999
Approved: Apr. 19, 1999

PASSENGER TRANSPORT BY AIR
How Germany may cope with a rapidly growing demand

ABSTRACT

In general, transport by air is the fastest mode of traffic. In economical and ecological terms, however, it appears less desirable. Moreover, its glory is usually confined to non-stop-links except when bridging land-sea interfaces or very long distances. Its current stand is mostly based on the lack of competing systems. Therefore, the capacity of airports is in many cases being extended. Attempts by railways to establish attractive alternatives of transport are not promising. In contrast, a transrapid net would provide substantial improvement as shown by the example of Germany which in this respect stands for most of Europe.

KEY WORDS

air transport, passenger transport, energy consumption, transport speed

1. INTRODUCTION

Airports in Germany and elsewhere are complaining of a trend most economists would welcome: the demand for air transportation is increasing rapidly.

This would pose no problem in countries like Saudi Arabia (cf. BARTH & SCHLIEPHAKE 1998, p. 137ff.) or parts of the United States where land property is cheap, distances between airports and the urban core areas may be 50 km or more, and no or few environmentalists hamper planning process and construction.

In Germany, as in other Central European countries, there is a strong concern about the negative impact of growing mobility as a consumer of space and energy and a producer of polluting agents. HUGHES (1993) has shown, from the British example, how a growing personal mobility may double CO_2-emissions up to the year 2020, if the transportation market remains deregulated and individual motor traffic the primary option.

In Germany, it seems that no major infrastructure project can be realised without the political and social consent in the area of planning (cf. SCHLIEPHAKE 1993), and the riots around the famous "Startbahn West" (western runway of Frankfurt Airport in the early 1980s are still remembered).

Germans - and their guests - try to avoid any negative impact on their environment, but they also like to use the most convenient mode of transport. Therefore, the demand for air transportation is growing even more quickly than the general transportation demand which has itself - in terms of kilometres per person - more than trebled since the 1960s (Figure 1).

2. DEVELOPMENT AND CURRENT SITUATION OF AIR TRANSPORT IN GERMANY

According to Table 2, air traffic, in terms of passenger figures (starting and landing), has nearly trebled over the last 20 years. This increase is hardly due to the integration of Eastern Germany where the number of passenger (not included in Figure 2) merely rose from 1.1m in 1975 to 1.5m in 1987. In 1997, 4.1m passengers embarked or disembarked at the three major east-German airports of Leipzig, Dresden and Erfurt, which is about 3.4% of the total passenger movement. Many of the potential air travellers use personal transport by land to major airports in the west or in Berlin. Therefore, east-German airports do not yet have a passenger share proportional to their surrounding population which, in their mobility behaviour, shows no market differences from west-Germany.

In 1976 40.6m passengers moved (embarking and disembarking) at the controlled airports in western Germany and this figure rose to 121.15m for both parts of Germany in 1997. The share of the four major airports with more than 10m passengers/year in 1996, notably Frankfurt, Munich, Düsseldorf and Berlin (with three ports of Tempelhof, Tegel and Schönefeld) among the total increased from 1976 do 1987

