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IMPLICATIONS OF THE ADOPTION OF COMMERCIAL JET AIRCRAFT

INTRODUCTION

By JOHN H. FREDERICK

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DURING the Spring Semester of 1956, the Seminar in Air Transportation under my direction in the School of Business and Public Administration at the University of Maryland, as is our custom, devoted its attention to an outstanding aspect of the commercial airline industry. The topic selected by the members of the Seminar, perhaps naturally considering the current interest in the subject, was concerned with the possible impact on the airlines of this country of the jet aircraft soon to be in operation.

Each of the following six articles was written by members of the Seminar with only slight direction by me. They are so outstanding in their approach to this important problem, representing as they do the thinking of people not connected with either airlines or aircraft manufacturing, that I asked that they be considered for publication in the *Journal*. They discuss problems which have already arisen and also some sure to arise, from the standpoint of those who will have to deal with such problems or at least be affected by the results if they are not dealt with properly.

AIRWAY TRAFFIC CONTROL

By WILLIAM J. WELSH AND MAX M. RULE

WITH the advent of the jet age just around the corner, one of the major problems facing our Civil Aeronautics Administration is that of "air traffic control," or, in other words, what to do about our vanishing air space. The steadily increasing density of air traffic is gradually approaching the critical stage inasmuch as its rapid growth has far outstripped the pace of technical and political progress in the development of new and improved methods of traffic control. The jet, with its inherent characteristics of speed and high altitude efficiency, will so greatly complicate the problem that swift action must be taken to prepare ourselves for this eventuality.

Unfortunately, valuable time has already been lost because of a dispute about the system or systems to be used within the government and industry and between civil and military interests. This dispute

has finally culminated in a series of events designed to find a solution to the problem before the jet age arrives. These events were:

1. The findings of a study group and their report to Budget Director Rowland R. Hughes. This group, the Aviation Facilities Study Group, found decided evidence that the nation is following a piecemeal rather than a "systems" approach in attempting to meet aviation's needs for proper facilities such as airports, navigational aids, traffic control devices and the communications systems that link them together.

2. A decision by President Eisenhower, based upon the Aviation Facilities Study Group's findings, to implement a study of the long-range aviation requirements.

3. A closer working relationship between the Civil Aeronautics Administration and the Department of Defense.

4. The development by CCA of a five-year, \$1,000,000,000 Federal Airways Plan.

5. The approval by the Air Coordinating Committee of the CAA's plan and a budget request to Congress for the first year's appropriation.

These events have set the wheels in motion to prepare for the traffic increase expected between fiscal years 1957 through 1961. Plans call for a greatly extended and improved system of navigational aids defining a greater number of channels of flight, improved traffic control facilities and equipment, and faster communications.

The majority of the CAA's budget for the new airway plan will go toward:

Omniranges/DME—Very high frequency omnirange and distance measuring equipment will continue to provide navigational guidance for short distances. Continued use of VOR/DME will require an additional 383 facilities thru Fiscal Year 1961. These facilities, set in the proper pattern, will furnish speedy guidance to fast flying jet aircraft.

Long Range Radar—This type will be utilized to provide adequate and rapid separation between aircraft in the enroute area rather than in terminal areas. It is planned, in the interest of economy, to use the military's air defense radar as an adjunct to the civil air traffic control system.

Secondary Radar—A secondary radar system consisting of the air traffic control radar beacon system is proposed in addition to surveillance and long range radars for a total of 134 ground air traffic control interrogator installations.

Airport Surveillance Radar—Locations will be increased from 44 to 99. The military radar approach control (RAPCON) facilities operated by CAA will be continued as a part of the common system.

ATC Tower Services—Airport traffic control service will be discontinued at locations serving less than 18,000 total annual itinerant and air carrier operations. However, an additional 40 locations are planned.

Other expenditures will include Long Range Navigational Aids and the High Altitude Control of Air-Space both of which are designed to

cope with the turbojet problem. Remaining funds will go toward the expansion of approach lighting, airport surface detection equipment, air traffic control coordinating equipment, direct pilot-center communications, and precision approach radar.

It is hoped that the plan will ultimately culminate in a "common civil military system" fully automatic in operation and providing:

1. Private line communications
2. An identification system
3. Enroute navigation and control
4. A system for transition from the airways
5. A precision approach and landing system
6. Airport control after landing.

Although these recent developments indicate our government's willingness and ability to prepare for the introduction of the jet, there are many new and, as yet, unexplored areas which must be examined in detail in consideration of the basic differences between jet and conventional aircraft.

These differences were recently defined in the CAA's published list of one hundred questions which remain to be answered in connection with turbojet operations. In the field of air traffic control, some of the more important aspects are:

1. The problem of handling mixed jet and conventional air traffic. The turbojet with speeds of 600 miles per hour, flying at 40,000 feet will require fast and accurate enroute navigational data and will require airport control instructions while still far out from the airport. A jet which is 300 miles from an airport is, in time, only thirty minutes away. CAA's plan for increased control methods will, of course, assist materially in handling this problem.

2. The problem of priorities in take-off and landing because of the jet engine fuel characteristics. Since the jet engine burns tremendous quantities of fuel at low altitudes, it is contended that once an approach is made, the aircraft must land because the remaining fuel will be insufficient for holding or proceeding to an alternate destination. Similarly, once the engines are started for flight, there must be no delay in take-off. Unless future technical developments present an answer to this problem, it seems apparent that priorities must be established for turbojet aircraft.

3. The effects of high speed and high altitude on navigational aids and communication reception. The use of visual signals are, of course, impossible at high altitudes. Navigational aids, on the other hand should be much improved because of the increased range. Reception should be better than at lower altitudes.

4. The effects of "overlap" of VHF signals at high altitude. Unfortunately, the higher our planes fly today, the greater is their increase in range for VHF signal reception. This means that a plane flying at 40,000 feet over Philadelphia, for instance, may be within signal range of New York, Baltimore and Washington, and may be receiving signals

from all four areas simultaneously. This resulting "overlap" is very undesirable from a safety standpoint. Further technological developments will be necessary to overcome the problem.

5. The effect of jet aircraft on enroute separation because of their high cruise speed. The present enroute separation or distance between aircraft flying at the same altitude is standardized at a ten minute minimum. This means, literally, that planes may take-off every ten minutes bound for the same destination and flying at the same altitude. The introduction of jet transport into this pattern throws the whole system into chaos. The jet with its increased speed will overtake conventional aircraft with a much increased chance for mid-air collision.

6. The effects of mixing high speed military aircraft with civil jets at high altitudes. The danger here, of course, is also mid-air collision. However, military and civil aircraft have been operating together at low altitudes for years and there should be no good reason why this mutual arrangement cannot be continued at greater elevations.

7. Requirement for airborne identification equipment because of the high closure rate. This again is the problem of mid-air collision which is made even more critical by the increased speed of the aircraft. Reliance on visual recognition is out of the question and hence there must be some form of fairly long range identification such as built-in airborne radar.

8. Operational procedures and equipment required in the event of sudden loss of pressurization at high altitude. If the internal air pressure in a jet mainliner traveling at 40,000 feet should suddenly escape, it is highly probable that all passengers would perish before the craft could descend to a safe altitude. This possibility may necessitate emergency equipment and standing operational procedures on all jet aircraft.

Other problems in the same vein but, of perhaps less importance, under consideration by CAA are:

1. Effects of high speed and therefore, high "G" effect on passengers and crew
2. High altitude effect on passengers
3. Effect of high altitude turbulence on passengers.

These, then, are the main problems of air traffic control which are yet to be solved before the grand entrance of the commercial jet era. Undoubtedly, many of them have already been solved by the Air Force in the military operation of jets, and it is hoped, in the interest of economy, that much information will be made available for commercial use. Its applicability, of course, depends upon cost, since cost is the controlling factor in commercial operation. In any event, the government is fully cognizant of the problems which exist, and the airlines are indeed fortunate to have this tremendous burden assumed in their behalf, free of cost, and with very few strings attached.

