ISSUES REGARDING THE COMPATIBILITY OF AIRPORTS AND PROPOSED LARGE AND HIGH SPEED AIRCRAFT

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ABSTRACT

In order to accommodate this increasing demand, major aircraft manufacturers are now undertaking studies and research to build the new-technology aircraft cited above. For the next few years, Boeing is actually considering the development of stretched derivatives of the current 747 [Boeing, 1994; Gervais, 1994] known as 747-500X and 747-600X, whereas Airbus is developing a new aircraft to carry over 500 passengers – the A3XX. Both Boeing and Airbus, however, have plans to build a completely new aircraft, which will be able to carry up to 800 passengers in a tri-class configuration. The air transportation community has termed new large aircraft "NLA" for all new aircraft developments large than the current 747. The NLA, or double-decker, would have an upper deck all along the fuselage, allowing a passenger capacity up to 1000 passengers [Chevallier & Gamper, 1996].

INTRODUCTION

Market forecasts indicate that demand for air transportation will consistently increase during the next 20 years. By the year 2011, demand for air travel is expected to be over twice the current demand [David, 1995]. Airbus Industrie [1997] forecasts an annual growth in air travel of 5.9% in the next ten years and an average growth rate of 4.6% for the subsequent ten years. These numbers are very close to the annual average rate of 5.4% forecast by Boeing [1997b].

Since many airports are now constrained by busy airspace and runway capacity, there seems to be an opportunity for development of larger, faster aircraft which would be able to move more people more rapidly [Building Research Board, 1989], helping relieving the effects of air traffic congestion. In fact, many airlines are currently demanding the construction of larger aircraft which will allow more efficient use of both air fleet and airport facilities. This higher efficiency will be achieved through a lower operating cost [Travers, 1995], and through an increase in "hub-and-spoke" operations, in which large subsonic aircraft will carry passengers between major airports – the "hubs" –, where they will connect to smaller aircraft to travel between these major centers and the regional airports [David, 1995].

"Hub-and-spoke" operations seem to be a strong trend in airline operations. In fact, many airports are now competing for this transfer market [de Neufville, 1995]. New airports, like Denver, have actually been designed with the main purpose of serving as "hub" airports. Larger aircraft would be primarily used in long-haul routes, mainly from North America and Europe to Asia, and in inter-Asian routes [Travers, 1995]. There is also a potential market in high-density routes in Japan [Gervais, 1994].

Besides the increase in "hub-and-spoke" operations, Boeing also previews a market for 1000 to 1500 units of a new supersonic aircraft. This market will be generated by the doubling in long-haul, overwater travels from the year 2000 to 2015. This new generation supersonic aircraft will be capable of carrying 250-300 passengers at a speed between Mach 2.0 and 2.5 [Boeing, 1996a].

In order to accommodate this increasing demand, major aircraft manufacturers are now undertaking studies and research to build the new-technology aircraft cited above. For the next few years, Boeing is actually considering the development of stretched derivatives of the current 747 [Boeing, 1994; Gervais, 1994] known as 747-500X and 747-600X, whereas Airbus is developing a new aircraft to carry over 500 passengers – the A3XX. Both Boeing and Airbus, however, have plans to build a completely new aircraft, which will be able to carry up to 800 passengers in a tri-class configuration. The air transportation community has termed new large aircraft "NLA" for all new aircraft developments large than the current 747. The NLA, or double-decker, would have an upper deck all along the fuselage, allowing a passenger capacity up to 1000 passengers [Chevallier & Gamper, 1996].

Manufacturers have also undertaken studies to develop the new generation supersonic aircraft. British Aerospace has recently combined with Aerospatiale and Deutsche Aerospace on the European Supersonic Research Program (ESRP). They refer to their project as AST2 – Advanced Supersonic Transport [David, 1995]. It is very likely that Airbus will assume this project. Boeing's development has its origins in the US Supersonic Transport (SST), in the 1960's. The current project is referred to as HSCT – High Speed Civil Transport [Boeing, 1996a]. Both aircraft will be able to carry over 250 passengers for up to 6,500 nautical miles at a Mach 2.4 speed. The first prototypes are not expected before the year 2010.

Aircraft - Airport Compatibility

Despite the fact that Boeing has recently postponed the construction of the 747-500/600X [Boeing, 1997a], the advent of larger aircraft now seems to be a matter of time. The question that arises now is how this aircraft will impact their interface with the ground: the airports.

Airport planning and design process is closely related to aircraft characteristics [Ashford & Wright, 1992; Horonjeff & McKelvey, 1994]. Until the 70's, the latter always ruled the former. However, strong constraints in land availability and the very high costs of airport construction and expansion have caused manufacturers to be more concerned about making new aircraft fit existing airports [Barros & Wirasinghe, 1997]. And fact is that no existing airport seems to be fully prepared to accommodate the new aircraft referred to above. A recent survey undertaken by the Airport Council International (ACI) NLA Task Force showed that 16 out of 23 large airports around the world anticipate investments over US$ 100 million to adapt/expand the existing facilities to operate the NLA. The remaining seven airports anticipate moderate or low investments [Chevallier & Gamper, 1996]. The same survey found that the median date expected by those airports for the introduction of the NLA is 2001, even though this date does not seem to be achievable any more.