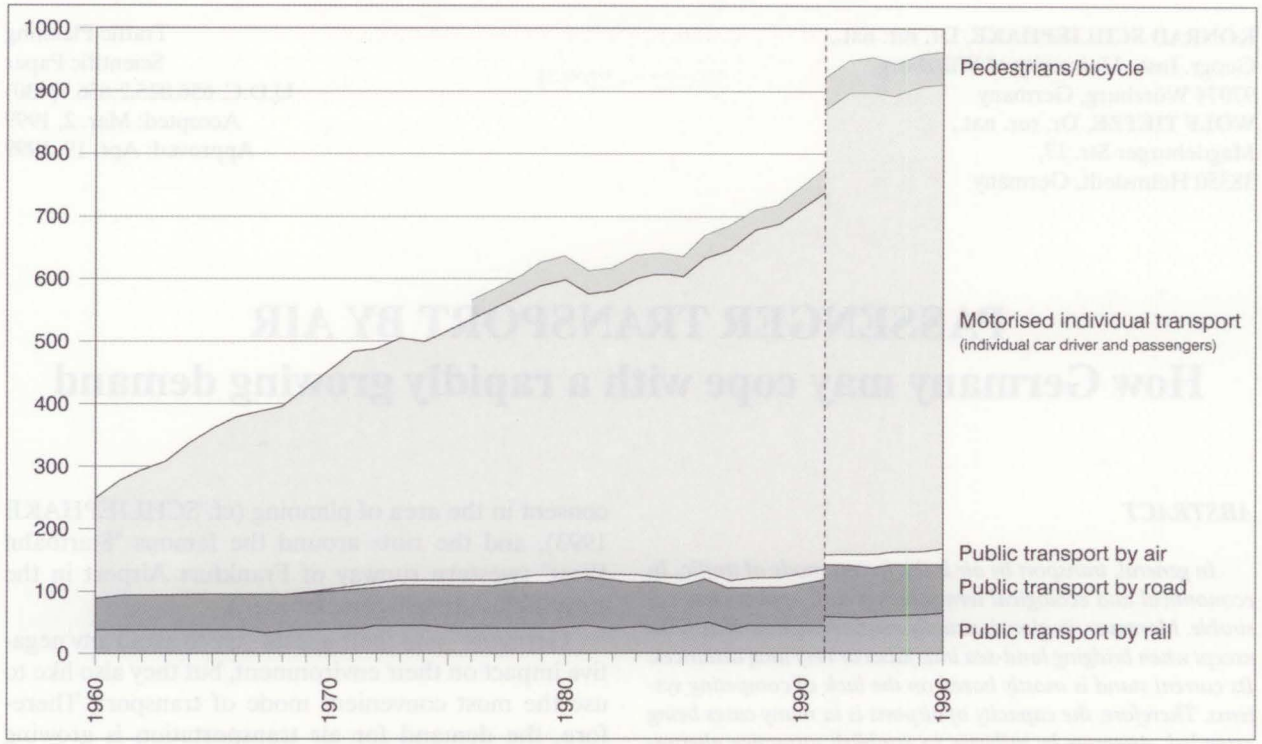

Figure 1 - Development of personal transportation by modes in Germany, 1960-1996

Source: SCHLIEPHAKE

(maximum share: 74.3%), reflecting a concentration of movements on certain hubs. Since 1987 the trend has been slightly reversed and emerging airports in the east (Leipzig, Dresden and Erfurt) as well as the phenomenon of air congestion (cf. Chap. 4), have diverted a slight share. The part of the four major German airports now stands at 69.3%.

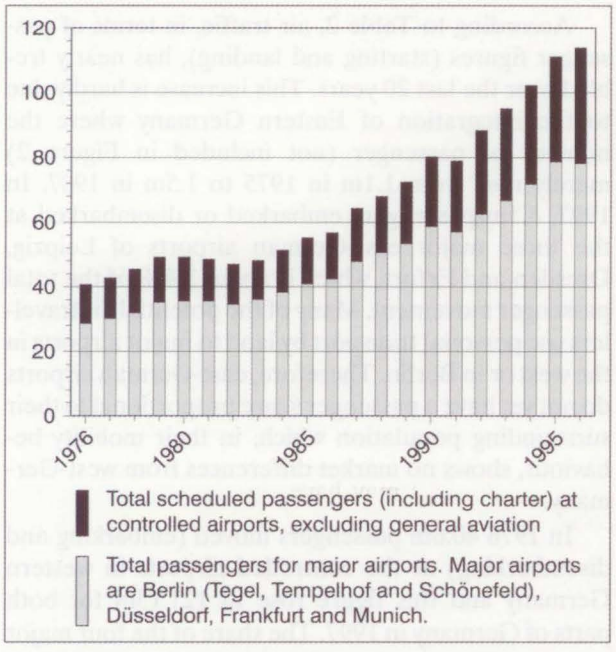

Figure 2. Germany. Development of passenger air transport, 1976-1996 and share of major airports (million passengers/year)

Source: SCHLIEPHAKE

With the reconstruction of road and rail infrastructure in eastern Germany it is probable that a trend towards concentration on the major hubs, as was visible till the 1980s, will show up again.

Since 1991 the number of passengers in German air traffic has grown by 7.8% p.a. (Frankfurt; +6.7% p.a.). All over Europe the increase in passenger numbers continues as we see from Table 1.

Although there is no certainty, few transportation planners and politicians doubt that the growth will be reversed. Even with a more modest growth rate of 5% p.a. this would mean that in 2005 Frankfurt would host approx. 60 m passengers waiting for something like 950 plane departures per day or 46 per hour during current airport operation from 4.30 to 1 a.m. This compares with today's 595 scheduled departures on an average summer day.