AIRLINE FINANCING AND OPERATIONAL PROBLEMS

BY FRANKLIN W. DONAHUE AND BENJAMIN E. PERRY

PRIOR to what has been referred to as the current "equipment buying binge" of the certificated carriers, airline financing for new equipment was usually accomplished with five-year bank loans to be repaid from earnings and primarily through rapid book depreciation of the new equipment long before its serviceable life span was completed. Aircraft, of course, are used long beyond this depreciation write off period and subsequently change hands quite a few times before becoming unserviceable. The book value of airline aircraft, because of this method of depreciation, is considerably understated. While this is the past picture it now appears that there will be a considerable number of changes. Most of the airlines, it would appear, are embarking on quite a gamble; backed up of course by the progressive thinkers in the air industry who are always credited with the utmost optimism.

The financing for the new jet aircraft, and other new aircraft acquisitions, is entirely different. Long term debt was unheard of in the past but now the airlines are initiating 20 and 25-year loans, payment on many loans not to start until 10 years hence. Instead of borrowing from a few of the larger banks the airlines are resorting to life insurance companies such as Metropolitan, Prudential and Equitable.

The practice of depreciating the aircraft over a seven-year period or less, with the new jets costing upwards of \$5,000,000 each seems all but impossible, plus the fact that the airlines are buying large quantities of these planes not just a few. Orders for new aircraft per company average over \$270,000,000 for three of the "Big Four." A firm order for new equipment involves advance deposits and progress payments as much as four or five years before delivery. The advance outlay may amount to as much as 35% or more of the purchase price. Taking the industry as a whole it is believed that over \$1,000,000,000 of financing will be needed.

Last year the airlines total revenue was \$1,600,000,000 or about \$400,000,000 less than commitments for projected new equipment. With the bulk of the new planes scheduled to be delivered in 1960, the carriers have scheduled capital expenditures of about \$500,000,000 a year for the next five years or approximately 30 per cent of current revenue.

As of 30 June 1955, the entire assets of the United States air transportation industry, domestic, international, territorial and cargo was \$1,300,000,000 ($\frac{1}{3}$ long term debt, $\frac{2}{3}$ actual net worth). Not a very rosy picture when the airlines are taking on over \$2,000,000,000 more in long term debt. Some question the advisability of such a situation

asking "if the traffic potential doesn't generate and earnings aren't as expected who is going to bail the airlines out?" So far the Civil Aeronautics Board has never let a major airline go into bankruptcy and perhaps some of the airlines are relying on the continuance of such a policy as they assume these tremendous obligations. Again perhaps some "behind the scenes" government negotiations have already gone on to strengthen the position of the airlines in their buying spree.

The advantages of a strong commercial air transport system in being is an immeasurable asset to our foreign policy and national defense. The addition of these jets to our present fleet of aircraft will certainly enhance our position at the diplomatic conference tables.

Some of the optimism being demonstrated is warranted, and it is a great tribute to the industry's effort to continue upward. In the last nine years the domestic airlines have increased their passenger miles flown from 6,000,000,000 to 20,000,000,000. Each of the Big Four are larger today than the entire industry was in 1946. Earnings last year were 55 per cent greater than 1954 earnings. The airlines are overtaking the buses and railroads in passenger traffic. Airline traffic amounted to 33 per cent of that generated by all modes in intercity travel exclusive of the private automobile. It is predicted that by 1960 the airlines will have a greater traffic volume than either rail or bus. That does not necessarily mean that all the increase will be taken away from rail and bus but that new sources of traffic will be uncovered. A very strong potential for this undeveloped traffic is the 2,500,000 United States tourists expected to be traveling to Europe annually by 1960. Whether or not new traffic will be sufficient to gain the 100 per cent increase in passenger load for the jet era remains to be seen. Without a doubt a terrific selling campaign will have to be waged.

OPERATIONAL AND ORGANIZATION PROBLEMS

The next big question is; what effect will all the ramifications of the jet age have on the airlines themselves? Probably no major reorganization of the airlines will be necessary, however, considerable expansion of existing departments can be expected with changing emphasis on certain aspects of the overall company operation.

First—The sales force, advertising and public relations are going to bear a major brunt of the promotional activities of the oncoming jet age.

Second—Preliminary studies, under the guise of research and development, will have to be made in which the known characteristics of the new planes will be applied to regularly scheduled operations. United Air Lines has been conducting such a study entitled "Paper Jet" since some time in 1954. This exercise has provided this company with basic information on, cost of operation, maintenance requirements, and flight times. Unfortunately, or fortunately for United, this information is a closely guarded company secret and not available to

the public primarily for competitive reasons. It is assumed that United Airlines used this study as a means of determining which aircraft to purchase so that they did not wind up in the position of having a "second best" airplane.

Third—Based on such studies the operations and maintenance departments can be effectively reorganized and undoubtedly expanded; at least in the initial period. The reason the term expansion is used here is due to the expected use of both piston type aircraft and jet aircraft together for a considerable transition period, if not continually. This of course would mean that a specialized segment would be added to both operations and maintenance.

Fourth—Safety will become increasingly important and with the greater ramifications of this problem, i.e., seat belts, oxygen, emergencies at high altitudes, pressurization problems, etc., it is believed that a separate section of airline operations must be established or expanded greatly for cooperation with manufacturers and the Civil Aeronautics Administration in accomplishing this feat of maximum safety at 600 miles per hour for airline passengers.

The large numbers of people likely to be involved in any one accident, the much greater quantities of fuel carried, the higher speeds and greater energies of a jet plane make it absolutely necessary that every facet of operation both air and ground be carefully examined to eliminate safety hazards.

There are many reasons to anticipate an even higher standard of safety for the jet transport than is now employed with current equipment. Proof of that will be lacking, however, until the new jet transports have seen extended service.

The substitution of a less volatile fuel than gasoline probably represents the greatest single safety improvement. However, this fuel is not entirely safe and requires different ground handling and precautions. New criteria will be established and will hold true for other aspects of ground handling. Ground checks and inspections must be geared to a new set of rules. For instance, improper starting and ground operation of turbine engines can easily result in more serious engine damage than with reciprocating engines. The ingestion of foreign objects into the engines can be a major source of trouble and the cause of serious ground accidents involving larger numbers of people than ever before. In order to prevent such accidents the airlines will have to exercise the most effective control possible over mechanical practices and shop, runway and ramp housekeeping.

The much greater quantities of fuel aboard these planes, greater energies tied up in the jet airplane, make it absolutely necessary that every facet of ground operation be carefully examined to eliminate hazards.

Fifth—How are the pilots going to take to the jet era? Historically speaking, pilots have sought increased compensations as technological

advancements in aircraft have increased their productive capacity. Will they want more money to do this job or will they be satisfied with more time off? It would appear that the airlines will reach the impasse that the railroads have, i.e., they will pay a pilot for an eight-hour day even if it only takes him two hours to do the job. While time in flight will be relatively shorter the jet pilot will be under a much greater physical and mental strain due to critically narrow flight plan tolerances, greater speeds and higher altitudes. Aero medicine should reevaluate current physical requirements for transport pilots in the light of this additional strain. Any developments that may shorten a pilot's productive years would have a serious impact on present employment agreements.

Sixth—Ground time saving appears to be more important to the larger jet transports than to the present conventional aircraft. Since the airplane is an economic tool only during the time it is actually in flight and since its potential economic value is based upon its ability to produce a great number of ton miles and/or passenger miles per unit of time, it logically follows that ground time saving becomes more important as the size and speed of the airplane increases. The jet transport represents marked increases in both these dimensions. Ground time therefore must be reduced to a minimum. One major airline has calculated one minute of wasted time of a jet airliner to represent nine flight miles. A few minutes delay then represents a major setback in flight distance.

