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# The Management Systems Approach to Airport Planning: Identifying and Overcoming Restraints

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# THE MANAGEMENT SYSTEMS APPROACH TO AIRPORT PLANNING: IDENTIFYING AND OVERCOMING RESTRAINTS

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THE MANAGEMENT systems approach that is becoming so widely used throughout business and government organizations offered some unique ideas in developing a comprehensive planning procedure for building the Dallas-Fort Worth Regional Airport. Actually, the term management systems approach is just a new label for something we used in my early days with TWA: namely, looking at a total picture before the concrete is poured or a rivet driven into a building. The advantage of today's type of system planning is that a more scientific technique is used that allows for more orderly planning with greater examination of detail.

The definition of the systems approach we have used is perhaps oversimplified, but it has served as a useful guideline. It means an orderly arrangement of all elements into one total package. It is breaking everything down into easily identifiable parts, then working with those parts until every possible contingency has been examined. We then unite those various subparts, subsystems if you please, into what we feel is the best solution.

Applying this technique to our particular problem of designing an airport, we identified what we felt were the most important subsystems that make an entire airport system. By so doing, we establish seven component groups with which to deal. These components are tantamount to restraints to free traffic flows. This point concerning traffic flows should be emphasized since there are sociological restraints that are outside this discussion.

It would be well to point out that other people have identified restraints in airports, and this is not original with us. Notably, the Civil Aeronautics Board in a publication entitled *Problems of Airport Congestion by 1975*,[1] identified six major restraints. In the book *Air Transportation 1975 and Beyond*, by Bernard A. Schriever and William W. Seifert,[2] a section entitled "Factors in Planning of New Airports" listed some twelve items that could be equated as restraints. A comparison of the viewpoints expressed in these publications with our own ideas would not serve any useful purpose, but you should be aware of other viewpoints.

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[1] Civil Aeronautics Board, *Problems of Airport Congestion by 1975*, Superintendent of Documents, Washington, D.C. (1969).

[2] Schriever, B.A. and Seifert, W.W., *Air Transportation: 1975 and Beyond*, M.I.T. Press, Cambridge, Massachusetts (1968).

## I. Restraints to Free Traffic Flows

The first restraint with which to deal is the *airspace* available for present and projected flight operations. Essentially, the question is: Is there enough *airspace* over and around the airport to allow all desired arrivals and departures without resultant delays?

Saturation of the airspace is one of today's major problems because it creates a flying hazard and it is economically costly. It is costly to the airport and the region it serves because air commerce becomes limited. It is costly to the airlines because of lost time and extended operational costs. Airspace will continue to be a problem even when "reliever" airports are built to serve a particular region. While ground operational capacity will be increased, airspace becomes even more a premium, especially under Instrument Flight Rules (IFR) conditions.

Getting down to earth, the second restraint is that of *runways*. Regardless of limitless open sky with 99% Visual Flight Rules (VFR) days, runway capacities must be capable of handling all the scheduled takeoffs and landings without delays. Inadequate runways create hazards and increase economic costs, as does airspace saturation.

The third airside restraint with which to deal is the *taxiway* problem. Even if you can get the aircraft into and out of the air without delays or unnecessary hazards, the taxiways have to be adequate to keep the runways cleared. Designing a taxiway complex to do this is not simple but is extremely necessary. Taxiways that are parallel to runways without adequate crossovers for aircraft to clear runways after landings can cause lost time by stacking aircraft in the air and on the ground. During peak hour conditions, the "queing" effect thus developed, causes delays not only at the airport being served but at other downline airports.

The last airside restraint is the *apron* area adjacent to the terminals. Like parking space anywhere, aircraft apron space is at a premium. Adequate gate positions and maneuverability are the prime consideration in this phase of planning. Without sufficient parking stalls, saturation in reverse occurs; that is, traffic backs up on the taxiways and runways and in the airways. An additional hazard to both men and equipment exists without room for aircraft to move around. Millions of dollars a year are lost because of aircraft incidents occurring on the aprons of today's terminals.

Let us now turn to the landside problem and identify the fifth restraint of *terminal space*. Planners must look at the requirements for terminal space and the ability to expand and alter those terminals when necessary without shutting down operations. It is estimated that in the United States, some four hundred million dollars will be spent on terminal improvements alone in the next five years. This fact speaks for itself. For years the terminal problem has existed because development always lags current passenger levels. By the time airports expand to planned levels, they are outdated. Consequently, we seem to be building terminals with longer and longer fingers, or concourses, since this is the easiest way out of the problem.

Before long, we can build terminal fingers from airport to airport and let the passenger walk to his destination.

The landside of the terminal is paved in the same manner as is the airside, and for the same reason. This brings us to the sixth restraint: *parking facilities*. Parking, and its design or lack of it, is the thing most obvious to the passenger. A serious shortage of parking will eventually restrict airport usage. Public transport to airports, as an alternative, is totally inadequate, if it even exists. While cities have been talking rapid transit between central business districts and airports for years, only a few such as Tokyo and Cleveland, have actually done anything. The automobile, then, will continue to be the primary mode of transport to and from airports, and it is an airport's responsibility to provide for this. Besides, it just makes good business to do so since parking revenue is the second major source of airport income.