In order to correctly evaluate the impact of the NLA and the new supersonic aircraft on airport planning and operations, a deep investigation is necessary. The object of this paper is to present and discuss the main issues related to this compatibility, assessing potential problems and pointing to possible solutions. In the next sections, the projected characteristics of those aircraft will be presented, and then the previewed impacts on the airports will be presented and discussed.

NEW AIRCRAFT PRELIMINARY CHARACTERISTICS

New Large Aircraft

Table 1 provides a comparison between current heavy aircraft and the NLA. Note that virtually all the major airports in the world are designed to service the B747-400, which is currently the largest passenger airplane inactivity. Boeing 777, Airbus A340 and McDonnel-Douglas MD-11 are almost as large as the 747, although with a lower passenger capacity. Figure 1 compares the size of the Boeing NLA with the 747.

TABLE 1. EXISTING AND PROPOSED SUBSONIC AIRCRAFT DIMENSIONS

Aircraft	Wingspan (m)	Length (m)	Wheel base (m)	Wheel track (m)	Runway length (m)[a]	Passengers	Maximum takeoff weight (kg)
A340-200	60.3	59.4	23.2	10.7	2316	262-375	253511
A340-300	60.3	63.7	25.6	10.7	N/A	295-335	253500
B777-200	60.9	63.7	25.9	11.0	2651	305-375	242670
B777-300	60.9	73.8	25.9	11.0	2651	368	299370
MD-11	51.8	61.3	24.6	10.7	2986	323-410	273287
B747-400	64.9	70.4	25.6	11.0	2681	400	362871
A3XX-100	77.1	69.7	N/A	N/A	N/A	500-600	471000
B747-500X	64.4	77.8	29.2	11.0	N/A	500-600	N/A
A3XX-200	80.0	76.2	N/A	N/A	N/A	600-800	N/A
Boeing NLA	88.0	85.0	N/A	17.0	N/A	600-800	771101

Sources: Ashford & Wright [1992]; Boeing [1994, 1996b]; Horonjeff & Mckelvey [1994]; Wissel [1994]; Burns & McDonnels [1995]; David [1995]
N/A: Not Available
[a] At sea level, standard day, no wind, level runway

For better space usage, however, all proposed NLA have an upper deck. The 747 already has an upper deck, but it covers only a short part of the aircraft fuselage. The 747-500/600X is a stretched version of the current 747 with a longer upper deck. In turn, the A3XX is a brand new project, and is intended to be the very first aircraft with two full-fuselage decks. NLA of both manufacturers will be based on new concepts.

In order to accommodate the increase in passenger capacity, nearly all aircraft dimensions must also be increased. It can be seen in Table 1 that all NLA have larger dimensions than the 747-400 – with the possible exception of runway requirement, since manufacturers are designing these aircraft so as to fit existing runways [David, 1995].

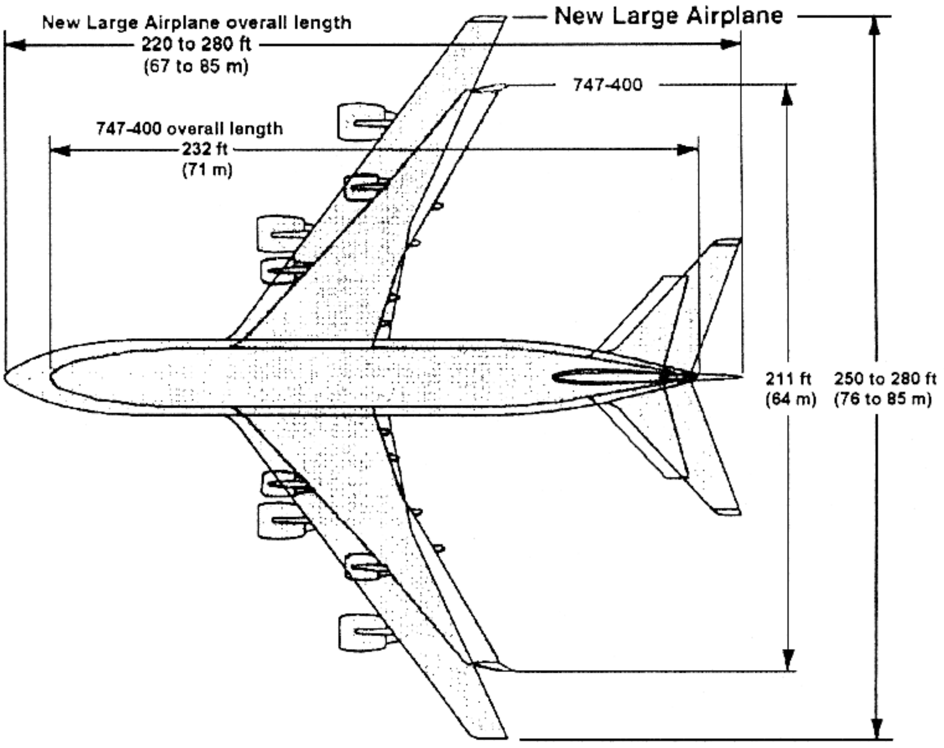

Figure 1. Size Comparison: NLA versus 747-400.

