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ECONOMIC CONDITIONS OF TECHNICAL CHANGES IN WORLD CIVIL AIR TRANSPORT

Summary. The world economic environment of the turn of the century produced many new challenges to civil aviation in expectation of a continued growth in the transportation of passengers and cargo. To meet this growing demand, it will be necessary to increase the fleet and to modernise infrastructure – a process hampered by finances and capacity constraints.

Such constraints are especially pressing with regard to the acquisition of new types of large aircraft such as the Airbus A380 and the Boeing 787 and 747-8. Future dominance of the market is, however, difficult to predict, as this will be the outcome of a combination of uncertain parameters.

EKONOMICZNE UWARUNKOWANIA ZMIAN TECHNICZNYCH W ŚWIATOWYM LOTNICTWIE CYWILNYM

Streszczenie. Rozwój ekonomiczny świata na przełomie wieku, który spowodował możliwość intensyfikacji wielu dziedzin życia gospodarczego, zaowocował nowymi wyzwaniami w lotnictwie cywilnym, zarówno pasażerskim jak i ładunków. Aby zaspokoić stale rosnący popyt, warunkiem koniecznym dalszego rozwoju branży lotniczej będzie zwiększenie ilości floty i modernizacja infrastruktury. Procesy te były dotychczas hamowanego zarówno przez ograniczenia finansowe jak i bariery konstrukcyjne

Takie ograniczenia są szczególnie związane z wymaganiami dotyczącymi zakupu nowych typów dużych samolotów takich jak Airbus 380 oraz Boeing 787 i 747 – 8. Przyszła dominacja na rynku konkretnej firmy jest trudna do przewidzenia, gdyż będzie wynikiem kombinacji wielu różnorodnych parametrów.

1. CHANGES IN WORLD CIVIL AVIATION

The turn of the 20th century was a time of essential changes in world civil aviation. It resulted from the combination of dynamic economic growth, the creation and development of new economic centres, a pressure on integration, liberalisation, and a strong decision made by companies to operate in a global environment. The globalization of the world economy released unprecedented increases of competitive pressure, which gave aviation a leading position on the transport market. Polish aviation takes part in this process, which includes changes in transport policy dictated by membership of the European Union.

Current changes in international civil aviation are based on forecasts that are used as guidelines that determine the domain and type of market ventures. Such forecasts create a possibility to participate in mainstream development. During the next twenty years (2008-2027), the projected world economic growth per annum will probably be about 3%. It is expected that this will produce an increase in the number of passengers carried of 4,5% and a rise of the volume of transported goods of 6,0%. It is also expected that transport performance (passenger-kilometres: pkm) will increase even 5,0% annually in passenger transport and 6,0% in the transport of goods.

In the next twenty years the number of passengers using air transport could rise from 2,2 billion to about 7 billion. These numbers show a range of chances challenging the air transport industry. A more than triple increase in air transport will involve a radical rise in the number of aircraft. The projected increase in the fleet must be supported by the transport performance, which domain constitutes the types and carriage capacity of aircraft.

The structure of transport performance shown in the first figure (fig. 1) [20] indicates that the best part of the fleet will be used in passenger transport. Yet a substantial part of airplanes will also be needed to provide cargo services and transport of mail.

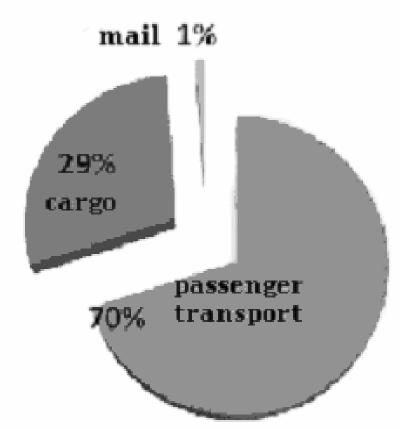

Fig. 1. The structure of air cargo transport volume in the world air transport
Rys. 1. Struktura ogólnej pracy przewozowej w światowym transporcie lotniczym

According to projected growth the evaluation of transport policy, which has been practised so far indicates that the majority of civil aviation companies have already made determined steps to create an efficient strategy. This new strategy will allow these companies to gain a competitive supremacy in quite new conditions, or just let them to stay in the main sphere of economic effectiveness.