Corresponding to the airside taxiway and runway situation, the seventh restraint is constituted of the problems connected with *roadways and highways*. Many of today's airports have highways that dead-end into the terminal or terminal parking lot. Traffic flow then becomes a problem. It is a problem that many planners are not dealing with, and primarily by default, since they are concerned with other things. In the Civil Aeronautics Board study previously cited, several of the airports mentioned have highway access as their most restraining factor. The roads and highways simply cannot handle all the traffic wanting to go into and out of the airport in high demand periods. Again, we are creating serious problems by not designing a roadway system within the airports, and to and from the cities, to handle the flow of traffic.

## II. Overcoming Restraints to Free Traffic Flow

To overcome some of the problems of the airport planner and achieve an optimum total airport system, we reviewed these restraints with our prime architects and engineers. In doing so, many of the traditional solutions to these problems have been abandoned. Although not all of the optimum solutions we advocate can be implemented within our available funding, "man's reach must exceed his grasp."

In planning the Dallas-Fort Worth Regional Airport, the first step was to develop and operate a simulation of the airspace (the first restraint) above the region. Airspace simulation and the major market proximity were the primary considerations used in determining a site. The resultant choice was an area separated from existing airport facilities that can be operated in IFR conditions without conflicting traffic.

In addition, wind conditions, existing urban development, soils, ground access and possible development of ground access were inputs to site selection. The site chosen encompasses approximately 16,500 acres with another 1,500 acres under zoning restrictions. Two basic factors were used to determine this land area: 1) the provision for room to encompass those functions necessary to support ultimate airport development and; 2) the need for on-site space to act as a noise buffer.

Another product of the airspace simulation was the basic runway layout plan necessary to accommodate saturated conditions. The simulation helped us to plan for this, the second restraint. For example, in ultimate development, the runway configuration includes nine runways to serve what could be considered three basic airports. The main airport complex will have six runways, with a V/STOL terminal complex having two runways and an executive terminal complex with one runway. Our studies indicate that our main complex runways can accommodate 266 VFR operations per hour or 178 IFR operations per hour.

The next restraint to overcome was the taxiway system. Here, too, a computer simulation has been utilized to ascertain optimum layout. The complex developed as a result of the simulation provides rapid entry and egress to runways. This guarantees minimum congestion for taxiing aircraft between the runways and docking locations for passengers, cargo, or maintenance. It also provides minimum congestion for aircraft taxi operations as the complex is constructed phase by phase to its ultimate configuration. This was an important consideration since construction on this airport will not cease for at least twenty years.

Developed conjunctively with the previously mentioned airside restrainst were the apron areas adjacent to the terminals. The commercial airliners of the near future present real physical problems. Turning radii, wing spans, and fuselage lengths and heights of future aircraft will be increased significantly over those of the present. The prudent planner would assume that these increases will be even greater in future years. With these things in mind, the traditional airside configuration of present terminal buildings, characterized by concourses and other impediments to the free flow of turning and taxiing aircraft, is then inadequate for the future.

At the Regional Airport, therefore, the airside face is relatively smooth, following a curvilinear (semi-circular) form with the convex side to the aircraft. The apron area extends airside 420 feet from the terminal face and allows restraint free taxiing on the apron and generally negates delay caused by "traffic jams" of aircraft. Such shapes will prevent "lock-ins" of docked aircraft as are particularly prevalent in the terminal designs which have closely adjacent parallel concourses. The design we have decided to use will give the airlines minimum delays with maximum profit in operation.

The possible landside restrains, subsystems, consisting of terminal facilities, parking areas, and intra-airport roadways required the analysis of comprehensive and complex relationships which almost defied individual treatment in planning. Basically, the design theme integrates multiples of the smallest, most efficient unit airport into an efficient scheme. This efficient unit consists of a small parking lot on one side of a passenger service building and an aircraft on the other.

With this concept, we eliminated the tradition of having one terminal building serve all the airlines and handle all passengers. The airport will consist of several terminal buildings, thirteen in ultimate development, in the shape of a semicircle. These semicircles are on either side of a roadway that bisects the airport. Each terminal will be uniform in design, thus allowing for economies of scale. One airlines, if it desires, can have a terminal completely to itself or share it with a combination of other airlines. Each terminal building will be a self-contained unit and able to operate independently of the other terminals. In the initial phase, up to 1975, there will be five terminal buildings serving eight airlines.

In dealing with the terminal design itself, we specified short walking distances in order to expedite traffic flow. Long walking distances were eliminated by not having longitudinal concourses. The terminal will be about 125 feet wide and the passenger will only have a short distance to travel from the enplaning roadway to the aircraft. The use of a passenger amenities study also enabled us to determine what and where in the terminals passengers want service facilities. With this, we eliminated unnecessary amenities in the design and removed obstruction to passenger flow. This, along with short walking distances, gave what we felt was the most efficient scheme for a passenger terminal.