To further cut down ground time the handling of passengers and cargo must be accelerated. The airlines must analyze current methods and realize that more rapid and effective loading and unloading of passengers and cargo must take place with the jet aircraft. Some form of docking equipment seems to be indicated if design flexibility to handle various aircraft is to be accomplished. The use of preloaded containers for cargo and baggage will certainly save time and prevent damage.

The acceleration of passenger loading is quite a problem in itself, because, for one thing the airlines can't make the passengers run. It appears that two door loading will be mandatory and accurate and quick routing of passengers through the entrance gate and to those loading doors must be accomplished.

The problem of protecting the passengers from the elements is a real one. The umbrella brigade is a thing of the past so far as the jets are concerned and more efficient ways must be devised to move passengers to planes during inclement weather. Some underground system rather than the awning method would appear to be the best solution.

Seventh—Scheduling the new jets appears as still another problem. There appears to be great optimism in this area. It is anticipated that the jet will be superior to either the DC-6 or DC-7 in this respect. Utilization is a major factor in scheduling the jets. Current aircraft are scheduled on the basis of seven to nine hours flying time per 24-

hour day. Unfavorable arrival times and elapsed flight time has much to do with this low utilization. This problem will be reduced by a considerable margin with the jets and it is expected that the utilization hours will be better with the jets providing that turn around times are accelerated also.

Consistency of on time departures and arrivals should attain a new high in jet transport operations. This is with particular regard to the effect of winds. Headwinds apparently have significantly less effect on high speed aircraft. The greater potential for higher speed aircraft to produce on time performance will make for greater precision of operation. Aircraft disposition for schedule backup purposes can be planned more strictly in regard to maintenance and servicing requirements. Therefore mechanical reliability of the jets and effective servicing will be of greater relative importance in attaining high utilization than in the current aircraft.

The problems of scheduling airline services at frequencies that best meet the public desire and are still consistent with airline earnings are difficult. The jet transport apparently will not change this. A balance will still have to be struck between schedule frequency, length of trip (in miles and time) size and number of airplanes the airline is financially able to apply to the operation. A complete running statistical analysis of patronage will be the key measure of how successful a balance is attained.

Eighth—As can be seen from the foregoing, maintenance of the new jets is going to be all important. Whether or not the airlines perform that maintenance themselves or contract for it will depend a lot on the size and capital of the respective airlines. It is believed that the larger airlines, American, Eastern, United and Trans-World will perform their own maintenance. Some of the smaller airlines may also do the same. This means an initial outlay of greater than \$3,000,000 for the basic tools to accomplish this maintenance. For the most part the tooling for present aircraft maintenance in no way resembles what is required for the jets. In addition the training of personnel for this new maintenance job requires from twelve to eighteen months of on the job training. This is true whether the individual is a new man or one making the transition from conventional aircraft to jets. The additional noise created by these maintenance units creates still another problem within the airport community area and only expensive noise suppression devices can eliminate the greater portion of this problem.

AIRPORT PLANNING AND MANAGEMENT

BY CHARLES S. FRALEIGH, JR., AND GRACE M. GODDARD

THE effect of jet operations on airport planning and management is of no less importance than that of plane and equipment development, traffic control, passenger requirements aloft, etc. In fact, a long, hard look must be taken without further delay at the adequacy of airports and their facilities. Airports as presently constituted are important limiting factors in the widespread use of jet planes, especially of the larger craft for transcontinental and overseas flights.

An appraisal must be made of the adequacy of the airports most likely to receive the large jets initially. This is the most pressing problem, but, concurrently with this, planning must proceed for other cities likely to receive such service shortly thereafter. Moreover, airports likely to handle only the smaller jets require survey. In connection with adequacy, major problem areas apparently are as follows: (1) length, width, and strength of runways, taxiways, aprons, etc. (2) longer, unobstructed approaches for landings and takeoff (3) passenger and baggage handling facilities and procedures (4) noise as it affects nearby residents, airport employees and waiting passengers (5) fuel servicing and handling, and (6) servicing and maintenance problems. These and lesser problems are related to presently existing airports, but there is also the necessity of proper location and design of future airports, dictated in large part by jet plane demands.

Airport adequacy will be discussed as it applies to both the large and small jets, though greater stress will be placed on the larger planes and their requirements.

Adequacy of Present Airports

One might, at this point, logically ask what airports will be affected and to what extent. The answer to this problem is not available at this time though there has been much conjecture on the part of writers, aircraft manufacturers' representatives, airline spokesmen and many others. In May, 1956 the CAA made public its intention to fly an Air Force B-47 jet bomber into selected civil airports to determine their capability to handle commercial jets with comparable landing and take-off characteristics. A tentative airport selection criteria is based on the volume of traffic handled.¹ To be included, on this basis, will probably be the ten largest traffic generating cities,² which are shown in the first group below. The second group of cities listed also should be included because of traffic volume as well as the nature of flights. The latter would include both international as well as long-haul domestic flights.

¹ Obtained from Aviation Information Branch, CAA.

² As of July 1955.

First Group

<i>City</i>	<i>Runway Length</i>	<i>Altitude</i>	<i>Gross Loading Weight*</i>	
			<i>Single Wheel</i>	<i>Dual Wheel</i>
New York (La Guardia)	5,900'	20'	100	135
New York (International)	9,500'	12'	200	260
Chicago (Midway)	6,400'	618'	120	160
Chicago (O'Hare)	7,300'	657'	120	160
Los Angeles (International)	8,600'	125'	200	260
Washington, D. C. (National)	6,700'	16'	120	160
San Francisco (Municipal)	8,900'	11'	200	260
Miami (International)	9,400'	9'	150	200
Detroit (Wayne-Major)	7,900'	639'	200	260
Atlanta (Municipal)	7,800'	1,024'	120	160
Boston (Logan)	10,000'	19'	200	260
Dallas (Love)	7,700'	485'	100	135

*Weights given in pounds. Add three zeros to figures listed.

Second Group

<i>City</i>	<i>Runway Length</i>	<i>Altitude</i>	<i>Gross Loading Weight*</i>	
			<i>Single Wheel</i>	<i>Dual Wheel</i>
Denver (Stapleton)	10,000'**	5,331'	120	160
Kansas City, Mo. (Municipal)	7,000'	758'	150	200
Cleveland (Municipal)	6,400'	789'	200	260
Minneapolis-St. Paul (Intl.)	6,500'	840'	120	160
New Orleans (Moisant Intl.)	7,000'	3'	120	160
Philadelphia (International)	7,300'	10'	120	160
Pittsburgh (International)	7,500'	1,168'	120	160
St. Louis, Mo. (Lambert)	10,000'	558'	200	260
Seattle-Tacoma (Intl.)	8,500'	424'	120	160
Seattle-Tacoma (Boeing)	10,000'	17'	120	160

*Weights given in pounds. Add three zeros to figures listed.

**Adjusted or effective length is 6,500 feet.

The data shown above do not present an accurate measure of use-capability of runway lengths. These figures must be adjusted downward to compensate for altitude and weather. CAA's present standard calls for increasing the length seven percent for each 1,000 feet of elevation, a standard which probably will continue to be valid. Currently, the length is increased by one half of one percent for each degree that the mean temperature of the hottest month of the year exceeds 59. This factor may also continue to be valid, but must be established precisely. What does this mean? It means, for example, that the effective length of the runway at Denver is 6,500 feet, New York's Idlewild is 8,724, Chicago's O'Hare is 6,838, Boston's 9,185, Los Angeles' 7,317, and at San Francisco the adjustment is relatively minor—8,612 feet.

Before discussing the handling of large jets, it is best to dispense with the smaller ones as there would appear to be no pressing problem.