Source: Boeing [1994]

The increase in passenger capacity, and its consequent growth in the maximum takeoff weight, will require a longer fuselage, as well as larger wings. At this point, the Airbus design causes a slightly smaller impact on airport operations than Boeing's, because Airbus' new aircraft are being developed with shorter fuselage and wings. Furthermore, the ICAO Airport Design Study Group (ADSG) is studying the establishment of a new Code Letter "F" for aircraft with a wingspan of up to 80 m [Chevallier & Gamper, 1996], below the 85 m maximum projected by Boeing. To overcome this problem, both Boeing and Airbus consider the possibility of developing folding wings, which would allow a wingspan on the ground similar to that of the 747. The wings would be folded somewhere between the runway and the apron. However, the installation of such folding device would create many disadvantages, such as extra weight, loss of fuel tankage, increased maintenance requirements and problems to comply with certification requirements [Travers, 1995].

Greater takeoff weight will also require different undercarriage assemblies. Manufacturers are designing the NLA to accomplish with aircraft classification number (ACN) 65. Boeing anticipates a wheel track of 17 m [Gervais, 1994], certainly with a higher number of wheels than the 747. The A3XX-100 is expected to have 20 wheels, whereas the A3XX-200 could have up to 24 wheels [David, 1995].

Noise and pollution do not seem to be a problem to the NLA. In terms of noise, all projects are aiming to comply with FAR 36 Stage 3 requirements. Pollutants emission is expected to be higher than the current aircraft patterns, but the amount of pollutants emitted per passenger mile should be lesser [David, 1995].

New Supersonic Aircraft

Development of new supersonic aircraft is beginning to leave its early phase, but there are still many problems left to be solved. Thus not much information is available right now, and even what has been already released could easily be altered in the next years. A preliminary investigation is all that is feasible at this time.

Table 2 shows the dimensions of the aircraft under study by Boeing and the ESRP and compare them to the Concorde. Figure 2 shows the preliminary design of Airbus AST2. It can be seen that new developments are looking at passengers capacity as much as two to three times the capacity of the Concorde. However, no dimension exceeds the values dealt with by airports nowadays, except for the length and the wheel base. In order to allow supersonic speeds, the fuselage must be kept narrow. Hence, to accommodate a higher number of passengers, both Boeing HSCT and Airbus AST2 will be almost 95 m long, far exceeding all existing aircraft in this dimension. This could be a major problem for operation in existing airports.

TABLE 2. EXISTING AND PROPOSED SUPERSONIC AIRCRAFT DIMENSIONS

Aircraft	Wingspan (m)	Length (m)	Wheel base (m)	Wheel track (m)	Runway length (m)[a]	Passengers	Maximum takeoff weight (kg)
Concorde	25.3	62.6	18.2	7.7	3443	108-128	185064
HSCT	39.6	94.5	N/A	N/A	3352	292	315000
AST2	39.0	94.8	35.0	N/A	3352	250	N/A

Sources: Ashford & Wright [1992]; Horonjeff & Mckelvey [1994]; David [1995] ; Boeing [1996a]
N/A: Not Available
[a] At sea level, standard day, no wind, level runway

Another critical problem of supersonic aircraft is noise. The generation of sonic booms at supersonic speeds force the aircraft to operate at subsonic speeds when flying overland. This could make the operation of these aircraft unfeasible on some routes crossing large portions of land. To overcome this problem, some sort of waypoint routing might be necessary [Boeing, 1996a]. Figure 3 shows an example of waypoint routing. When approaching the airport, supersonic aircraft – like all others – noise levels will have to comply with FAR 36 Stage 3.

Engines that will propel these new aircraft are being designed by both Pratt & Whitney and General Electric with the goal of low production of oxides of nitrogen (NO_x). A possible concept under study is a double-stage combustor, that Boeing says will produce 80% to 90% less NO_x. The primal intention is to prevent harms to the ozone layer [Boeing, 1996a].

