CHARACTERISTICS OF PRESENT AND FUTURE AIRPORTS IMPACTING AIRCRAFT AND AIRPORT COMPATIBILITY

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Abstract

The airport characteristics affecting compatibility are reviewed in detail as applied to the airside and landside activities for both passenger and cargo traffic - domestic and international. The various concerns resulting from the impact of new aircraft or operating procedures on these characteristics are identified. Several of the major problem areas are discussed in some detail, and possible solutions, most of which involve trade-offs with existing designs or practices, are examined. The major problem areas are shown to be dominated by the constraints imposed by the lack of available land for expansions, and by other interactions with the surrounding community.

Introduction

Did the airlines realize, when they made their initial decisions to buy wide bodied jumbos that they would eventually have to pay hidden costs of several billion dollars for airport changes? Yes, the jumbo jet's introduction in the 1970's forced this scale of massive investments in new and existing airport facilities. At Kennedy Airport, several hundred million dollars were involved. A quick review of the Port Authority's investment just in runways and taxiways at this airport shows that this amounted to over $50 million in the late 1960's and early 1970's, and of course, this figure can be multiplied several times over when considering changes which were required in terminal buildings, cargo areas, on-airport and access roads, parking lots, utilities, new equipment, and other associated fallout. Considering the worldwide use of these aircraft, a similar story was repeated at more than ten score airports and the full effects have not yet rippled through the system.

While costly, these changes were made, and the growth in passengers and cargo has been handled, even with prevailing peak hour problems.

Today, however, many airport operators considering additional development are asking the question "Is it possible?" before "Can we afford it?"

Most airports existing today had their origins in the 1930's and 1940's at the beginnings of commercial aviation. These airports were originally located outside or at the edge of town and their size was a function of the large aircraft then on the drawing boards. Medium size busy airports such as Cleveland, Philadelphia, Boston, and Newark come to mind, and small airports such as Washington National and New York's LaGuardia are foremost in importance.

A typical large commercial aircraft being considered in those days was a DC-6 with a wing span of 117 ft., a length of 100 ft., and a 58 passenger capacity. Today's wide-bodied aircraft, of course, have wing spans of 160 to 200 ft., lengths up to 230 ft., and passenger shock loads of 300 to 500 people. There is even talk of aircraft with wing spans reaching 300 ft., overall length of 400 ft., and passenger capacities of 800 people - all before the end of the century.

This leads to a current preoccupation with squeezing these aircraft into existing airports - a little like putting the toothpaste back in the tube. For while aircraft were getting larger, city development since the 1940's came right up to the airport boundaries and these facilities wound up in an extremely sensitive urban environment.

Many legal, environmental, financial and community constraints on new airport construction as well as on the expansion of existing airports are manifested. In fact, in many critical geographical areas, the maximum achievable airport size and configuration within which to accommodate commercial aircraft are being approached.

Airport Characteristics Affecting Compatibility

Which are the airport characteristics bearing on the aircraft/airport compatibility question? Airport physical characteristics are the most obvious but equally important are environmental effects on physical and procedural changes. Also of concern are the technological advances which will be required to accommodate future aircraft operations.

Runway strength, length, width, safety areas, and end safety areas are primary considerations. New aircraft must in virtually all cases be able to operate from existing runway lengths. Ways may be found to strengthen pavement in spite of temporary operational problems, but there will only be rare cases where runways can be extended significantly. Fortunately, an examination of the top 30 air carrier airports in this country shows that most can offer runway lengths at or above 10,000 feet for most wind conditions. Isolated cases such as Washington National and LaGuardia with runway lengths around 7,000 feet need to be confined to certain stage length missions and this is already happening.

Close behind the runway questions are those concerning taxiway strength, width, radii, shoulders, and clearances to other taxiways and obstacles. Again - except possibly in the case of taxiway bridges - upgrading of taxiway strength, width, radii, and shoulders is primarily a question of money and finding ways to do the work without shutting down the airport. The clearance item is not as easy. For example, FAA standards call for a separation of 400 feet between runways and taxiways, and 300 feet between taxiway and taxiway - for any airport accommodating B-727-200 aircraft or larger. For future aircraft beyond the B-747 and up to a wing span of 240 feet, these separations become 600 feet and 360 feet respectively. At many air carrier airports these lower separations do not exist and even at those airports where they do exist, there is no room for future increases. Miles of taxiway systems are "boxed-in" between runways and apron areas - at Kennedy Airport virtually all of the peripheral taxiway system serving the passenger terminals falls into this category.