All these actions indicate that economic growth involves a necessity for making the air route network wider. It is coupled with aspiration of world business to take part in new economic activities, and also to the dynamic increase of internal demand on air services in these regions. To meet this growing demand it is necessary to increase the fleet and to modernize aerial infrastructure. At the present stage it is easy to observe an increase of congestion in airspace. The rising number of aircraft contributes to decline in runway accessibility. Forecasts indicate that the conditions for use of airspace and airports will become problematic. This involves problems with providing quality changes in the fleet demanding accelerated modernization of the existing fleet and the incorporation of new aircraft to increase passenger capacity and tonnage. This process is involves an expensive, and slow, modernization process of the infrastructure and of telecommunication systems, which is coupled with the requirements on the aircraft construction industry to produce machines with the ability for long distance flights without or with a minimal number of intermediate stops. The realisation of such actions is facing obstacles. Huge, oversized aircraft have a high takeoff weight and need elongated runways, more space for taxiying and more space to park. Only a little number of airports will be able to come up to scratch, which induces essential limits in the usage of airports. The realisation of effective transport policy demands understanding and must take into account global trends and tendencies in the development process of international civil aviation. In this area of activity it is necessary to finetune investment priorities, remodel development systems to achieve competitive supremacy, screen and analyse consumer needs, and build a creative mechanism that will accommodate the enlargement of demand to increase spatial, economic and technical infrastructure.

In the last period we can observe the dynamic increase in air transport carriage.

The scale of operations in this area indicates that over a thousand airlines achieve an annual performance of above 25 million scheduled flights that carry over 2 billion passengers and over 40 million of tonnes of goods. The gross annual volume of transport performed (i.e. passengers, cargo and mail) has reached about 520 billion of tonne-kilometre. The world airlines are using about 26 thousand large and medium-sized airplanes offering a total of 3 million passenger seats plus a transport ability of 85 thousand of tonnes of goods. We can observe the dynamic of changes by comparing statistics of 2006 and 2007 presented in table 1.

Table 1

Usage statistics of the world civil transport in years 2006-2007
(as of 1 July of each year) [21], [22]

The fleet		2006	2007
The number of passenger and cargo aircraft	Total*	25 750	26 340
	ICAO members**	22 133	22 685
Flights (million)		25	25,5
Passengers (billion)		2	2,2
Goods (million of tonnes)		38	40
The transport ability	Passengers (million)	3,0	3,5
	Goods (thousand of tonnes)***	85	90
Total volume of performed transport (billion of tonne-kilometre)		487,5	514,7

* Aircraft having the volume at least 18 passenger seats or taking an equivalent cargo load (having the takeoff weight above 7 tonnes),
** Aircraft having the takeoff weight 9 tonnes,
*** Including weight of passengers and their luggage, cargo and mail.

For a precision of the projected distribution of aircraft, it is very important to have an inventory of the fleet in particular regions, especially in terms of the necessity to supplement this inventory on existing ways of activity and to diversificate the market with new destinations. Information concerning this problem in table 2 indicates that the North and South American markets have the greatest number of passenger airplanes. In view of this fact the best part of producing airplane constructions is marked down to cater to clients from these regions. Next will be recipients from Europe, including CIS (The Commonwealth of Independent States) and Asia, Australia and the Near East.

Table 2

Airline fleets in the particular regions of the world in 2006 and 2007
(as of 1 July of each year) [6], [28]

Region	2006		2007	
	Volume of fleet (in pieces)	Participation in the world fleet %	Volume of fleet (in pieces)	Participation in the world fleet %
North and South Americas	10 915	42,4	10 910	41,4
Europe and CIS	8 170	31,7	8 390	31,9
Asia, Australia and the Near East	5 220	20,3	5 530	21,0
Africa	1 445	5,6	1 510	5,7
World	25 750	100,0	2 6340	100,0

* Passenger airplanes having the volume at least 18 passenger seats or taking equivalent cargo load (having the takeoff weight above 7 tones)

A ranking of the largest airlines is also headed by the USA, including American Airlines with 670 aircraft, Southwest with 500, and Delta with 450. The increase of the world fleet in 2006 and 2007 at the rate of 2,3% compared with a corresponding increase of the transport performance at the rate of 5,5% indicates that the usage of the fleet is rising. The domain of the transport performance, which is a function of airplane usage in particular regions of the world, is presented on fig. 2 (own study on the basis of [26]).