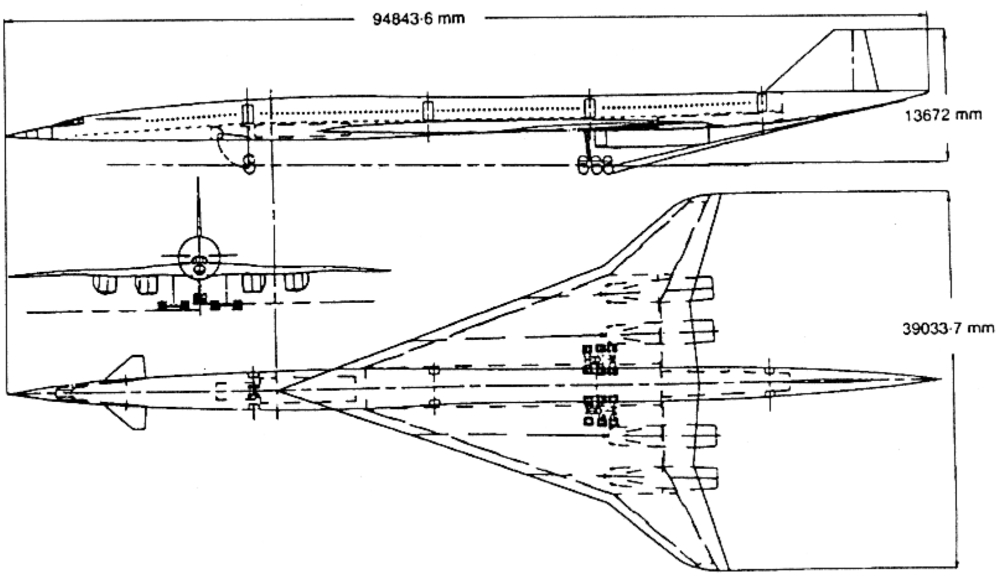

Figure 2. The AST2 supersonic aircraft.

Source: David [1995]

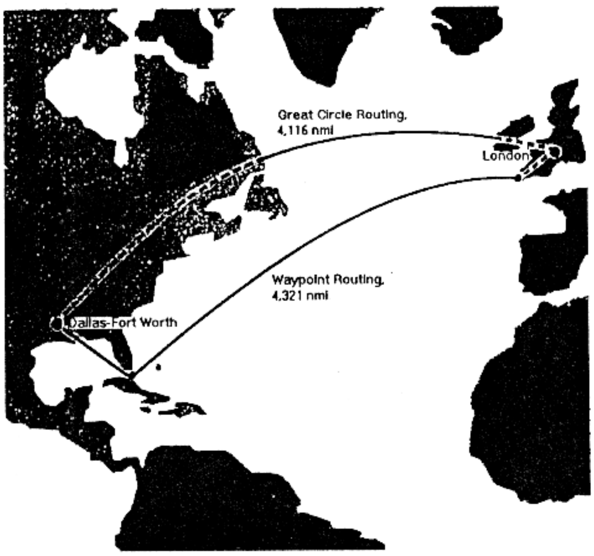

Figure 3. Example of waypoint routing.
Source: Boeing [1996a]

NEW AIRCRAFT-AIRPORT COMPATIBILITY: ISSUES AND PROBLEMS

From the airport curb size and parking facilities to the length and number of runways, virtually all airport facilities and operations depend on the type of aircraft that will be operated at the airport [Barros & Wirasinghe, 1997]. Now that aircraft with different characteristics are imminently coming into operation, it is of interest of both airport operators and aircraft manufacturers to evaluate the impacts of those new aircraft on the airport design and operations. Airport operators want to know what changes will be necessary in the existing facilities, how much it will cost, and who will pay the bill. Aircraft manufacturers, in their turn, wish to anticipate the effects of their design on airports, so that they are able to perform feasible alterations in aircraft design to minimize the impact on the airports. This section reviews all major issues of airport planning under the light of the introduction of new aircraft.

Air Traffic Control

A minimum separation between aircraft approaching an airport is necessary because of wing tip vortex – or wake turbulence – generation. Table 3 shows the FAA separation rules under IFR conditions. Wake turbulence effects are generally proportional to aircraft weight [Horonjeff & McKelvey, 1994]. So far, no study has been concluded on the wake turbulence effects generated by the NLA. However, given that its height could be as much as twice the 747's, it is assumed that separation requirements will have to be increased in 1 or 2 nautical miles for the NLA [Chevallier & Gamper, 1996]. This raise in the separation will impact runway capacity, which might be compensated by a decrease in the number of aircraft operations.

TABLE 3. IFR MINIMUM SEPARATION RULES ON APPROACH (NM)

	Trailing aircraft type[a]		
Leading aircraft type[a]	Small	Large	Heavy
Small	3.0	3.0	3.0
Large	4.0	3.0	3.0
Heavy	6.0	5.0	4.0

Source: FAA [1978]
[a] Small: aircraft weighting no more than 12,500 lb. (5,625 kg)
Large: aircraft weighting more than 12,500 lb. (5,625 kg) and less than 300,000 lb. (135,000 kg)
Heavy: aircraft weighting in excess of 300,000 lb. (135,000 kg)

As the new supersonic aircraft fit the FAA's specifications for heavy aircraft, no significant impact is forecast on approach separations.

Airfield Design

Probably one of the most affected areas of the airport by new aircraft is the design of the airfield – the configuration and dimensions of runways, taxiways, and aprons. Aircraft dimensions directly determine the requirements for runway length and width, taxiway width, runway-to-taxiway and taxiway-to-taxiway separations, and apron design. These requirements are usually based on an airport reference code given by either ICAO or FAA. Table 4 shows the airport reference codes given by ICAO. It can be seen that an airport design to accommodate the Boeing 747 is classified with the reference code 4E. However, the NLA do not fit in any category because their wingspans are larger than 65 m, the maximum value in the ICAO classification. Therefore, ICAO will need to create a new code "F" to refer to NLA [Fife, 1994; Chevallier & Gamper, 1996].