The Convair "Skylark 600," which is probably typical of the smaller planes, is being designed to operate from 5,000 foot runways with a maximum gross take-off weight of 170,000 pounds and a typical take-off weight of 150,000 pounds. With critical characteristics such as these, all the cities listed above would have airports with adequate runway lengths and only two would be deficient in weight (Dallas and New York's La Guardia). Many other cities also would be able to handle this type plane with little or no modification to runway lengths and strengths. One estimate has placed the figure of entirely adequate airports at more than one hundred.³

In discussing airport capability to handle the larger jets, we will again use planes typical of the class. In this case, Douglas' domestic and intercontinental versions will be considered. Either one or both in some cases will in all likelihood operate to and from the cities listed in the two groups above.

Intercontinental flights with the maximum useable take-off weight would require runways to be 9,000 feet or more in length and capable of handling 287,500 pounds. Only New York's International and Boston's Logan have the necessary runway length and possibly the strength, the latter depending upon the actual take-off weight. Miami should have the length though its weight deficiency is too great for the runway to hold up under sustained use.

The domestic versions of the Douglas plane have a maximum usable take-off weight of 250,000 and 265,000 pounds, respectively. Runway length for the former is 9,440 feet, and 8,640 for the latter. These lengths are comparable to those required for the intercontinental versions. But reductions are possible by decreasing load and range, an uneconomical operation for a plane designed for the heavier load and longer range. It is estimated that with a range of 1,830 miles, a runway length of 6,500 feet would be needed. If this estimate is proved to be accurate, only five of the cities listed above would appear to be adversely affected. As regards the weight factor, only the cities listed at 260,000 pounds would be free of the danger of runway damage due to excessive weight.

An alternate solution to the expensive lengthening and strengthening of runways, is a challenge to the aircraft industry. Planes must, if feasible from the standpoint of engineering and of economics of operations, be so designed that present airports do not become completely obsolete. A solution to the take-off problem may be found in the use of after-burners on the jet engines which would permit quicker, more steep ascent. Also, highly desirable is "reverse thrust" to slow the plane after touching down on the runway. Successful application of these two items should have a tremendous effect on runway length requirements.

Other considerations related to runway, taxiway, and approach capability are no less important than the factors just discussed, though solving of some of them may be more readily accomplished than others.

³ Made by J. G. Zevely, Convair Director of Sales and Contracts.

The first of these is the width of runways, taxiways and, in some cases, aprons. "Runway widths must be adequate to handle the maximum cross-wind conditions, and allow for reasonable precision take-off and, particularly, landing guidance errors."⁴ In this connection, the Civil Aeronautics Administrator in a speech at the Air Force Association Jet Age Conference, which was held at Washington, D. C., February 4, 1956, stated, "many people will be pleasantly surprised to learn, we find it possible to consider very seriously a proposal . . . that the standard (runway width) be reduced to 150 feet (that is, from 200 feet, on the two largest categories of airports)." He further stated that, "The jet transports . . . have wing span not significantly larger than today's aircraft, and we may be able to offset some of the cost of additional runway length by reducing the width." Runway width on major airports does not appear to be a problem.

The problem of taxiways will need some consideration. The British, in their experience with the Comet, found that high-speed taxiing was a necessity as fuel consumption was too rapid in this phase. Some taxiing will be required even though planes may be loaded some distance from the terminal. This presents the need for taxiways curved so that the plane need not decelerate. Taxiways designed in this manner would also permit the jet plane to gain some of its take-off speed prior to getting on the runway (this would require a change in clearance procedures). It should be noted in this connection that an Air Force F-84 requires a runway two and one half times as long as does the piston-engine F-51 to allow it to gather necessary power as it gathers speed.⁵

In addition to the curvature aspects, the British found a definite need for holding areas where bypassing of piston-engine planes could be accomplished. Certainly, this aspect will be important in many of our major terminals where traffic is heavy.

Finally, the weight which the taxiway can support is likewise a problem just as it is on the runway and deficiencies will have to be corrected.

Apron deficiencies may not exist due to the desirability of loading and unloading passengers at points remote from the terminal area. Such loading appears necessary due to noise, and the heat and blast effect of jet engines.

The approaches to runways present an area of uncertainty. "High-speed planes will follow more shallow paths on approaching and leaving airports, and will have larger radius of turn."⁶ "This emphasizes the necessity for 'planning of larger, clear and unobstructed zoned areas beyond the ends of the runways.'"⁷ The B-47 jet experiment

⁴ William Littlewood, "Air Transport and the Jet Age" in the *National Defense Transportation Journal*, March-April 1956, p. 62.

⁵ Walter A. Kilrain, "Jets Pose Airport Design Problems," *American Aviation*, May 25, 1953, p. 37.

⁶ "Airport and Airway Changes Urged," *American Aviation*, July 7, 1952, p. 22.

⁷ *Ibid.*, p. 22.

should prove or disprove this thesis. Zoning changes and removal of some present obstructions could easily be required.

The effect of jet plane operation on airport pavement is an important consideration. This problem is concerned with the effects of blast, heat and jet fuel spillage. Jet fuel, although it has a petroleum base, evaporates far more slowly than aviation gasoline, and consequently has more time to harm the pavement. An International Civil Aviation Organization news release of December 3, 1952, had the following to say in this regard:

"The United States delegate reported that experiments carried out in his country showed that very difficult and serious pavement problems may be created by jet aircraft, particularly by those whose engines are mounted close to the ground (e.g. hung in pods below the wing). Certain of these tests resulted in temperatures as high as 400-500°F (200-260°C) at the surface of the ground. If assisted takeoff, using rockets, afterburners, or some other means of augmented thrust, becomes necessary for commercial jet-liners, the problem will become more difficult still; core temperatures of assisted takeoff devices run from 3500 to 5200°F with speed of exhaust gases between 6000 and 8000 feet per second; temperatures 2½ feet below the core and 25 feet away are about 700°F (370°C).

"Fuel may spill from jet engines during starting, stopping and acceleration; the petroleum compound has a softening effect on certain types of non-rigid pavements, but its effect depends, for one thing, on the surface of this pavement; pavements made of well-compacted, densely-graded materials are not so much affected because the fuel does not penetrate so deeply; even here, however, the softened surface is then more sensitive to the eroding effects of heat and blast from the gases emitted by the engines. Concrete itself is not affected by spillage . . ."

Major General R. M. Ramey, United States Air Force, in testifying before a House Armed Services Subcommittee in 1954 stated, in effect, that "jet experience was dotted with stories of asphaltic pavements disintegrated by spilled fuel, of jet engines ruined by sucking up loose stones, and by accidents caused by runway ruts."⁸ Out of this experience supposedly has come a strong preference for Portland cement among air base commanders and constructors.

Along with the foregoing is the necessity for keeping runways, ramps, run-up areas, etc., free of engine-damaging debris. Acquisition of motorized sweeping devices in sufficient numbers would be the answer.

The Noise Aspect

The aspect of jet noise and its attendant problems may be divided into two areas for consideration. The first concerns its effect on residents in the immediate vicinity of the airport, and the latter, on airport employees, passengers and others.

At present there is both optimism and pessimism concerning the

⁸ "Asphalt and the Jet Air Base," *Business Week*, February 27, 1954.

possibility of reducing jet noise to tolerable levels. The crux of the problem is to reduce noise without reducing power. Unless some startling innovation occurs in the near future, it will be necessary to educate the public to this additional noise. Experiments by Boeing have been successful in cutting noise to levels of present-day piston engines.⁹ This must, however, prove feasible economically and operationally to be acceptable.

In addition to educating the public to jet noise, other means are available to lessen the objection of nearby residents. In some instances the landing and take-off pattern can be safely altered to fly over less congested areas; and certainly in the location of any new airport, this factor must be given due consideration. The fact that a jet airliner will be overhead a shorter time is a factor in its favor.