Reflecting on this issue, several options may be considered:

- Reduction in air transport by administrative measures, notably taxes on kerosene, tickets, curbs on expansion plans and restrictions on night flights; a strategy which is probably not (politically) feasible vis-à-vis a general trend towards deregulation, liberalisation and valorisation of market trends;
- Adaptation of the airport infrastructure to the growing demand by building additional runways

Table 1. Major European airports. Development in passenger figures (in million)

Airport	Passengers 1991	Passengers 1996	Growth p.a.
London (Heathrow and Gatwick)	58.94	79.86	6.3%
Paris (Orly and CDG)	45.30	59.09	5.5%
Frankfurt (Rhine-Main)	27.87	38.62	6.7%
Amsterdam (Schiphol)	16.54	27.79	10.9%
Rome (Fiumicino)	16.49	23.85	7.8%
Copenhagen (Kastrup)	11.95	15.9	5.9%
Madrid (Barajas)	16.46	21.86	5.8%
Zurich (Kloten)	12.15	16.23	6.0%
Total 8 airports	205.70	283.20	6.6%

Calculation: K. Schliephake, Verkehr in Zahlen 1997, p. 359.

and relieving it from any economic and ecological restrictions that, up to now, have reduced the offer in passenger flights: a concept that may not be realistic, notably in urban areas, due to political opposition;

- Construction or reactivation of new airports away from the urban areas where notably former military airports in western and eastern Germany (see Table 2) may be transformed: this option is quite costly as many of the airports lack the relevant equipment including major road and rail access;
- Transfer of some of the short-haul traffic to other carriers with properties similar to air transportation, notably reliability, independence from congested roads, comfort and service.

The first two alternatives will not be considered in our report, but several recent studies of the European Conference of Ministers of Transport are mentioned (cf. notably Efficient transport... 1998; Transport infrastructure... 1998). In contrast, the third and fourth options merit further consideration.

3. REACTIVATION OF AIRFIELDS

Although the scene is dominated by the four major airports (cf. Table 1), there is a huge airport infrastructure in Germany with a potential for (re-)activation as we can see from Table 2.

The figures from Table 2 pertain to

- 17 international airports
- 22 additional controlled airports of which 10 show scheduled public flights and 10 can receive jet planes
- 36 airfields for public use with surfaced runways of 1000 metres or more length. As jet planes require a minimum of approx. 2000 m runway, 12 would be able to cope with this type of aircraft.

However, our listing should be seen critically under the aspects of technical equipment and demand. Most of the former military airports in east Germany (whereas Table 2 lists only those which are currently open to the general public) are not in top condition, with concrete runways and no modern equipment for night flights and passenger reception. Due to their former military purpose, they tend to be at some distance from urban agglomerations and lack connections to major roads and railways.

Airports, as any transportation infrastructure, are demand-oriented as satisfactory demand only stems from major urban areas and from travellers who want to cover distances of at least 300-500 km (cf. Chap. 5). For the rest of the country and for lesser distances, passengers prefer ground travel, notably by the railway network.

Projects to build up a regional air transport system in the early 1970s saw little success and the heavily subsided airports of Hof and Bayreuth remain as one of the last examples. Kassel Airport (Table 2, No. 29) which once was to serve northern Hesse and adjacent territories is a symbol of failure, and other airports like Saarbrüken or Erfurt (with international flights up to the 1980s) are stagnating at best. Among the controlled airports, only Rostock (Table 2, No. 38) may have some chance to attract scheduled flights. Within the airfields for public use, Barth (Table 2, No. 44) might receive holiday-makers at the Baltic seashore again, as it did up till the 1980s.

Congestion and the fear of further growth at the major airports, empty air and land spaces and futile efforts to attract traffic at some of the others - is there a solution to such contradictions?

Table 2. Public airports in Germany with a runway of more than 1,000 metres length