FAA has a different method to classify airports, although one can find some correspondence between categories in both ICAO's and FAA's classifications given in Table 5. Airbus NLA seem to comply with airplane design group VI, but Boeing NLA could still need a new category – or design its wingspan as 80 m or less to fit category VI.

As both NLA and the new supersonic aircraft are being designed to have the same runway length requirements as the current 747, no problem is anticipated at current airports. However, the fact that the NLA do not or might not comply with any category either on ICAO's or FAA's code may be critical. Runways and taxiways clearance and separation requirements are based on those classifications. Airports designed with strict compliance with those codes might not be able to accommodate NLA without serious restrictions. For example, two parallel taxiways in an ICAO code E airport would have their centerlines separated by 80 m, not enough to guarantee simultaneous operation of two NLA moving on opposite directions if a minimum wing tip clearance is to be satisfied. Problems like this are expected also with runways and aprons. As the increases in width of and separation between runways, taxiways and aprons are added, their cumulative effect might be quite significant [David, 1995]. An example of this effect is given in Figure 4. Preliminary studies for the New York / JFK airport are shown in Figure 5. Land availability might impose severe restrictions to the proposed alterations, creating the need for either restricted operations or the construction of a new airport.

TABLE 4. ICAO AERODROME REFERENCE CODE

Aerodrome code number	Reference field length (m)	Aerodrome code letter	Wingspan (m)	Outer main gearwheel span (m)
1	<800	A	<15	<4.5
2	800–<1200	B	15–<24	4.5–<6
3	1200–<1800	C	24–<36	6–<9
4	≥1800	D	36–<52	9–<14
		E	52–<65	9–<14

Source: ICAO [1990]

TABLE 5. FAA AIRPORT REFERENCE CODE

Aircraft approach category	Aircraft approach speed (kn)	Airplane design group	Aircraft wingspan (m)
A	<91	I	<15
B	91–<121	II	15–<24
C	121–<141	III	24–<36
D	141–<166	IV	36–<52
E	≥166	V	52–<65
		VI	65–<80

Source: FAA [1989]. Units converted from ft to the most next integer value in m.

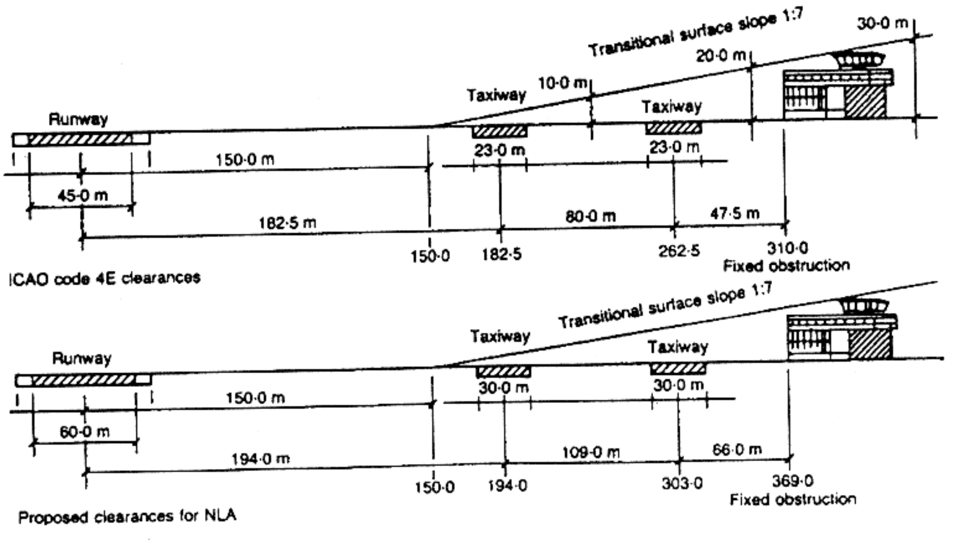

Figure 4. Cumulative effect of changes in clearance distances.

Source: David [1995]