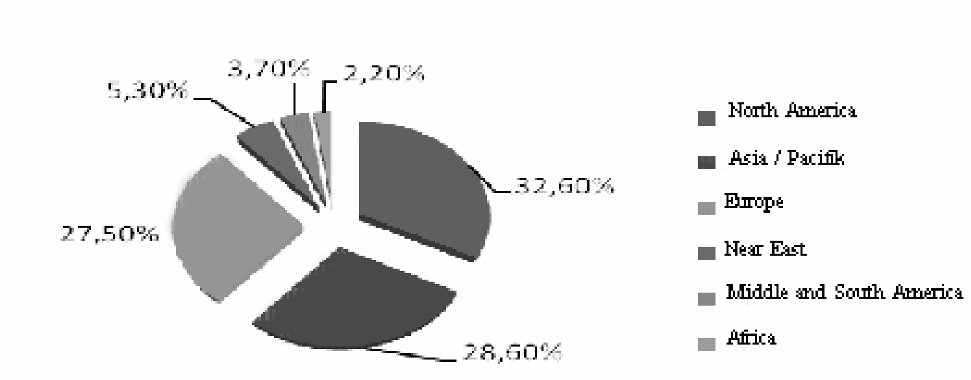

Fig. 2. Regional distribution of world air transport volume in 2007 (as of 1 January 2007)
Rys. 2. Struktura podziału regionalnego w światowym transporcie lotniczym (stan na 1 stycznia 2007 r.)

The policy for construction and distribution of the air fleet requires precise knowledge of the proportion of exploitation of the most popular aircraft. The ranking of big airplanes in 2007 is headed by the Boeing 737 with 4583 units sold. The next place is taken by the Airbus A320 series with 3097 airplanes, Boeing MD-80 with 1022 sold, Boeing 767 with 880, Airbus A330 with 480 airplanes, Tupolev Tu-154 with 432 airplanes, Douglas DC-9 with 413 and Airbus A300 with 392 airplanes delivered. In the regional aircraft group the first position is taken by Bombardier CRI 100/200 with 954 airplanes, next are: Embraer Dash 8/Q with 673 airplanes, ATR 42/72 with 642 airplanes, Raytheon Beech 1900 with 443 airplanes, Antonov An-24 with 438 airplanes and Jakovlev Jak-40 with 400 airplanes. Aircraft in use are subject to modernization and that is why new models of existing designs are still appearing. In 1990 the latest version of Next Generation Boeing 737-600/-7/-8 emerged, in 2001 also 900 model appeared.

The construction changes introduced in those types of airplanes consisted mostly in: larger wing span, an increase fuel capacity, a very wide use of composite materials, and also installing modern avionic systems. One example is the use large LCD screens in the cockpit. In the newest Boeing 737-900 ER the seating capacity will be extended up to 215, with its range lengthened to 5900 kilometers. Nowadays the largest number of Boeings is used by Southwest Airlines. It has 468 airplanes of the 737-300/5/8 series. Poland is using 17 airplanes of Boeing 737-300/-4/-5. PLL LOT has 8 airplanes and Centralwings uses 9. The second position of the ranking is taken by the Airbus A320 and above all A318 (107 seats), A319 (124 seats), A320 (150 seats) and A321 (185 seats). All together in 150 airlines there are 2761 airplanes in use. The A320, which was introduced in 1988, is classified in the category of new types. They set new standards for comfort and economic effectiveness. For the first time in commercial air transport, Airbus introduced a revolutionary fly-by-wire system. The A320 is increasingly popular among traditional carriers, which is confirmed by the fact that 44 carriers replaced their Boeing 737 with the A320. Only in two cases A320s were replaced by the Boeing 737. On the basis of the A320 engineers constructed evolutionary versions with special equipment for VIPs and additional fuel tanks enabling long distance flights. These types of executive airplanes, the A318 Elite (range: 7 600 km), A319 (range 11 100 km), and A320 Prestige (range 7 600 km) were bought for transporting presidents, prime ministers and the other members of the governments in countries like Brazil, France, Italy and the Czech Republic. These types of airplanes were bought also as private company aircraft for large corporations.