Number	Location, name	Eastern Germany	Number of surfaced runways	Length of surfaced runways (metres)
1	Berlin-Schönefeld	E	2	3000 + 2700
2	Berlin-Tegel		2	3023 + 2424
3	Berlin-Tempelhof		2	2116 + 2092
4	Bremen		1	2034
5	Dresden	E	1	2500
6	Düsseldorf		2	3000 + 1630
7	Erfurt[a]	E	1	2000
8	Frankfurt/Main		3	3 x 4000
9	Hamburg		2	3250 + 3666
10	Hanover		2[b]	3200 + 2340
11	Köln-Bonn		3	2459 + 3800 + 1866
12	Leipzig-Halle	E	1	2500 + 3600 (under construction)
13	Munich		2	4000 + 4000
14	Münster-Osnabrück		1	2170
15	Nürnberg		1	2700
16	Saarbrücken[a]		1	2000
17	Stuttgart		1	2505
	Controlled aerodromes			
18	Altenburg[d]	E	1	1975
19	Augsburg[c]		1	1280
20	Bayreuth[c]		1	895
21	Braunschweig		1	1560
22	Dortmund[c]		1	1050
23	Egelsbach (Frankfurt)		1	860
24	Friedrichshafen[c]		1	2150
25	Hahn (Pfalz)[d]		1	2440
26	Heringsdorf[c]	E	1	2300
27	Hof[c]		1	1480
28	Ingolstadt[d]		2	2940 + 2439
29	Kassel		1	1500
30	Kiel[c]		1	1260
31	Lemwerder (Bremen)		1	1900
32	Lübeck		1	1800
33	Mönchengladbach[c]		1	1200
34	Neubrandenburg[d]	E	1	2393
35	Oberpfaffenhofen (München)		1	2286
36	Paderborn[c]		1	2180
37	Parchim (Mecklenburg)[d]	E	1	3000
38	Rostock-Laage[d]	E	1	2500
39	Schwäbisch Hall		1	920
40	Westerland (Sylt)[c]		2	2113 + 1696

Airfields for public use (runway longer than 1000 m)				
41	Allendorf (Eder)		1	1097
42	Altenburg (Sachsen)[d]	E	1	1795
43	Baden-Baden		1	1050
44	Barth	E	1	1200
45	Bautzen[d]	E	1	1590
46	Borkum		1	1000
47	Brandis (Sachsen)[d]	E	1	1400
48	Cochstedt (Harz)[d]	E	1	2210
49	Cottbus[d]	E	1	2500
50	Dessau[d]	E	1	1000
51	Diepholz[d]		1	1283
52	Donaueschingen		1	1200
53	Eisenach[d]	E	1	1200
54	Emden		1	1000
55	Essen-Mülheim		1	1200
56	Finow (Eberswalde)[d]	E	1	2520
57	Flensburg		1	1040
58	Groenhain (Sachsen)[d]	E	1	1640
59	Halle-Oppin[d]	E	1	1000
60	Hamburg-Finkenwerder		1	1875
61	Hafurt		1	1000
62	Kamenz (Sachsen)[d]	E	1	1100
63	Mainz-Finthen		1	1000
64	Mengen		1	1120
65	Norderney		1	1000
66	Peenemünde[d]	E	1	1300
67	Rechlin (Müritz)[d]	E	1	2080
68	Rothenburg (Oberlausitz)[d]	E	1	2500
69	Siegen		1	1150
70	Stendal[d]	E	1	1180
71	Strausberg[d]	E	1	1200
72	Trier[d]		1	1040
73	Welzow[d]	E	1	2500
74	Werneuchen[d]	E	1	1499
75	Wriezin[d]	E	1	2400
76	Zweibrücken[d]		1	2400

a = International airport with no scheduled international flights
b = Additional surfaced runway with less than 1000 metres length
c = With scheduled public flights
d = Former military airports

Only surfaced runways of airports are registered.

Source: Compiled by K. Schliephake from various sources, notably air timetables (summer 1998) and Flieger-Taschenkalender... 1997.

4. SEPARATION OF REGIONAL AND LONG-HAUL AIR TRAFFIC

In the United States, where air traffic (measured in person-kilometres per inhabitant) is nearly six times more intensive than in Germany, different airports cater for regional and long-haul traffic in metropolitan areas. In Germany, such division of work only exists in a few cases. It is a fact in Berlin where the old Tempelhof field (Table 2, No. 3) - which became famous during the Berlin airlift in 1948 - is now used for regional and turbo-prop traffic only. But the balance between West Berlin's Tegel (Table 2, No. 2) and Schönefeld (Table 2, No. 1) as the former international airport of GDR has yet to be established. However, as no one of the former military airfields in Brandenburg seems appropriate (plans to construct a totally new airport near Sperenberg, 50 km south of Berlin, are explained by TIETZE 1996) there may be no alternative to an extension of Berlin-Schönefeld. Being located close to the motorways and railway ring around Berlin, it has the advantage of excellent links with all the eastern and central Germany by car, regional and through-trains.

Mönchengladbach Airport (Table 2, No. 33) presents another success story. When the main passenger buildings of Düsseldorf Airport were damaged by fire in 1996 some of the short-haul scheduled services were transferred to Mönchengladbach, managed by Düsseldorf Airport LLC. They have remained there since, and an average of 20 turbo-prop flights leave daily for destinations in Germany and western Europe.