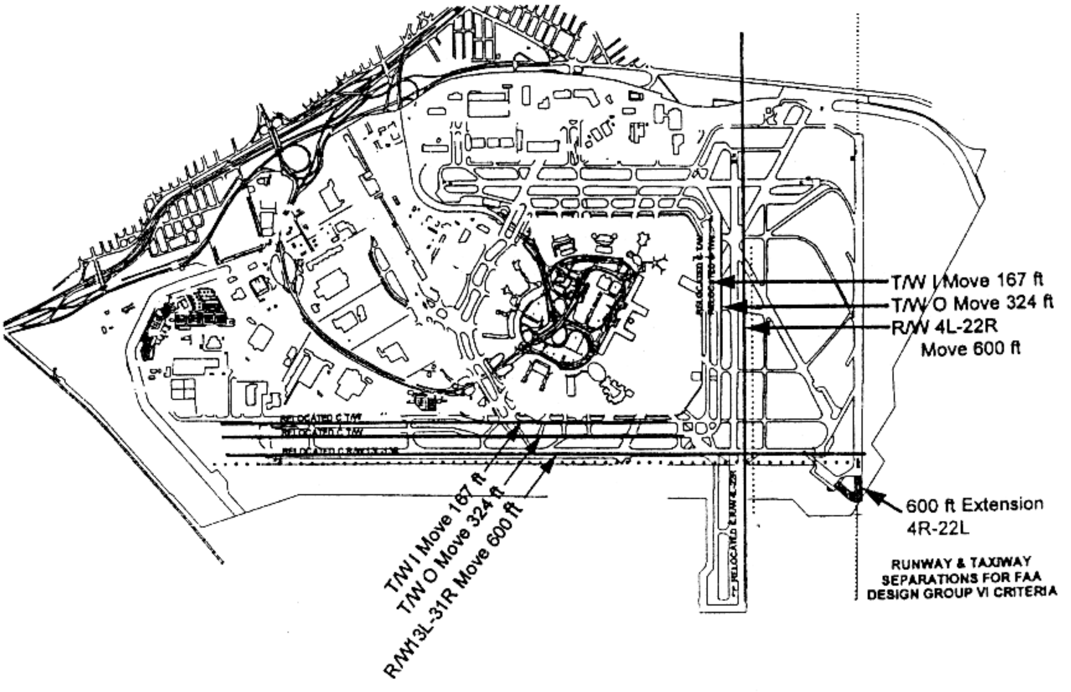

Figure 5. Proposed changes to New York JFK Airport to comply with FAA Group VI.

Source: Fife [1994]

Due to greater proposed wheel base and track, taxiway fillets will have to be redesigned on intersections with runways and other taxiways. A study carried by the Port Authority of New York & New Jersey [Fife, 1994] is shown in Figure 6.

Terminal Area

From airport access to the number of gates, nearly all aspects of passenger terminal planning are affected by aircraft size and capacity. The passenger terminal area is generally agreed to be one of the most sensitive to the effects of larger airplanes [Fife, 1994; Chevallier & Gamper, 1996], yet there has been little research on these effects. This section reviews the main issues of passenger terminal planning and the possible impacts of new larger aircraft on existing and future terminals.

Number of Gates

The number of gates is one of the first variables to be considered when planning the passenger terminal [Barros & Wirasinghe, 1997]. The determination of the number of gates in a terminal has been a primal concern of many air transportation researchers around the world [Tošic, 1992; Bandara, 1989; Bandara & Wirasinghe, 1989].

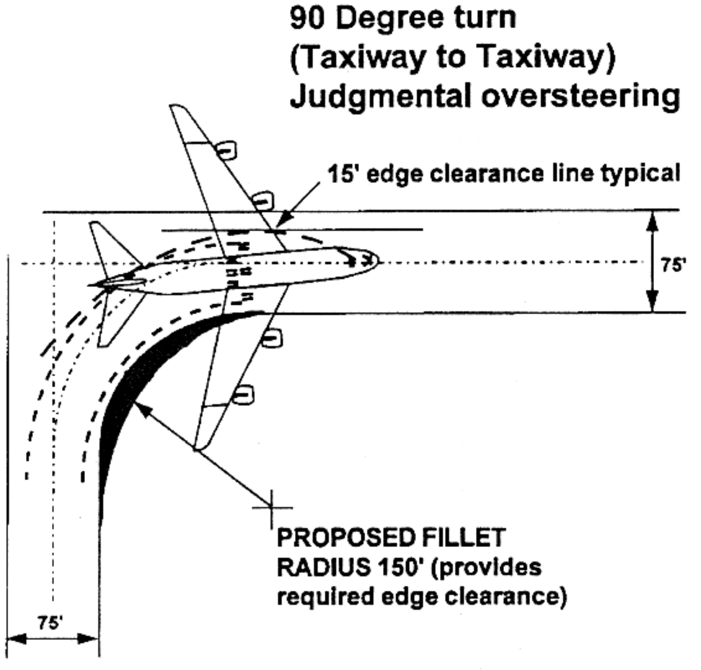

Figure 6. Additional fillet in taxiway curves.

Source: Fife [1994]

The number of gates required is directly proportional to both the gate occupancy time and the aircraft arrival rate, as it can be seen in the following equation [Bandara & Wirasinghe, 1989]:

$$G = A(T+S) \quad (1)$$

where G is the number of gates required, A is the aircraft arrival rate, T is the gate occupancy time and S is the gate separation requirement (maneuvering time). If A and T are random variables with known probability distributions, then it is possible to determine the number of gates G so that, at a given level of confidence, no aircraft will have to wait for service.

The assumption that no aircraft must be delayed due to lack of gates is valid for short periods only. In the long run, there must be a balance between the cost of providing a certain number of gates and the benefits this provision will bring. These benefits can be measured as delays that would be imposed to aircraft if the gates were not provided. In other words, there is a tradeoff between the cost of providing the gates and the cost of aircraft delays. The problem then becomes to minimize the total cost of gates per unit of time, C_G, given by [Bandara, 1989]:

$$C_G = K_G G + K_W W \quad (2)$$

where G is the number of gates provided, W is the total delay imposed by aircraft per unit of time, K_G is the discounted cost of a gate per unit of time, and K_W is the cost per unit of time of delay. From queuing theory, it can be shown that both G and W are functions of the gate service rate μ. W is also a function of the aircraft arrival rate. The number of gates G is given by:

$$G = \mu(T+S) \quad (3)$$

The problem then becomes to find the value of μ which minimizes C_G.