The second area mentioned—effect on employees and passengers—should not present insurmountable obstacles. By handling loading and unloading operations away from the terminal area and construction of a sound deflection wall between that point and the terminal, the effect of noise should be materially lessened. If, on the other hand, it is desirable to bring the plane to the apron, this may be done by towing. Boeing has designed a suitable towmotor¹⁰ but the economics of such a system are not favorable. Labor costs, especially at busy airports, would be tremendous. Bringing the plane to the apron under its own power appears to be unacceptable, not only from the noise standpoint but also that of safety. The latter concerns accidents which might be caused to individuals as a result of the jet engine stream.

Noise in maintenance shops and on the run up line would be annoying to both workers and to nearby residents. The need here is for inexpensive, portable mufflers. Both mufflers and semi-portable suppressors are devices that cut down noise levels during ground operations. In this sense, they are like the jet engine test cell and simple blast wall that do not reduce the noise but deflect its intensity from neighbors.¹¹ The Air Force is developing such devices and their adoption in commercial operations appears highly desirable.

Terminal Considerations

Terminal passenger and baggage handling facilities will require modification, though not all of this will be as a result of jet operations. Some of it is properly attributable to the normal long-range increase in air transportation of both passengers and cargo.

From the standpoint of the passenger, the present cumbersome, time-consuming method of ticketing must undergo revision. With large plane loads of passengers piling up to a ticket window just prior to de-

⁹ "What's Happening in Transportation," A news digest published by The Transportation Association of America, February 21, 1956.

¹⁰ "USAF Develops New Jet Muffler," Aviation Week, November 29, 1954, p. 18.

¹¹ "Future's Planes versus Today's Fields," Aviation Week, May 8, 1950, p. 42.

parture, a "pony express" method of handling is not adequate. Modern mechanical methods of ticketing must be given priority in the planning of this activity. Louis R. Inwood, Philadelphia aviation director, says he doubts that there is an airport in the U. S. that can properly handle ticketing of passengers for 80-passenger planes, much less 150 or 160.¹²

Of no less importance is the need for baggage handling. Handcart methods must give way to efficient mechanical means or passengers will become even more exasperated than they now are with the time delay and lack of efficiency. A suitable system would seem best predicated on the use of a full or at least partial conveyor belt system from plane side to baggage room.

Other terminal facilities such as restaurants, rest rooms, and the like, may require modification so as to reduce the annoyance of noise and to handle increased traffic. The New York Port Authority recently announced that the new Knott Hotels Corporation's International Hotel at Idlewild will incorporate new features designed to isolate the sound of jet airliners.¹³ One item will be the utilization of double-glazed windows. This idea may have to be transferred to other buildings, including the terminal itself.

Fuel and Its Handling

In any analysis of jet fuel requirements and handling procedures, one factor is foremost—standardization. Jet engine fuel must be standardized, preferably on a single grade and type but not more than two. When one considers the tremendous quantities involved—6,000 to 18,000 gallons for a single flight, depending on length—additional storage and fueling facilities become a necessity. And this requirement is to be superimposed on the continued need for storage and handling facilities for other types of fuel. "It is obvious that with such quantities involved, the type of fuel must be standardized for it would be a staggering job to provide storage capacity for several types."¹⁴ Mr. C. J. Lowen, Civil Aeronautics Administrator is credited with the statement that, "Our conference was told that standardization studies have been going on for a year and a half."

Even assuming, then, that standardization will be accomplished, the necessity for adequate storage capacity and high-speed, under-wing fueling is clear. First, as regards the problem of storage, there appears to be no other way than construction of underground facilities capable of handling the added fuel required and having such facilities connected with high-speed fueling outlets, at least four in number for the large jets, and as required for the smaller ones. However, it would seem highly desirable to standardize the number of fueling points and their

¹² Sunday Star Newspaper, Washington, D. C., May 6, 1956.

¹³ L. C. Philmus, "Airports Face Financial and Facilities Bottlenecks in Commercial Jet Age," *American Aviation*, January 30, 1956, p. 65.

¹⁴ Statement by C. J. Lowen, Civil Aeronautics Administrator, at the Jet Age Conference of the Air Force Association, Washington, D. C., February 4, 1956.

locations on the different planes so that the fueling installation could be designed accordingly. The factor of location of this installation then becomes very important. The location must be related to the loading and unloading point for passengers, a subject which has been previously discussed.

Another phase of refueling is that involving the use of distilled water for take-offs. Large jets require 600 gallons in hot weather.¹⁵ Facilities for handling this item must also be made available at the "refueling point."

Servicing and Maintenance Problems

Servicing and maintenance aspects must be taken into account by the airlines without delay so that they will be fully prepared when the jets start to fly. This phase of operations is of no less importance than any other as a major change in equipment such as this brings with it new servicing and maintenance requirements. The airlines will require new equipment, and must also retrain ground crews to the extent necessary to properly service and repair jet engines and other equipment peculiar to a jet.

Mr. W. A. Patterson, President of United Air Lines, pointed up this need as regards training in a recent magazine article¹⁶ in which he stated "ground crews must be well prepared to meet entirely different requirements in a completely new field." Several airlines have recently announced ambitious training programs for such personnel. It can be safely assumed that this aspect presents no great problem and that the airlines, realizing their responsibility, are moving forward rapidly to accomplish the necessary retraining.

Airport Improvement Financing

The airport improvement financing problem at the moment has both a bright and dark side. The dark concerns the objection of local sources to providing additional monies, the bright concerns federal appropriation. The following is quoted from the remarks of Joseph D. Blatt to the CAA sponsored Jet Aircraft Meeting at Washington, D. C., January 11, 1956:

"Representatives of local governments and the major airport providers put the airline operating industry on notice that aviation was in competition with schools, roads, sewers, water supply, etc., and that in the opinion of the experts present at the meeting aviation could not expect to get any more local support from the local taxpayer. General obligation bonds for airport improvements could no longer be approved. If the airlines demanded airport improvements to accommodate the larger jet aircraft, then the airlines would have to pay for these improvements through increased fees and charges."

¹⁵ "Jet Age Ahead—Airports Lag" Article, U. S. News and World Report, January 20, 1956, p. 49.

¹⁶ "Jet Airlines," National Defense Transportation Journal, March-April 1956, p. 41.

Expressions of opinion similar to the foregoing have been made by other authorities in the field, and several cities have experienced difficulty in have bond issues approved for expansion purposes. Some have been refused. This fact must be taken into account by airplane manufacturers and the airlines and an honest attempt made to produce planes which do not require ever larger fields from which to operate.

The other side of the picture concerns the federal government's participation for the next three fiscal years. Expenditures are projected at a rate of \$63,000,000 per year. This is significant when one considers that the federal government spent nothing in 1954 and only the niggardly sum of \$22,000,000 in 1955. It would seem highly desirable that as much of this amount as is possible should be earmarked for jet facilities at the larger airports. In fact, it is recommended that Congress be asked to authorize a greater portion of these funds be allocated to these airports, that is, the ones with known "jet deficiencies."

AIRLINE SCHEDULING, ROUTE PATTERNS AND SALES

BY PAUL SHANNON CLINE

OPERATING characteristics of jet aircraft of the Boeing 707 and Douglas DC-8 types dictate that route segments be longer than 500 miles. Preferably, they should be as long as 750 to 1,000 miles in order to prevent the segment block speeds from being nullified by time spent at intermediate stations. Therefore it would seem that the route pattern could be quite easily planned by connecting the major traffic generating stations which are located within a range no closer than 750 to 1,000 miles of each other.

For the individual airline, only a very minor number of its stations can be classified as major traffic generating points when appraised by future standards of passenger capacity. This accounts for the fact that proposed schedules of elapsed flying time between stations are given for only major points in company publicity on jet purchases. One Boeing 707 Stratoliner operating on the proposed schedule of four and one-quarter hours between Los Angeles and New York¹ will be able to transport the annual passenger loads as shown in Table I.