Around the major German hub, Frankfurt, things are different. Egelsbach (Table 2, No. 23) is more than overloaded by general aviation activities and Table 2 shows no alternative in the area. Charter companies which shy away from the high costs charged by Frankfurt Airport PLC contemplate on Hahn Airport (Table 2, No. 25), approx. 110 km west of Frankfurt. But this well-equipped cold-war relic in the woods of the Palatinate is located far from major towns and has no mass transportation connection.

In the south, the new Munich Airport with its two independent runways (Table 2, No. 13) has enough capacity to cope with the projected growth. Stuttgart's new airport is under construction at its original location (Table 2, No. 17) and will be linked to the motorway and rail network with no shortcomings for the near future.

Airports in northern Germany, notably Hamburg with 8.1m passengers (Table 2, No. 9; the project of the new Kaltenkirchen Airport seems to be finally shelved), Hanover with 4.4m passengers (Table 2, No. 10) and Bremen with 1.6m (Table 2, No. 4) have fewer problems to cope with traffic. Their growth has been below average (Hamburg: +4% passengers p.a. 1991-1996; Hanover and Bremen: +7.4%).

5. ALTERNATIVES FOR SHORT-HAUL TRAFFIC

Frankfurt Airport is congested and there is no alternative location in sight. Thus, we look at the structure of air traffic at the four major airports shown in Table 3.

Nearly 40% of the plane movements are short-haul, i.e. covering less than 500km distance between origin and (next) destination. Is air transport competitive in that range? Table 4 may give an answer for the selected relations.

Regarding interurban travel, today's intercity trains have a definite time advantage up to a distance of approx. 400 km, and the picture will remain stable with a rise in rail speed (including stops) of up to 160 km/h. This will notably be achieved by the new high-speed rail link from Frankfurt to Cologne (in operation in 2002, travel time: 58 min). From Berlin to Hanover the new ICE trains can cover the distance of 293 km in 107 min since the opening in September 1998 of the direct track via Stendal, whereas the plane

Table 3. Major German airports. Short- and long-haul aircraft movements per average day, summer 1998

Airport	No of passengers (average per day, 1996)	Total plane movements (average summer day, 1998)	Share of short-haul movements (less than 500 km)	Share of long-haul movements (more than 500 km)
Berlin (Schönefeld, Tegel, Tempelhof)	29800	255	45.2%	54.8%
Frankfurt (Rhein-Main)	105820	595	33.7%	66.3%
Düsseldorf	39150	290	37.0%	63.0%
Munich	42600	390	47.8%	52.2%
Total	217370	1530	39.8%	60.2%

Calculations by K. Schliephake and W. Tietze from airport timetables (summer 1998) Passenger figures (1996) from Verkehr in Zahlen... 1997, p. 99.

Table 4. Travel time between selected cities in Germany by air and rail, 1998/2002 in minutes

Origin-Destination (rail distance)	Minutes by plane[a]	Minutes by train in 1998	Minutes by train in 2002[b]
Frankfurt-Stuttgart (203 km)	145	81	76
Frankfurt-Düsseldorf (266 km)	145	159	105
Frankfurt-Hanover (353 km)	155	136	132
Frankfurt-Leipzig (378 km)	150	245	142
Frankfurt-Munich (417 km)	155	202	157
Frankfurt-Hamburg (536 km)	175	215	202
Frankfurt-Berlin (567 km)	155	229	214

Calculations by K. Schliephake from air and rail timetables, winter 1998/99.

takes 155 min (including boarding and transfer from/to city centre, cf. Table 4).

Transport planners therefore, want to shift short-haul transport from air to rail. The German railways PLC and Lufthansa will start in 2002 to replace flights between Frankfurt, Köln-Bonn, Düsseldorf, Stuttgart and Nürnberg by directly chartered ICE--train to cut short-range flights to/from Frankfurt by approx. one third. Nearly 10% of all flight slots currently used are to become free for additional long--haul transport - a quick remedy for airport capacity problems for at least the next few years.

Such shifts are easy where airports have direct links to the railway network as is the case with

- Berlin-Schönefeld (IC and IR trains)
- Düsseldorf (regional and a few IC trains, future terminal of ICE trains from Frankfurt-Cologne)
- Frankfurt (IC and ICE trains)
- Stuttgart (currently regional trains only, link to high-speed network is planned)
- Köln-Bonn (will be linked by high-speed line to Düsseldorf and Frankfurt in 2002)
- Leipzig-Halle (the new airport will have direct railway access after 2000).