Aircraft structural bridges or decks deserve special attention because of the difficulty in strengthening these or bringing them up to future width standards. The runway decks at LaGuardia Airport will require a major investment to strengthen even to the limited additional extent feasible. Complete rebuilding for substantial increases in aircraft weight would cause very serious operational dislocations.

Obstacle clearance becomes more important as wing spans, wheel base and gear spacing increase. This applies particularly to ground movements on taxiways and ramps as well as to flight operating clearances. Current FAA standards call for taxiway

obstacle free widths of 340 ft. for B-727-200 aircraft up to B-747, and 400 ft. for future 240 ft. wingspan aircraft. Again, many airports have no hope of ever achieving complete 200 ft. separation between taxiway centerlines and obstacles.

Physical clearance to or interference with critically located electronic facilities, such as ILS glide slopes and visibility measuring transmissometers, would also be concerns. New large wingspan aircraft with massive metallic reflecting surfaces might jeopardize low visibility operations because of physical and electronic clearance considerations. Technological advances are required here, along the lines of the less sensitive Microwave Landing Systems.

Ramp area limitations may be paramount since such items as ramp strength, gate position clearances, and taxilane clear areas must be reconsidered. This is especially critical since in many cases one new aircraft will displace two existing smaller aircraft positions because of overall area constraints. This has already happened in attempting to fit the current crop of aircraft into apron areas. This applies not only to accommodating the wide-bodied aircraft but in many cases to the DC-9-80 and the 727-200. Subsidiary to these concerns but important are existing investments in second level loading devices and aircraft parking and docking guidance systems.

Fueling systems and procedures could be affected by substantial increases in aircraft size and configuration. Large sums spent for existing underground fuel systems may need to be written off before their time, unless procedural or technological advances can accommodate the greater demand within the distribution system in place. Projecting the analysis to the end of the century, alternative future fuels and their associated ground systems must be considered. A number of studies have shown that hydrogen or methane will be the next step in aircraft fuels. If this is the case, or even if the move is simply to synthetic fuels, substantial ground storage and distribution facilities will almost certainly be required, and the safety questions associated with certain of these fuels - not only within the airport but with regard to adjacent communities - must be solved.

Of course, increases in aircraft size mean increases in passenger capacity and loads, further straining increasingly inadequate terminal building facilities. With the moves over the last two years to higher density seating, these effects are already appearing, but shock loads of 300 to 500 passengers will become the norm at most terminals rather than the exception. Hold room size, counter space, processing space are among the concerns.

- Baggage handling problems, which today put this item among the top reasons for real passenger delay, may change from a problem to a nightmare, unless the technical and procedural developmental work underway today emerge into the realm of feasibility.
- Curb frontage and auto parking lot processing capacity relate to these higher peak loads, while internal and external roadway capacity, and parking lot size relate to total annual increases in passenger loads as well.
- Security clearance points, hold areas, and procedures will need to be reexamined, expanded, or modified in order to process large aircraft loads on a "normal" rather than exception basis.
- All of this expansion must take place while also permitting the needed ramp expansion on one side and roadway/parking lot work on the other side. The exceptional airport with undeveloped land may need to follow the path of Newark and Atlanta and provide completely new terminal areas.

For the international passenger, the current unique American approach to entry facilitation must be thrown out and replaced with a more effective and humane way. In fact, the need to do this exists now at many major entry airports, where fully loaded wide-body aircraft arrivals must often be kept waiting for extended periods before finding a gate. This is due to a combination of the peak loads as well as the pace and method of federal entry processing. Little hope for additional federal manpower is possible in today's climate, so procedural changes are imperative. These may be perhaps as radical as the use of advanced technology detection equipment, and the preclearing or on-board screening of passengers - possibly using surrogate inspectors.

A whole host of additional concerns about larger aircraft have yet to be touched upon.

The current fleet of monster size crash-fire-rescue trucks, with their incredible quantities of fire fighting agents, frequently roar down runways and taxiways at high speeds in order to meet minimum response time requirements. Have we not reached the upper limits of vehicle capability and is the next step the very expensive alternative of several levels of duplication in fire stations and equipment around the airport?