Assuming that American Airlines retains its daily round-trip schedule of three non-stop first-class flights and three non-stop coach flights which it was operating in December 1955,² and that it operates all of them with a 75 per cent load factor, it will fly 938,618,040 passenger-miles on this one route each year in the jet era. This could be accomplished with six to nine planes, depending upon the turn-around time,

¹ "Equipment Notes," *Official Airline Guide*, December 1955, p. A-15.

² *Ibid.*, pp. C-48, 49.

TABLE I
ANNUAL PASSENGER CAPACITY OF ONE BOEING 707-120 OR 707-220
OPERATING BETWEEN LOS ANGELES AND NEW YORK*

First-Class (109 Passengers)*				Tourist (125 Passengers)			Mixed (49 and 69 Passengers)		
Load Factor (%)	No. of Passengers per Flight	Passengers Carried	Passenger Miles (000)	No. of Passengers per Flight	Passengers Carried	Passenger Miles (000)	No. of Passengers per Flight	Passengers Carried	Passenger Miles (000)
65†	70	50,400	124.4	81	58,320	143.9	77	55,440	136.8
75	82	59,040	145.8	94	67,680	167.1	89	64,080	158.2
85	93	66,960	165.3	106	76,320	188.4	100	72,000	177.7
95	104	74,880	170.1	119	85,680	211.5	112	80,640	199.1
100	109	78,480	193.8	125	90,000	222.2	118	84,960	209.7

* Figures based on statistics from *Interavia*, Vol. XI, No. 3, 1956, p. 177 and assuming one round trip per day for 360 days per year.

† Load factor for domestic trunk airlines in 1955 was 64.06 %. See: Air Transport Association, *Facts and Figures, 1956*.

Based on official mileage record of the Civil Aeronautics Board which gives Los Angeles, New York mileage as 2,469 miles.

the departure times at each end of the route, and the number of planes held in reserve for "backing up" flights in case of mechanical, electronic, or other maintenance troubles on a plane scheduled to operate on a given flight.

In addition to the round-trip transcontinental flight discussed above, some of the planes might be utilized for night trips of shorter distances, such as New York to Chicago. This arrangement of schedules would result in effective utilization of equipment and still allow at least two hours turn-around time at the end of each flight segment. Thus, the matter of scheduling and route patterns appears to be simplified by the operational limiting characteristics of the jet aircraft.

Unless the recently announced Convair Skylark is placed in service, ten or twelve points in the United States will be recipients of all the jet service, and rightly so. Into these cities will be fed passengers from areas which today are considered good traffic generating stations on the routes of the regional carriers. In effect, our present regional carriers will become large feeder lines. From the point of view of the transcontinental air traveler, it will be to his advantage to obtain connecting reservations at the nearest airport served by jet aircraft rather than to cross the country on a series of regional carrier flights or local flights of the transcontinental carriers. Such connections should be easy to obtain since all transcontinental carriers except Northwest-Orient Airlines have already purchased jets.

Are the airlines overexpanding passenger capacity? If we can assume that the population of the United States will continue to grow at the present rate and that our standard of living will remain high, it would appear that the decisions of the airlines with regard to large orders for jets are quite sound. One particularly optimistic note for the airlines comes out of the fact that the American public since World War II "has increased its spending on airline travel at a greater average yearly rate—18 per cent annually—than it has on any other type of personal spending."³ Referring again to the example of American Airlines, it will be seen that, with allowances for planes undergoing inspections and repairs, approximately one-third of its initial jet fleet will be utilized to provide service on one route. A close examination of the route pattern of other carriers will doubtless reveal similar situations.

The appearance of the turbo-prop aircraft on the domestic routes just one year ahead of the turbo-jet deliveries will also serve to boost seat-miles flown. Their introduction will start the trend toward a "phasing out" of the least economical models of the present piston type planes. Questions regarding the market for these outmoded planes are already arising. It is not likely that large corporations will purchase four-engine craft for business use as they have the DC-3, nor will airlines in small foreign countries have need for the range or passenger capacity that these planes provide. If sales are made to supplemental air

³ *Air Transport Facts and Figures, 1956*, p. 4.

carriers, competition from another sector of the industry increases and seat-mile capacity remains static or in all probability increases.

The prime importance of passenger potential for the future cannot be disputed. Neither can the difficulty of predicting it. In 1955 the air-line percentage of the intercity passenger-mile market by rail pullman and air combined was 75.55 per cent.⁴ Assuming that the long-haul passengers travel by these two modes, and directing attention to the fact that the rate of penetration of this combined market has been increasing at a decreasing rate since 1953, we realize the magnitude of the sales problem which the industry faces. Predictions of future domestic passenger-miles for a given year vary as much as five billion miles even when the decreasing rate of growth is considered, as shown by the following:

TABLE II

ESTIMATES OF SCHEDULED AIRLINE PASSENGER MILES FOR 1960 AND 1961

Agency or Person Making Estimate	Passenger Miles	
	1960	1961
	(Millions)	
CAA, Office of Planning, Research and Development*	29.0	n.a.
William J. Hogan, Sr. Vice Pres., American Airlines†	n.a.	34-35
Karl Larsson, Chief Sales Engr., Canadair, Ltd.‡	34.1	37.6

* "Traffic Shifts to Air," *Official Airline Guide*, November 1955, p. A-14.

‡ Anthony Vandyk, "Are Airlines Overbuying? No, Says Canadair's Sales Chief," *American Aviation*, February 27, 1956, pp. 71, 72.

† "American Air Official Forecasts Slower Rate of Air Traffic Growth," *Wall Street Journal*, February 21, 1956.

n.a. Not available.

If the conservative figure given above by the Civil Aeronautics Administration is increased by only two billion to arrive at a 1961 figure of 31.0 billion we may then arrive at an average estimate for 1961 of 34.4 billion passenger-miles. This will mean an increase during the next six years of 73.7 per cent as compared with an increase during the past six years of 195 per cent.⁵ Therefore, even with the rate of penetration of the long-haul passenger potential increasing at a decreasing rate to 34.4 billion passenger-miles in 1961, the annual seat-miles available by that year could be increased from the 1955 total of 29.9 billion to 48 billion⁶ and a load factor of 71.6 per cent maintained.

To reduce undesirable excess capacity some airline equipment must be sold and seat sales must be increased. The advantage of the lowest seat-mile operating costs in air transport history will become a reality only if passenger demand can be expanded. For the anticipated expan-

⁴ *Ibid.*, p. 19.

⁵ Passenger miles for 1955 were 19.8 billions; the 1949 figure was 6.7 billions. *Ibid.*

⁶ Aircraft operated in domestic service during 1955 numbered 675. *Ibid.* Leading industry economist anonymously estimates in *American Aviation*, January 30, 1956, p. 71, that the annual seat-miles available in 1962 will be 47,942,820.

sion, improvements in procedures and equipment will be needed for dealing with incoming telephone calls; reservations; ticketing; no-shows; passenger flow in terminals and on ramps; en route passenger services; and baggage handling at counters and aboard planes.

Elaborate telephone-manning formulas being used by some of the trunklines make an attempt to balance the number of reservationists times their capacity for answering calls with the anticipated number of calls during a given period. If the estimate of calls is incorrect or if there is a sudden increase in the number of contacts per passenger (often as a result of inclement weather before flight time) the reservations agents are swamped with calls and many persons endure irritating waiting periods after being answered by the airline switchboard operator.⁷ Until such time as new communications equipment solves this problem the airlines might ameliorate conditions somewhat by clever advertising as, for example:

Frankly, we're sorry you sometimes have to wait for our reservationists to accept your requests. Research is being conducted to find a faster way of serving you. In the meantime, if it is not necessary that you make your reservations during the business hours of the day, we can usually offer you more speedy service during the evening hours and on week-ends.