Parking has been placed as close as possible to the terminal by designing for multilevel parking. Each terminal half-loop can have a miximum of fourteen-hundred parking spaces on grade and up to twenty-one hundred structured spaces. The number actually built will depend on demand. However, as an aid in planning for the initial parking requirements, an operations research model was used to determine parking demand by airline. This study enabled us to determine how many parking spaces each airline would need for its own passengers. To compensate demand for other parking requirements, areas have been designated for remote parking and for valet structures. In all, we will have some 20,000 parking spaces for passengers in 1973.

This leads us to the seventh restraint, roadways. The intra-terminal roadway consists of two parts—the spine road that bisects the terminal loops and the internal roadways adjacent to the terminal buildings. Coming into the airport from the main east-west arterial highways serving Dallas-Fort Worth, the passengers will enter a high speed multi-lane spine road running north and south. This will provide a double entry to the airport because each end of the spine road has entry and egress capability. This provides twice the capability of each lane in the traditional airport design in which the main highway dead-ends into the parking lot.

To get to the terminal, the passenger will cross over the spine roadway on an interchange into a low speed road that allows him to drive or be driven directly to the terminal gate from which he will be leaving. He will then be able to take the shortest and most direct possible route to his aircraft. If he is driving and desires to park, a circulating road will allow him to drive within the terminal parking lot to an available space not more than 240 feet from the terminal building.

As you might have deduced, there could be a problem with having several terminals instead of one. The primary one is moving the passenger from one terminal gate to another terminal gate as he changes airlines. In addition, a problem exists in transporting the passenger from one parking area to another. To solve these problems, detailed programs are underway to develop systems of rapid transit for passengers and baggage. These would include originating, terminating, and transferring passengers. The transit system should carry the passenger to within 200 feet of his aircraft boarding position or 600 feet of his parked car.

The people-mover we need will require a complex control system because of the numerous interrelated destinations required. The entire system must be integrated into the design of the airport, be relatively maintenance free and able to provide fast, comfortable and above all, safe service.

The degree of on-demand service for a 24-hour-a-day operation is a major problem. One extreme is to have scheduled service that works within a fixed time schedule with trains of cars. The other extreme is a system of individual cars that respond to a station call in the same way an elevator does. The passenger gets into the car and is taken directly to his destination.

In reality, a compromise will be reached that will give a passenger relatively immediate service. In peak employee hours, there will be a scheduled service to handle the large passenger demand. The resultant degree of sophistication of our system will depend on the funds available and the ingenuity of transit system builders. We are asking for something that is not now available and that will help revolutionize the rapid transit industry. The entire country may benefit from this research and development program. (In February, the Department of Transportation awarded the Regional Airport Board $1,021,315. to aid in development of this transit system.)

A final restraint to ultimate capability might be the expansibility of an airport. In overcoming the seven restraints, this particular problem was encountered. Expansibility presented a problem from two sides: 1) land required for growth; 2) capability of airport structures to be expanded as needed.

In dealing with the land problem, it was decided to start out expansible. Historically, attempts to acquire more property for airport expansion have been an almost impossible situation because of increased land costs and impossible governmental relationships. To be capable of enlarging the airport's activities without enlarging the airport itself, sufficient acreage (as developed by a land use study) for runways, automobile parking, air cargo and maintenance areas, as well as other functions, was purchased in the beginning. Costly future land acquisitions can be avoided and construction can go on without interrupting airport operations.

In planning expansibility for airport structures, the primary concern was the terminal facilities. Terminals must be able to grow to meet airline, as well as aircraft, growth. Our airport has attempted to reduce the typical expansion procedure of adding fingers by using a linear unit terminal concept. Because these terminals are in the shape of half circles, and because they are modular, they can be stretched from several hundred feet to 3,500 feet in length as gate requirements increase. The building can be widened within certain limits, without reducing apron space, to accommodate baggage claim equipment, ticketing areas and other functions. A third story can be added to accommodate multi-deck aircraft holding rooms.

An important advantage of expansibility using modular construction in terminal design is the cost reduction that can be effected. Repetition of beams, columns, and materials offer economies in production. Initial cost savings are realized because only the square footage needed is built. This, in itself, is a most important advantage of our airport concept.

## III. Conclusion

In conclusion, the subsystems making up the airport are: (1) the airspace over and around the airport site; (2) the number and design of runways; (3) the taxiway system; (4) the apron areas; (5) the terminal buildings; (6) the parking lots; (7) the roadways and highways.

If we create an airport as free from restraints as possible, airlines will get higher aircraft utilization and passengers will get delay-free service. If we don't plan in the best possible way, we will go the way of the railroads in terms of growth.

The management systems approach can help solve our problems. We have to keep trying the best methods available to maintain this one basic concept: an airport is the point of transfer between the ground and air modes of transportation. Simplicity in designing new airports or expanding old ones spells success.