The popularity of individual types of aircraft is closely linked to construction changes improving convenience and economics of usage. The general trend is reflected by changes in jet propulsion, which is presented in the table 3 [24], [27].

Table 3

Changes in the number and quality of the world fleet in the last 25 years (1982-2007)

Type of engine	1982		2007		Exchange in quantity
	Number of aircraft	Share in %	Number of aircraft	Share in %	
Jet engine	6596	73,4	18759	82,7	+12163
Turboprop engine	1483	16,5	3812	16,8	+2329
Piston engine	908	10,1	114	0,5	-794
Total	8987	100,0	22685	100,0	+13698

Changes in this area in the last 25 years caused the disappearance of the less economic piston propulsion. The turbo-propeller propulsion was stable at the same level, but the number of airplanes with the jet propulsion increased rapidly and in 2007 it was at 82,7% of the world fleet.

2. CHARACTERISTICS OF LARGE COMMERCIAL AIRCRAFT

The rapid development of the world economy is challenging air transport in mass transport of people and goods. The biggest transport companies are now fighting for the global transport market. They are concentrating their efforts on building and modernizing large airplanes that can transport a few hundred people or 250 tones of goods. This segment of the market is starting to be exclusive, taking into account that not many companies can compete at the technological level, which is necessary for building machines generating a large financial profits in the process of sale and usage. Producers of civil airplanes (above 100 passenger seats) united in LCA – Large Civil Aircraft, generate more than 50% of their dealings in the civil sector, which is headed by the American Boeing company and the European consortium Airbus, which is now entering the period of intensified competition. Fundamentally only these two powerful companies count on the market. They are decisive for the supply and cater to the needs in this segment. Statistics included in table 4 (own study on the basis of [27], [28]) confirm the fact, that the biggest quantity of changes in large airplanes are in the Boeing group (especially Boeing 737) and in the Airbus group – type A320 and A319. Table 4 does not take into account the latest types of the Airbus A380 and Boeing 787, because these airplanes require a separate discussion regarding their function in recent civil air transport history.

Each project of airplane that is categorized as large, incurs multi-billion expenses, a reimbursement is achieved only when the company sells at least 600 units. This takes about 8-12 years. That is why presenting a new model on the market is hazardous and requires wider multi-national cooperation and participation of different kinds of technological companies**.**

Through the last decade the air transport needs have been growing at an increased rate and this is causing quick quantitative changes in the usage of means of transport. As the most characteristic example of the changes we can point to the production of large commercial aircraft by Boeing and Airbus, as presented in fig. 3 (own study on the basis of [7]).