Such promises must be sincere and the solution to the problem *must* be found before the jet schedules go into effect.

Confirmation of reservations in less than one second should convince the prospective air traveler that the concept of speed is not confined to the aircraft alone. Such lightning-fast service has been available to patrons of American Airlines in New York City since 1952, when the magnetronic reservisor, an electronic computer developed by the Tele-register Corporation, was placed in service. The extension of the rapid service to Buffalo in April 1956 was heralded as the "forerunner of a nation-wide airline electronic data processing system" for reservations by *Aviation Week* in its issue of March 19, 1956. Other airlines are now placing orders for electronic reservations equipment, and a nation-wide interconnection of such systems will speed service on interline reservations.

Electronic processing machines of American Airlines are now able to analyze information from a modified reservations punched card, automatically punch out a teletype tape properly addressed to stations concerned, and transmit the tape without human intervention. All pertinent information, such as the passenger's name, date of arrival at connecting stations, and space required is conveyed to the proper stations with a high degree of accuracy.⁸

⁷ Eric Bramley, "How to Speed Up Phone Service," *American Aviation*, February 14, 1955, pp. 71, 72.

⁸ Philip J. Klass, "New Airline 'Datamation' Theory to Undergo Evaluation at Buffalo," *Aviation Week*, March 19, 1956, pp. 65-71.

Electronic methods of computing fares, punching routing information, interrogating reservations systems for firm reservations will permit automatic ticketing also. For the passenger checking in with excess baggage the scale will issue a ticket showing the pounds of excess. To speed passenger and baggage check-in procedures the two processes may be divided, thereby reducing the waiting time in line for people with no baggage or with carry-on baggage.

While speaking of reservations and ticketing, mention should be made of the eternal no-show problem. All the electronic equipment yet devised is not able to forecast how many persons holding reservations on a given flight will fail to appear at flight time. Before penalties can be assessed effectively some policing methods must be developed which will prevent the following abuses:

1. The argument on the part of the ticket holder that he cancelled his reservation by phone before flight time and that the airline is in fault for not having a record of his call.

2. The use of a special telephone line for receiving cancellations only may be kept busy by indignant customers who claim to have been waiting several minutes to make a reservation or who think they deserve special attention because of their claims to fame.

Until such time as commercial airline flights assume the characteristics of commuter service, reservations remain a necessity.

AIRLINE PUBLIC RELATIONS

BY CHARLES M. BOYNTON

THE airlines today are facing an era presenting one of the best examples of why public relations are necessary in this industry. An anonymous airline president explained the present situation in these terms: "We are buying airplanes that haven't been fully designed with millions of dollars we don't have and are going to operate them off airports that are too small, in an air traffic control system that is too slow, *and we must fill them with more passengers than we have ever carried before.*"¹ To the public this might not mean too much at the present time, however, in the future when the full impact of this situation is realized, our airlines may find themselves in a very precarious position—unless careful public relations groundwork has been laid. The job our airline public relations man is faced with cannot be simply termed "educating the public." In order to aid in filling the seats that will be available to more passengers than have ever been carried by our airlines before, the public relations man must concern himself with at least seven major problems. These are:

¹ "The Jet Arrives; Billion Dollar Battle . . . Turns Drawingboard Dreams into Reality," *Newsweek*, March 5, 1956, p. 74.

1. A complete indoctrination of every airline employee, including the public relations man himself. Good public relations "starts at home." Unless the airline employee is aware of the facts concerning the approaching "jet era," misinterpretations may set in. Every employee of the airline is a public relations man, when questioned about facts covering his airline. A good example of the type of information that should be supplied our airline employees in the future is a booklet prepared by the Public Relations Department of Capital Airlines, Inc. for their employees, prior to the introduction of their new turbo-prop airplane, the "Viscount." In this booklet are covered all of the many facts and proposed plans concerning their latest purchase. Included are the reasons for the purchase, national and international significance that may be discussed, order in which they propose to replace their aircraft, method of paying for the aircraft, terminology employed, description of the aircraft, and many other matters that should be common knowledge to the employees of the airline. The purpose of this booklet was described to the employees in the following words:

. . . to provide you with background material so that all of us will be talking in the same vein.

This is a public relations guide. It establishes a policy so that we may be assured of consistency and common sense in our over-all program as we introduce the most advanced of transport planes.

During the next few months, you will receive a continuing flow of sales tools and technical information on the Viscount. This booklet will supplement that material by covering facts which most likely will crop up in your contacts with your passengers, the general public and with your friends and families.

Remember, talking is selling; especially when you talk about the Viscount.²

Booklets such as these, plus "follow-up" materials printed in airline house organs, speeches by members of management, and continuous contact work by public relations men, can create an alert, well informed and enthusiastic airline employee that will aid considerably in selling the "jet era" to the public.

2. The noise problem is one the airline public relations man will have to cope with in the future. This is actually a problem the airlines have always found to exist in the vicinity of airports, but jet aircraft will increase the number of people affected—due to the higher pitched and more penetrating sound that they generate. The public relations man has a particularly difficult problem in this case, as he cannot actually design a noise suppressor to quell the aggravating sounds emitted by the jet aircraft. The only realistic approach our airline public relations personnel can take to this problem is to try and accustom the public to the situation and hope that our aircraft manufacturers come up with an answer. It appears to be only a matter of time

² "Talk About the Viscount," (Washington: Capital Airlines, Inc., no date), p. 2.

before the manufacturers solve this problem — meanwhile, however, civic groups all over the country are busy preparing cases to present in opposition to the use of their areas for jet landings, due to the rumors that have been spreading concerning the noise of the jets. This is the area of consideration our public relations man must concern himself with. Once again he must present the facts to the public, through all the media at his disposal, and continuously strive to restrain the objections to the noise problem until the suppressors are perfected. The public is unaware of the efforts being made to develop these devices and should be informed by the airlines as to such efforts. The average citizen has faith in American ingenuity, and will respond more readily to this type of approach than he would to the type that attempts to reconcile him to the fate of ear-piercing aircraft alternately interrupting his daily route. The public relations man thus has a delaying action responsibility in this area of consideration, as well as one of fact presentation. He must convince the public that it is to their benefit to delay action on the proposed protests until solutions to the problem have been submitted, analyzed, and tested.

The Air Force has found that routing planes over lightly congested areas aids the noise problem. Actually, once the planes are in the air, they will be so high up that the noise will not affect people on the earth beneath them. The problem, therefore, may be localized. Since the aircraft will be soundproofed, passengers traveling on the planes may only experience the noise while in the process of arriving at or leaving the airport.

These facts should be given careful consideration by the public before any moves to bar jet aircraft from their communities are initiated. It is up to the airlines to insure that the public carefully weighs all the facts concerning these matters. Airline public relations men will have to work closely with people from “both sides of the fence”—airline personnel and aircraft manufacturers on one side and the public on the other—and strive to bring them both together toward the accomplishment of a sound, satisfactory, solution to this problem.

3. Many of our airports are inadequate for the use of the new aircraft. Enlarging these airports is going to cost money—money the average taxpayer just doesn't want to spend. To begin with, many communities don't want the jet aircraft flying near their homes because of the noise, and when they find out that they may have to pay more in taxes to fit their airports for such aircraft, there is likely to be even more resentment engendered. Only good public relations work will be able to sell these aircraft—convincing the public that the “jet era” has arrived and that they should be included in it. This is going to involve a lot of hard work on the part of airline public relations personnel. Most of this work will have to be done on the local level and will be chiefly directed at civic leaders of the communities affected. Actual contact work with these civic leaders, in an attempt to explain the advantages of including jet transportation in their community, must

be conducted. Good public relations work can be accomplished if the public relations man (or a member of airline management) speaks before local gatherings, club meetings or similar groupings of individuals to explain the advantages of the "jet era" to the community. Open meetings with "question and answer" periods will attract the average citizen and give him an opportunity to explain his viewpoint. This type of activity will often give the public relations man a better insight to the objections he will be encountering, and supply him with material he may use in his other activities connected with promoting the new jet aircraft. The airline public relations man will have to concern himself with achieving a public interest and desire for local participation in the "jet era" or the airlines may find that they will have to pay for any additions to existing facilities.