Virtually each new aircraft type, or derivative, over the last twenty years, have used larger, more powerful, engines. Assuming that this historical trend continues, there is a need to redo or extend runway blast pads, runway and taxiway erosion pavement, and those large areas of erosion pavement needed adjacent to most taxiway turns. Blast fence anchoring, baffle design, and height all will require analysis and possible change. Terminal building facades, ramp structures and service vehicles will be subjected to higher blast levels. One alternative may be to adopt new methods - such as the long-distance, "highspeed" towing of aircraft to remote areas for start-up. There are, of course, serious complications associated with this option ranging from slowing down aircraft ground movements to constructing a whole array of start-up areas and tug return roads - if room can be found.

What will be the impact of the larger wingspan aircraft equipped with larger more powerful engines on the myriad visual aids around the airport? Signs may need to be relocated further from aircraft pavement and therefore made larger and stronger. Elevated lighting fixtures are more susceptible to damage. A typical example was the initial effects of the B-747 takeoffs in France on edge lights and the subsequent development by the French of a low profile runway edge light. In this country strengthening redesigns were required. In-pavement lighting fixtures may also require strengthening for higher roll-over or impact wheel-loading.

Will these new aircraft put pilots higher or at radically new viewing angles so that vision cut-off or distortion of current ground visual aids, such as lighting, reflectors or marking, results? This was the case with wide-bodied aircraft where up to 70 feet forward of the aircraft was out of sight. New patterns might be required with increases in quantities of aids.

Will major improvements in the quality and quantity of runway visual aids be required because these new aircraft, following historical trends, land or depart at higher speeds?

Will systems such as fog dispersal equipment become a requirement if advancements in avionics combined with improved and highly reliable ground electronic aids speed the coming of extremely low visibility operations. Fog dispersal equipment is installed at several European locations on essentially a prototype basis and may require substantial additional development work.

Will these heavier aircraft hurtling down runways at presumably higher speeds exacerbate the current disturbed situation surrounding the subject of runway surface traction? During a contentious ICAO meeting earlier this year pilot, and to an extent airline, organizations sought to require the airport operator to measure surface friction on a real time basis and eventually provide this information to pilots. This premature action was thwarted by focusing attention on the fact that these measurements, even when properly taken, do not correlate with aircraft stopping performance and those assembled agreed to a major conceptual change. That is, measurements were determined to relate to "friction characteristics" and not "braking action". This is not to say that the desire to improve the margin of safety during inclement weather is not present, but it is imperative that further developmental work take place before considering the real time use of measurements and the potentially disasterous effects of providing possibly erroneous information to pilots. After all, it is the airport operator who would be charged with making the system work, in spite of the real life problems he would face in obtaining "legally" reliable measurements. For sure, improvements in the reliability and availability of the equipment-operator combination would be required and a way must be found to speedily take these measurements without long runway shutdowns.

Airports with substantial cargo movement will have problems in somewhat different forms. For example, heavier loads will certainly be involved, and the presumably larger volume capacity of the new aircraft will require larger storage and freight transfer facilities. Also, much of the cargo movements these days is in the belly of passenger aircraft and upper deck of combi aircraft. Current problems with the volume of vehicle movements between the airport freight handling areas and passenger terminal, and the loading operation at these terminals, will worsen.

Last on the list but not the last in importance is sensitivity in communities surrounding airports to aircraft noise. This subject will be discussed by another speaker in more detail but it must be understood that this sensitivity will dictate continual reductions in noise most likely even beyond current Federal regulations. In fact, it is conceivable that in heavily impacted communities or in states charged with regulating noise, local regulations will require action on non-conforming aircraft prior to Federal deadlines.

Identifying Critical Factors

The previous list was long and not all completely connected with new aircraft. It is true that part of the list is also associated with the growth in the industry and, to an extent, with the evolution towards continued operations in extremely poor weather conditions. However, it is important to cite all of these, since an airport operator's ability to accommodate larger or different aircraft may often reduce his already marginal ability to react to other changes. Only in the abstract can one experience a single isolated stimulus.