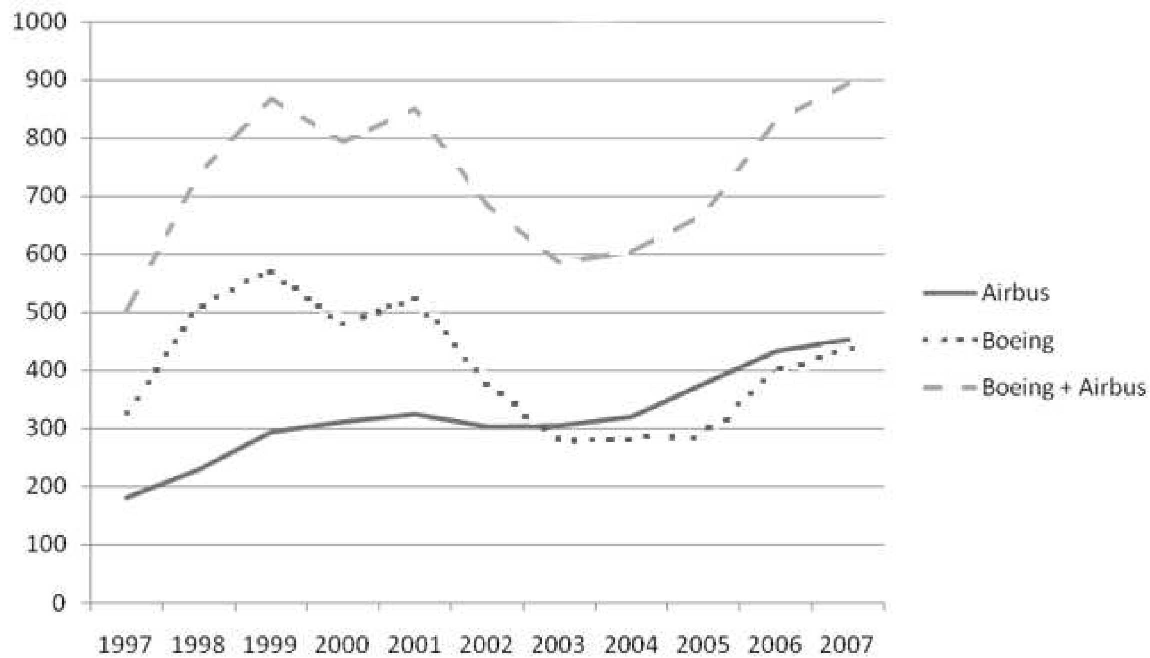

Fig. 3. Production of Boeing and Airbus passenger planes in years 1997 to 2007
Rys. 3. Produkcja samolotów pasażerskich Boeing i Airbus w latach 1997 - 2007

In 1988 the production volume of Boeing was almost twice that of Airbus, which gave Boeing control for over 60% of the market. The supremacy of this producer continued up to 2002, in which year companies started to feel the consequences of a terrorist attack, which led to a financial collapse of the air transport market in the USA, and the cancellation of orders by many companies operating world-wide (Boeing orders decreased by 27,7% while Airbus orders only by 6,8%). In the year 2003 Airbus took the lead on the market for the first time in the production of planes of this kind, and has systematically kept the advantage over Boeing since. In 2007 Boeing produced 441 units and Airbus 453, taking the position of the leading producer in the market (the value of sales of Airbus amounted to 24,3mld USD, while Boeing's to 20,0mld USD).

Table 4

Large communication airplanes in the air fleet of the world in 2006-2007

Type of aircraft	All			Use, by continent											
				North and South America			Europe			Asia			Africa		
	2006	2007	change	2006	2007	change	2006	2007	change	2006	2007	change	2006	2007	change
Airbus A300	408	392	-16	166	168	+2	166	89	-7	132	117	-15	14	18	+4
Airbus A310	200	193	-7	81	82	+1	81	40	-3	70	65	-5	6	6	0
Airbus A319	846	955	+109	380	408	+28	380	376	+45	119	153	+34	16	18	+2
Airbus A320	1530	1710	+180	530	558	+28	530	612	+57	403	485	+82	42	55	+13
Airbus A321	355	390	+35	53	54	+1	53	226	+14	80	95	+15	10	15	+5
Airbus A330	418	480	+62	55	62	+7	55	131	+14	234	268	+34	12	19	+7
Airbus A340	305	330	+25	24	22	-2	24	157	+12	109	114	+5	27	37	+10
Boeing 717	155	155	0	123	123	0	123	14	0	18	18	0	0	0	0
Boeing 727	620	560	-60	410	355	-55	410	15	-1	82	81	-1	112	109	-3
Boeing 737	4330	4583	+253	1768	1807	+39	1768	1281	+91	1114	1213	+99	258	282	+24
Boeing 747	989	985	-4	186	195	+9	186	250	+7	540	521	-19	20	19	-1
Boeing 757	996	1000	+4	664	670	+6	664	238	+8	90	79	-11	12	13	+1
Boeing 767	862	880	+18	466	467	+1	466	159	+4	210	215	+5	31	39	+8
Boeing 777	575	640	+65	133	135	+2	133	119	+8	320	367	+47	11	19	+8
Boeing MD-11	190	190	0	117	116	-1	117	48	0	25	26	+1	0	0	0
Boeing MD-80	1064	1022	-42	654	627	-27	654	297	-3	93	81	-12	17	17	0
Boeing MD-90	110	110	0	16	16	0	16	11	0	83	83	0	0	0	0
McDonnell Douglas DC-8	143	130	-13	112	100	-12	112	9	0	5	3	-2	17	18	+1
McDonnell Douglas DC-9	440	413	-27	385	361	-24	385	8	+3	18	8	-10	32	36	+4
McDonnell Douglas DC-10	175	168	-7	150	148	-2	150	9	-5	10	10	0	1	1	0
Antonov An-12	180	178	-2	1	1	0	1	118	+4	32	38	+6	33	21	-12
Ilyushin Ił-76	255	249	-6	1	1	0	1	185	-9	23	32	+9	37	31	-6
Tupolev Tu-134	277	278	+1	2	2	0	2	268	0	7	7	0	0	1	+1
Tupolev Tu-154	435	432	-3	3	3	0	3	400	0	30	27	-3	2	2	0