However, not all feeder traffic can be shifted to the railways. Business travellers may shy away from a break of mode and carrier during their trip and prefer a change from plane to plane. For connections to North Sea islands and to cities in central and eastern Europe and in the Alps, railway traffic is not possible or irregular with slow speeds. No professional traveller would travel in five hours by train from Berlin to Prague when a plane covers the same 380 km in approx. 160 min (including surface transfers and check-ins). For distances over 500 km, even at the national level, rail is not competitive. From Munich to Berlin and vice versa trains take 6 hr 30 min via the new high-speed track Wolfsburg-Kassel-Würzburg (863 km) or 7 hr 36 min along the traditional route via Leipzig-Bamberg (697 km). This cannot compete with a flight which covers the 500 km air distance in 70 min (+ 100 min surface transport and check-in/out).

6. THE ALTERNATIVES - AIR, RAIL OR MAGLEV/TRANSRAPID SYSTEMS

The idea of supplementing short-haul air traffic by rail has been spread by railway planners who focus on the technical updating of the conventional wheel-on--rail-system. But is this system really adaptable to the challenges of the future? The history of European railway development fostered, over the last 150 years by national governments for economic and military reasons, resulted in five different gauges, seven electrical systems and eleven safety systems within the national boundaries. Although today's engineers always find a solution to stick this patchwork together, it bears additional costs and losses in efficiency. Railways have become less and less competitive with road transportation and even more so with air transportation. Their wide-spread attempts to increase the travel speed have not shown satisfactory results. New tracks, new rolling stock and entirely rebuilt stations are needed while continent-wide standardisation usually remains insufficient and the costs are gigantic. Another approach to higher speeds, notably by tilting trains, does not give satisfactory results either.

According to TIETZE (1998) the most promising concept of a continent-wide uniformly track-bound ground transport is the Transrapid System with its magnetic levitation technique (Maglev), which has matured for general application in long distance passenger and (containerised) cargo traffic (cf. also NIKSIC et al. 1997). With its maximum economic and environmental standards, even construction costs are far below the level of conventional railways. The Transrapid system may be capable of successfully competing with air transport over distances of up to 2,000 km. A recent estimate by Lufthansa figures some 16,000 of its flights may be abandoned and shifted to a European Transrapid network with links into the major cities. Table 5 gives the travel times in a future Transrapid network attaining speeds of 300-400 km per hour.

Table 5. Travel time between selected cities in Germany by future Transrapid system, in minutes

Origin-Destination (rail distance)	Minutes by Transrapid	Number of intermediate stops
Frankfurt-Stuttgart (203 km)	30	0
Frankfurt-Düsseldorf (266 km)	40	3
Frankfurt-Hanover (353 km)	60	3
Frankfurt-Leipzig (378 km)	65	3
Frankfurt-Munich (417 km)	75	3
Frankfurt-Hamburg (536 km)	85	4
Frankfurt-Berlin (567 km)	90	5

Calculated by W. Tietze from various sources.

The realisation of the Transrapid project would be a turning in the right direction and, among other positive effects, save huge amounts of investments necessary to eventually increase the capacity of existing airports.

7. OUTLOOK

What future options will remain for air transportation which is so dear to German businessmen - always in search of efficiency - and German holidaymakers - always in search of sun and fun? They all want speedy and reliable transportation but they are afraid of its consumption of space and its effects on the environment (cf. also Schliephake 1996). Air transport only has a share of 2.4% of total energy consumption and 8.6% of hydrocarbons consumption in the transport sector of Germany (cf. Verkehr in Zahlen... 1997, p. 332). But, per person/km energy consumption is three times higher than for the average of all transport modes. In this context, the future of air transport depends on several elements, notably

- possible taxation of plane fuel and thus a rise in air fares
- development of living standards and level of consumption in Europe, where 63% of German airline passengers travel for holiday and leisure purposes and only 37% are business oriented
- development of alternative offers by surface transport, notably rail, and possibly high-speed magnetic trains as proposed between Berlin and Hamburg (Transrapid-System, cf. here Chap. 6).

The various visions of high-speed surface networks in Europe, whether they use traditional rail system or magnetic systems, have one disadvantage: they are far from being realised.

In the meantime, air traffic will continue to play its role in linking Europe's urban areas with each other and with the outside world. Direct railway access to major airports will shift short-haul away from feeder flights and thus increase the importance of major hubs. This is a very welcome process which leaves all options open, conserving energy, space and - what travellers want most - time and comfort.

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