The next step is to examine some of these existing and future concerns and attempt to isolate those which will cause major problems. Certainly, the first problem is with space or real estate, whether speaking about existing or new airports. For a variety of reasons, airports and the aviation industry are not always regarded as friends. In spite of the jobs that they provide, the economic development they stimulate, or the convenience they provide for easy access to the rest of the country and the world. Rather, in most of the areas where the effects listed are expected, severe community pressures exist against airport expansion. Or, environmental or legal constraints preclude expansion. At LaGuardia Airport, there has been an effort for over ten years to advance a project to provide a partial runway end safety area in Flushing Bay. However, New York City and State property and environmental considerations form a "gridlock" that may be impossible to break out of.

With very limited exceptions, new airports or major expansions of existing airports in areas of strong aviation growth will be extremely difficult if not impossible. Therefore, all aspects of new aircraft that impact space considerations at an airport are critical. New runway length requirements, greater clearance requirements between runways and taxiways, taxiways and taxiways, apron gate positions, and between runway, taxiways, taxilanes and obstacles will be physically impossible in many airports. However, some resolution to this situaiton may be found by reducing clearance margins through rigorous empirically based analysis similar to the effort at FAA's Oklahoma City office in developing the "Collision Risk Model" for runway clearance criteria.

As an example of revised clearances, consider the situation at LaGuardia Airport. While this airport does not handle four engine jets, the DC-10, L-1011 and A-300 have been safely introduced. Prior to that introduction, the taxiway to taxiway separation standard for these aircraft - 300 feet - was analyzed, and it was concluded that 235 feet could be used. The case was made to the FAA and a reconstruction of our taxiway system to this standard proceeded. This reconstruction is virtually complete and the last gap will be closed within the next few years. The rest is history - these aircraft were introduced in the early 1970's and their numbers have increased ever since, albeit on a scale reduced from forecasts.

To a lesser extent, it has been possible to accommodate these wide-bodied aircraft and stretched DC-9's and 727's within existing apron areas by tighter apron control. Outboard finger gates for the larger of these aircraft have been used and these aircraft are moved in and out of position with little impact on the adjacent peripheral taxiway system. However, this process has gone about as far as it can go in the Central Terminal Area and any further airline changes will almost require metal passing over metal, or major adverse impact on the adjacent taxiway system - and this will not be acceptable.

Perhaps farther in the future cost-effective technological advances in taxiing aircraft sensing and guidance systems will be achieved, enabling margins to be cut further. Of course, at some point the overall airport size envelope will of necessity constrain aircraft size.

Another problem could be the operational impact of new development. All construction, even within existing property rights, must be capable of being done without severe operational penalties or the "medicine may kill rather than cure". The first airports that come to mind when thinking about operational complexities associated with construction are smaller ones such as Washington-National. However, even at airports with multiple sets of parallel run-

ways, operational considerations have a heavy impact. A major decision on the type of reconstruction design for the Bay Runway at Kennedy was essentially dictated by the need to minimize the loss of this heavily used departure runway. As to terminal areas, for every airport that can accommodate new terminal locations such as Atlanta and Newark, there are one or two that cannot and must build essentially on top of or alongside the existing one.

Another very inflexible area is community reaction to environmental and safety matters. Aircraft noise is a paramount consideration and colors every other aspect. This will be discussed in another paper.

Other environmental concerns must be addressed and satisfactorily handled or local political approval of airport changes will not be forthcoming. These include: direct water and air pollution; adverse local effects of increased vehicular movements and concentrations; and impacts on river or tidal movements. Any future proposals for environmentally sensitive facilities, such as hydrogen fuel storage systems, would likewise need to be satisfactorily handled.

The pace of technological progress could be a problem. Increases in runway or runway system capacity require substantial technical work in the areas of wake vortex detection and dissipation, terminal airspace efficiency, and poor weather guidance in the air and on the ground. High speed airport access at a reasonable cost is also high on the list of technological needs. The list is long, ranging from the detection of drugs to the rapid recovery of baggage.

Summary

The commercial aviation industry arrived at today's highly reliable system while overcoming constant obstacles along the way. The industry is confident that it can continue to handle market growth. However, airport operator concerns must be factored into the total equation as early as possible before making decisions on new equipment. Following the airport problems encountered in the 1970's with the introduction of the "jumbos", it was thought that things had been turned around - the attention of airlines and manufacturers had finally been focused on the problems. Lately, with the increases in the price of fuel and with the intense effects of deregulation, disturbing talk is heard again. That is why these meetings are particularly appreciated. They present the opportunity to raise caution flags and to work with others in the industry to plan intelligently for the future.