A breakthrough moment in the construction of big planes was in 2004, when a program of building a new generation of planes went into effect. These aircraft were the Airbus A380 and Boeing 787 Dreamliner. Modern solutions were also used on narrow and wide-body constructions. The new types of planes met with great interest from users, mainly because of their economics of operation and high standard of comfort. Table 5 [9] shows the basic technical differences between these two types of aircraft.

Table 5

Comparison of Airbus 737 and Boeing A380 characteristics

	Airbus A380	Boeing 787 Dreamliner
Number of passengers	480-650	200-350
Engines	4	2
Maximum speed	0,85 mach	0,85 mach
Maximum range	16 200km	13 300 – 14 800km
Wingspan	79,75m	58m
First flight of the prototype	2005	2007
Empty weight	277 tonnes	114,5 tonnes
Passenger cabin width	6,55m	5,74m

Of the two competing companies, Airbus is in a better situation, because their A380 already is on the market. When this machine came into airline use in October 2007, it totally reoriented previous quality standards. The A380 is the most modern and most spacious civil airplane in terms of luxury, equipment innovation and travel comfort. Compared to the most exclusive transatlantic liners, the A380 represents a culmination of technological effort and has a chance to become the flag plane of the 21st century.

The design of the Airbus A380 was based on few main guidelines:

- capacity for long distance operations,
- the use of hubs and airports located near big cities,
- obtaining maximum passenger satisfaction during the flight,
- maximization of safety,
- minimizing operating costs.

The implementation of these guidelines in such a huge machine was the biggest challenge ever in the history of civil aviation, also because of the costs, which amounted to around 17 mld USD. Airbus A380 is the first plane with two full length passenger decks and a third deck for luggage transport and for the realization of social needs. The size of the deck was increased by 40%, which allowed widening of the space between the chairs and installation of stairs between the decks. The modern interiors of the passenger cabins and the installation of the necessary electronic equipment provide opportunities for a variety of activities on board: work, relaxation, entertainment, sleep. Its size enables the incorpororation of special rooms for office work and playrooms for children. The A380's bulk also makes it possible to put in luxury facilities, such as a bar, duty-free shop, beauty salon, club salon for business meetings and bathrooms with showers. In the design stage, the reasons for stress and tiredness and the risk of thrombosis, which affects around 5% of the travellers because of extended periods of sitting in small chairs (space priority), were also taken into serious consideration. The standard version of the cabin has 555 seats in three-class layout while the maximum, one-class layout version has 863 seats (earmarked above all for charter flights).

In terms of aerodynamics, A380 reached the sixth generation level and surpasses all already existing planes. It's fuselage is built up using the newest fiberglass composite materials: "Glare" (a laminate made of aluminum alloy and fiberglass). Carbon reinforced plastics are used throughout the construction of the plane. The steering system was modernized by installing new Electrical Back-up Hydraulic Actuator (EBHA) which is used as a fourth additional steering option. The traditional riveting of surface materials was replaced by the innovative technique of laser welding vulnerable spots. Together, the modern technologies enabled a reduction of the plane's weight by 15 tons while keeping the required structural rigidity. Obtained economic advantages were based on the maximialization of the number of passenger seats and cargo capability. The level of economic efficiency of the A380 is indicated by the fuel consumption costs index. With a full load of passengers, fuel consumption over a distance of 100km reaches 2,9l per passenger (similar to the cost of 2 people riding a passenger car).