With respect to the NLA, some conclusions can be drawn from here. First, from Equations 1 and 3, the number of required gates is directly proportional to the aircraft turnaround time. Thus, should the turnaround time of an aircraft carrying up to 1000 passenger be very high, the number of gates and, consequently, the cost of the terminal will be also very high. Both Boeing and Airbus realize this and are searching for solutions that allow a turnaround time not much higher than the 747's. Two hours is believed to be the maximum acceptable [Chevallier & Gamper, 1996]. Researchers are also considering the use of double level loading bridges, which would allow the two decks of the NLA to be assessed simultaneously, improving the boarding time.

Second, from Equations 1 and 2, the number of gates is also dependent on the aircraft arrival rate. The determination of the NLA arrival rate is specific for each airport and a critical factor for the planning of facilities intended to serve NLA. Assessing the arrival pattern of NLA right now is almost impossible, as not even the size of the market for the NLA is known at this moment. Forecasts by both Boeing and Airbus indicate a global market for approximately 500 of those aircraft [Airbus, 1997; Boeing, 1997b], but no precise indications for specific routes are available at the moment. Thus it is recommended that airport operators, airlines and manufacturers work together when planning the facilities to serve the NLA.

Another question arises when talking about existing facilities. Changes in existing gates could allow these facilities to be used by NLA. However, due to the greater wingspan of the NLA, and its consequent need for more spacing between gates, these changes could lead to a loss of aircraft positions. If not properly handled, this process could have a negative impact on the airport gate capacity, exactly the reverse of the relief intended with the NLA. Thus adaptation of facilities to serve the NLA must be carefully planned, and even so a slight loss of gate capacity might be inescapable.

Departure Lounges

Approximately for the last thirty years, the 747 has been the largest passenger aircraft in operation in the world.

Virtually all major airports in the world have their facilities sized to serve that aircraft. Now that aircraft with a passenger capacity 50%-100% greater are being introduced, these facilities might not be large enough. This is particularly true with the departure lounges.

One of the main functions of the passenger terminal is *change of movement type*, i.e. the accumulation of passengers who come to the airport in small groups to form batches, which will be carried together in an airplane and split into small groups again at the destiny airport [Ashford & Wright, 1992]. That means, no matter the aircraft size, all passengers will have to be processed during a short time range. This implies that the greater the aircraft passenger capacity, the greater the passenger facilities. Furthermore, most passengers would prefer to go on board as close as possible to the departure time, trying to enjoy their freedom of movement as much as they can before entering a crowded aircraft [Wirasinghe & Shehata, 1993]. Thus the departure lounge works like a buffer where passengers are "stored" until the time of boarding. However, not all passengers arrive at the departure lounge before the boarding starts. An S-shaped curve like the one shown in Figure 7 is usually assigned to describe the cumulative passenger arrival process to a departure lounge. The dimension on the Y-axis varies with the aircraft passenger capacity.

The method of sizing departure lounges developed by Wirasinghe & Shehata [1993] is very appropriate to undertake studies on the impact of NLA. The method uses deterministic queuing theory to assess the maximum number of passengers in the departure lounge and the optimal number of seats, given the cost of construction per terminal area, the cost per seat and the cost per minute of passenger compulsory standing. According to this method, the maximum accumulation of passengers in the departure lounge, Q, occurs at the time at which the boarding begins. Therefore, the area necessary for the departure lounge will depend on the method of boarding. Double-level bridges will allow shorter turnaround times, but on the other hand they will imply the necessity of larger lounge areas due to greater accumulation of passengers. Anyway, even if boarding is done only through the main deck as is widely assumed [Chevallier & Gamper, 1996], two bridges could be used with the same effect. In either case, the greater passenger capacity of the NLA is most likely to require major adaptations in current departure lounges.