The plane passed the airport infrastructure adjustment tests, in which it turned out to be compatible with existing large aircraft. The possibility of using the 45m width runways was confirmed. The application of a new generation of engines and large wing-span (better carrying capacity) caused that the length of the runway required for getting off the ground and landing is much shorter compared to the majority of big commercial jets. More and more airports around the world meet the requirement of having an F category for taking on A380. Of the 22 special vehicles used for the servicing of A380 while on the apron, only the aircraft push and pull tractors will need replacement (for a more powerful one). A dedicated service vehicle for the maintenance of the upper deck is also necessary. To reduce the noise level, the plane can taxi on only two of its engines. Thrust reversers, used during braking were also installed only on two engines which is contributed to a further reduction of the aircraft's weight. According to the constructors, the A380 is 35% quieter than the long distance planes used in present operation and meets the most restrictive QC2 noise protection standards. In addition, low fuel consumption causes reduction of the pollution of atmosphere high regions.

The entering of the Airbus A380 on the air market marks a new direction in air transport, based on mega-hubs and operating on markets through rational use of large numbers of seats offered in direct transport. The analysts do not agree if adoption of such an approach is right, because the A380 concept hasn't been proven in market practice yet. A different scenario is represented by Boeing, which relies on use of smaller planes, but comprehensively compatible with already existing ground infrastructure and minimalization of operating costs. Such a concept lay at the base of the construction program of a new version of the Boeing 747, the 747-8 Intercontinental. The search for an unequivocal answer which of the two development concepts will be more effective, so far points to no clear advantage to any of them. Extrapolation of data in table 6, shows that both have equal chances of success.

The Boeing 747-8 Intercontinental will be built on base of 747-400. Sharing 80% of components with that model will lower it's price in vital way. Boeing 747-8 will accommodate 450 seats in three-class layout and will be Boeing's biggest passenger jet. It's range will is 14815km, but it's biggest advantage comes from low fuel consumption costs: 20% lower in comparison to aircraft with similar parameters used today. Competitive fuel consumption is nowadays the most essential factor in economic efficiency improvement and also brings a meaningful ecological value because of a decrease in exhaust fumes. It is estimated that savings from this will amount to 8% of the passenger transport cost per kilometer of flight. The 747-8's carrying capacity also will be increased thanks to wider wing-span with modern aerodynamic profile and because of the replacement of three-part slotted flaps for the newest version of one- and two-part slotted flaps. The wings will be constructed from the most modern durability generation materials and will end with winglets diffusing air vortex. The crew will be able to enjoy the modern cabin equipped with new generation big screen displays that will make the analysis of the flight parameters a lot easier. GEnx-2367 turbofan was provided by General Electric - a company that meets the world standards Stage4 and CQ2 for noise emission and pollution.

From the evaluation of Boeing's 747-8 operational parameters it becomes clear that the American producer counts on a competitive advantage resulting mostly from economic reasons. It is predicted, that the operating cost of an identical flight will be around 20% lower, chiefly because of the difference between weights per passenger (takeoff weight of A380 - 560 tons, B747-8 - 436 tons), while the cost of one passenger-kilometer will decrease by 8%. Table 7 (own study on the basis of [7], [8] [9]) contains data that enable much wider analysis and evaluation of existing and predicted changes in Boeing 747-8 construction, both in relation to basic 747-400 model as well as to rival A380-800.

Table 6

Production and orders placed for Boeing and Airbus passenger planes in the years 1997-2007 [7], [8], [9]

Year	Airbus			Boeing			Airbus + Boeing		
	Production	Net orders	Orders pending	Production	Net orders	Pozostało do	Production	Net orders	Orders pending
1997	182	438	1009	321	505	1652	503	943	2661
1998	229	529	1309	509	567	1710	738	1096	3019
1999	294	430	1445	573	366	1503	867	776	2948
2000	311	492	1626	482	589	1610	793	1081	3236
2001	325	274	1575	525	272	1357	850	546	2932
2002	303	233	1505	381	176	1152	684	409	2657
2003	305	254	1454	281	239	1110	586	493	2564
2004	320	366	1500	285	272	1097	605	638	2597
2005	378	1055	2177	290	1002	1809	668	2057	3986
2006	434	790	2533	398	1044	2455	832	1834	4988
2007	453	1341	3421	441	1413	3427	894	2754	6848

Table 7

Comparison of passengers planes technical specification

Specification	747-700	747-8	A380-800
Length (m)	70,7	74,2	72,7
Wingspan (m)	64,4	68,5	79,8
Height (m)	19,4	19,4	24,1
Max. Cabin diameter (m)	6,13	6,13	6,58
Max. Takeoff weight (t)	396	436	560
Maximum range (km)	13 430	14 800	15 000
Cruising speed (Ma)	0,85	0,85	0,85
Seating capacity/3 classes	416	450	555
Fuel capacity (l)	204 340	227 900	310 000
Engines and thrust (kN)	4x270	4x296	4x310
Catalogue price (mln USD)	205-230	250-265	272-292
Year of coming in airline use	1989	2010	2006

The comparison between these two types of aircraft shows the advantage of A380 in terms of range and cabin diameter, however Boeing 747-8 is cheaper in operational cost and is characterized by lower catalogue price. Moreover it is more compatible with existing airport infrastructure. B7474-8 is able to land on runways of a 200 airports all over the world, while A380 can presently only do so at 20.

According to a BCG (Boston Consulting Group) evaluation, the new generation planes will generate costs comparable to existing big planes, which mean that the smaller ones will be more attractive to users, because they ensure wider choice of commercial applications, more convenient flight connections, higher frequency and shorter time of flights. Yet it is too early to predict the market evolution for theses planes.

Apart from the market segment of passenger planes, the market situation for cargo aircraft also requires a deeper evaluation. Here too competition is getting fiercer, especially between the biggest shareholders of the market, the Boeing and Airbus. Boeing has started a construction program for a cargo version of the B747-8, with a payload capacity of 140 tons. This is in response to the cargo version of Airbus A380-800F. The Boeing 747-8 will be 5,6m longer than the current 747-400F, which will result in an increase of carrying capacity of 24%. It will have a cargo space of $117m^3$, representing an additional capacity four pallets on the upper deck and two extra on the lower deck compared to the -400F model. The time needed for preparing the machine for the next flight will be shortened to one hour thanks to realization of loading and unloading from the nose and through the large cargo door to the hold. The American freighters are currently transporting half of the world's cargo and set the standards in this service segment.

The European A380-800F is designed for transporting 152 tons of cargo. In spite of increased load capacity the interest for this model in the market is so far limited. The main reason for this appears to be insufficient connection of its characteristics with existing airport infrastructure and the fact that the 747 is well established in the market. The technical qualities of both machines are compared in table 8 (own study on the basis of [8]), which points out that the differences between them are insignificant, while the supremacy of Boeing comes from long-lasting existence of the 747 model on the cargo market, making it easier to get the new model accepted.

Table 8

Comparison of cargo planes technical specification

Specification	747-8F	A380-8F
Length (m)	75,7	72,7
Wingspan (m)	68,5	79,8
Height (m)	19,4	24,1
Max. Cabin diameter (m)	6,13	6,58
Max. Takeoff weight (t)	436	590
Maximum range (km)	8280	10 400
Cruising speed (Ma)	0,85	0,85
Max. Load capacity (t)	140	152
Fuel capacity (l)	215 400	310 000
Engines and thrust(kN)	4x296	4x340
Catalogue price (mln USD)	265-275	272-292
Year of coming in exploitation	2009	2008

A competitive proposition from Airbus consortium is a hybrid which combines cargo and passenger transport. In combi version, A380 takes 473 passengers and seven cargo palettes on board.

Besides the two aircraft listed above, the Ukraine-based Antonov Aeronautical Scientific/Technical Complex in Kiev is also a meaningful participant in the market for cargo planes. Their biggest machine currently in use is the An-225 Mriya, which is exploited by the Ukrainian airline Antonov Airlines. The gigantic six engine An-225 has a takeoff weight of 600 tonnes and payload capacity to 250 tons. It was built in the late 1980s as modernized version of original project for transporting super heavy, oversize elements of Energia rockets and the Buran space shuttle. A reinforcement of the floor in the hold and the nose of the fuselage, installation of modern avionics system and improvement of the power plants have enabled the transportation of ultra-heavy freight inside and also on the "back" of the fuselage. Such have inter alia been components for the oil-industry weighing some 240 tons. The evaluation of the ultra-heavy freighters market points out that its development has very promising prospects. This type of transport will focus mainly on providing services for a growing need to transport heavyweight oversized equipment, for special destinations. The fight for the market in big aircraft segment is an interesting phenomenon, particularly because of the sizes of these giants. The production of these aircraft involves unique techniques, technology and work organization levels, and tremendous finance.

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