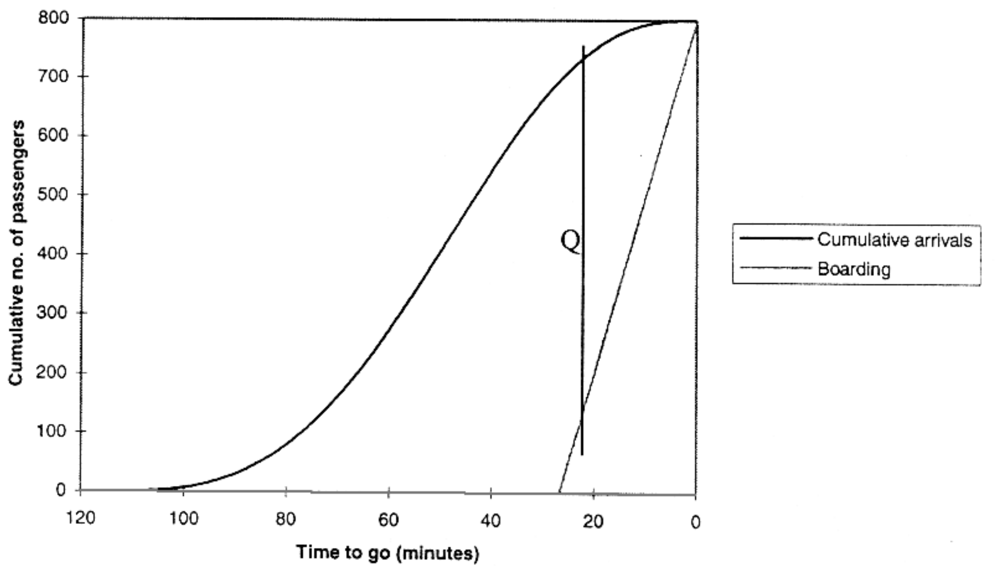

Figure 7. Sizing the departure lounge with deterministic queuing theory.

Barros & Wirasinghe [1998] present some analytical models to evaluate the optimum size of the departure lounge for the NLA under various circumstances, like the construction of a second floor to accommodate passengers and the use of the satellite section of a pier-satellite finger terminal as a single NLA gate. These models are also based on deterministic queuing theory, and have as objective function the minimization of the overall cost of the lounge per aircraft departure. The cost is given in terms of building and operation cost, disutility of passenger standing, and cost of providing seats. The outputs of the model are both the lounge size and the number of seats to be provided.

<u>Check-In / Baggage Handling / Security / Curbs</u>

Just like the departure lounges, other services in the terminal passenger are likely to be affected by the enlargement of the NLA passenger capacity. Check-in and security checks might require a greater number of counters. Both arrival and departure level curbs will probably need to be extended to accommodate more cars. Baggage handling system is also likely to require capacity improvement. Baggage claim area requirements are likely to be larger, and the baggage belt length required is estimated to be 110 m [Chevallier & Gamper, 1996]. The combined effect of all these changes might make the problem difficult to evaluate with analytical models. Simulation could then be used to help size all facilities and evaluate possible alternatives.

Rescue and Fire Fighting Equipment

As in the case of airside design, the determination of the level of protection at an airport is also done through the categorization of the airport. Again, the problem is that neither the NLA nor the new supersonic aircraft fit any of ICAO's categories, as can be seen in Table 6. ICAO's former classification does not contemplate aircraft over 76 m long, whereas the NLA is expected to be over 80 m long and the proposed supersonic aircraft are to be over 94 m long. To account for the NLA, ICAO has created a new aerodrome category 10, for airplanes up to 90 m long [Rao, 1997]. The new supersonic aircraft, however, will not fit this category.

For the NLA, this task might be facilitated by the criterion used by ICAO to determine the level of protection required. If the number of movements of the longest aircraft in the same category during the busiest consecutive three months of the year is less than 700, then the level of protection adopted may be one lower than that of that aircraft. As the NLA is most likely to fit category 10, then if the number of operations is low enough they could operate in a category 9 airport. The supersonic aircraft, however, is not likely to fit category 10, due to its much greater length (almost 20 m longer than the longest aircraft in category 9). Nevertheless, ICAO allows that the airport be classified as two categories below that of the longest aircraft, provided that the numbers of operations in each category are close to each other. Anyway, both NLA and the new supersonic aircraft require the establishment of new categories.

The above exercise is valid only while the current airport categorization is valid. However, this categorization was developed taking into account aircraft with only one passenger deck. The proposed design of the NLA includes a second deck and, consequently, a much higher passenger capacity. Thus emergency procedures, equipment and staff requirements might be completely different for the NLA.

TABLE 6. ICAO AIRPORT CATEGORIZATION FOR SECURITY PURPOSE

Airport Category	Airplane Overall Length (m)
1	0-9
2	9-12
3	12-18
4	18-24
5	24-28
6	28-39
7	39-49
8	49-61
9	61-76

Source: ICAO [1983]

CONCLUSIONS

Both the NLA and the new supersonic aircraft are becoming closer to reality than ever. The technology to build the NLA already exists and its introduction is just a matter of solving technical problems like the compatibility with existing airports. The new generation of supersonic aircraft, in its turn, is not economically viable yet, and its transition to the reality might depend on a major breakthrough, either in avionics or in propulsion technology. Anyhow, both new developments are expected to be operational in the second decade of the 21st century.

As said above, these new aircraft developments will impact airport planning and operations in a matter that might even require major changes in existing airports. Airports should therefore be aware of this possibility and prepare themselves for that. In order to do that, it is necessary to previously assess the consequences and the changes required by the advent of those new aircraft.

Much research has been carried on the effects of those new developments on the airport airside. What can be concluded so far is that impact is basically a matter of geometry – finding the necessary clearances and facility dimensions – and of economical analysis. The impact on the landside seems to be less studied, yet not less important and more difficult to analyze. Although it is generally agreed that passenger terminal operations will be strongly influenced by the introduction of larger aircraft, much research is still needed to determine the actual effects and the required changes in terminal facilities.

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