4. The public must be convinced that the new aircraft are safe. Noise breeds fear, and many of our country's citizens have heard and seen jet planes flown by the military, and will need convincing before they utilize seemingly similar planes for travel. They also have read of the failures that the British experienced with the first venture into "pure" jet air transportation, plus some of the crashes that have occurred in our own country. Although our public has faith in the aviation industry (that has no equal throughout the history of transportation) it still has the age-old fear of something "new." The expression "I'll wait and see" might apply in this case. When the new type aircraft have proven themselves and have posted good safety records, many of the "wait and see" passengers will then board the jets. These "wait and see" customers may have a marked effect upon the number of seats filled at a time when the airlines will need more passengers than ever before in their history. The airlines of our country might well follow the example of Capital Airlines, Inc. and conduct "pre-seat selling" campaigns. Included in these campaigns will have to be assurances of the efforts that are being made to insure that the new jet aircraft are being thoroughly tested and provided with every safety consideration necessary to continuing safe operation. It is estimated that over the nation's airports there are four near-collisions every flying day. How many of these "wait and see" customers would board a "new" jet plane if they were aware of this fact, plus the condition of our air traffic control system and crowded airways? These facts, however, are becoming increasingly well-known, and by 1959 they may be common knowledge. It is up to our airline public relations man to aid in the presentation of any campaigns designed to acquaint the public with the advantages the jet aircraft will offer. It is even more important that the airline public relations man impress management with the need for campaigns directed at informing the public, as well as selling it. It is going to take a lot of good public relations work to convince the public that the new aircraft will be the safest possible.

5. A good many problems the "jet era" will present are ones resulting from the introduction of new aircraft (and conceivably new pas-

sengers) into airports already overcrowded. Ticket offices, baggage counters, and all of the other passenger facilities located in and around the terminal building will be sorely overtaxed by present standards. Consider, for example, 100 to 150 passengers (expected capacity of jet aircraft) bursting forth from a jet airliner and rushing into the terminal building, clamoring for tickets on another flight; waiting in line to use the toilets; attempting to place a phone call; or performing any of the many other activities they might be expected to perform. Add to this the passengers on other flights, or those about to board planes, and you have a situation similar to what you might expect to find on Times Square, New York City, at 12 o'clock New Year's Eve. Situations such as this will add to the tension and anxiety that will exist, due to the problems previously mentioned. The public relations man must do everything possible to acquaint the airlines and airport management with this future problem and assist them in every way possible in solving it. The public, meanwhile, will have to be convinced that everything possible is being done to alleviate this situation. Careful planning is necessary and the groundwork for it should be laid as soon as possible. Although the delivery date for the new aircraft is not due for several years, it will take a great deal of time to make arrangements for handling the increased volume of traffic (both passenger and baggage) expected. Efforts should be made as soon as possible to expedite a solution to this problem, before it becomes a reality.

6. A problem which has existed for some time, and that shows no sign of decreasing, is that of drinking while in the air. With the introduction of new aircraft traveling higher and faster than any other means of transportation known to man, this problem becomes increasingly evident. Picture the poor stewardess trying to adjust an oxygen mask on an uncooperative, inebriated passenger, for instance. With pressurized cabins, the danger of a broken window or any tampering with control devices that might be accessible is one that could spell disaster for all of the occupants of the plane. Unruly passengers might well be guilty of a great number of destructive occurrences not affecting the operation of present day planes, but that would prove disastrous in our new commercial jet aircraft. The trouble seems to stem from the belief of our airline management that drinking must be allowed, as the public demands it. If the public realized the danger that will exist if passengers are allowed to drink on jet airliners, few would set foot on these planes, or if they did, would not see fit to drink themselves. Airlines have agreed on a policy restricting liquor service aloft to a two-drink limit. Such a policy will tend to quell the tide of alcoholism aboard many of our airlines. The solution could well be expedited if the public relations men of the airlines were to prove to airline management that the majority of their passengers do not favor drinking while aloft. Any factor that might contribute to a jet aircraft disaster should be given careful consideration by our airlines. Drinking aloft might prove to be this contributing factor at some unforeseeable

time in the future. At a time when more passengers are needed by our airlines than ever before, it won't take very many jet crashes to drive travelers from the airports. Public relations men can play a vital role in helping to solve this problem by determining just what the feeling of the public actually is—when confronted with all of the facts, pro and con, that might have a bearing on the case.

These are the more important public relations problems likely to be encountered by the airlines in the future. Actually, there are a great many others that may result from technological omissions, or just plain oversight on the part of members of the aviation industry. We are assuming in this discussion that matters such as the protection of passengers from the fiery jet blast, and safety devices such as provision for emergency supplies of oxygen at high altitudes (should a leak in the pressurized cabins occur) will be taken care of. As we mentioned at the beginning of this discussion, these are foreseeable problems which will conceivably present the greatest public relations challenge. Our aviation industry moves at such an accelerated pace, and the public relations difficulties that arise with this acceleration are so unpredictable, that only the future can unveil the true conclusion of this discussion.

THE JET AIRCRAFT

BY DONALD L. A. SAWYER

THE year 1955 will go down in history as that in which the airlines became a part of the jet age which had reached Great Britain in 1952 but was very slow in spreading to other parts of the globe. The commercial airlines of this country during 1955, placed orders with aircraft manufacturers for jet powered transports worth over one and one-half billion dollars.

Today every major country of the world has at least one commercial jet powered aircraft under development and the transport contest is in full sway between the British and American manufacturers. Appearance of a Russian transport in London in April, 1956 stirred speculation that there will be additional competition in the commercial transport field from behind the Iron Curtain. Certainly the Russian people will attempt to gain support for their jet powered transport by fostering sales to interested countries who may not be in a position to buy from the United States. The United States is, however, in a very excellent position regarding commercial transport aircraft and the ability to produce large numbers in a short period of time.

The French have been somewhat slower than the British with their transport research but their endeavors have been centered around a twin-engine medium-range jet transport designed for use on the

French airline routes in Europe. This aircraft will be in the same class as the British jet and will be used on many of the same routes throughout Europe.

The American jet transports are of longer range than those of the European countries because of the greater distance between major American cities. These transport aircraft must be able to cross the continent on a coast to coast flight; these same airplanes must be able to cross the Atlantic the same way, non-stop. The character of the new transport, at the present time, is patterned after existing transport aircraft with the exception of new engines and higher cruising speeds. A group of smaller jet transports has been proposed but no contract has been signed for these airplanes. This smaller transport is in competition with the turboprop transport that has been ordered in England and America.

Motive power for these new transports will be supplied by the turbine engine; used in the turbojet and turboprop. The new engine is lighter in weight, smaller in size, and greater in power than the piston type engine. It will, however, require more fuel for operation and at low altitudes this fuel consumption is very great. Because of this, these engines operate best at higher altitudes than at present.

The turbojet engine has two main components: the compressor, in the forward end, and the turbine, in the rear.

"Large volumes of air are drawn into the turbojet, compressed, mixed with fuel and burned continuously. The exhaust product of this burning operates the turbine for the compressor and produces the thrust which pushes the aircraft forward."¹

"The turbo-jet engine with its very high efficiency at high speed and high altitude is a natural for long-range deluxe passenger travel where the advantage of speed and comfort outweigh the economic factors of cost per seat mile or ton mile. . . . But the turbojet engine does not fit into short or medium ranges. At takeoff, its power efficiency is a fraction of its power efficiency at cruise. At sea level, its consumption of fuel is multiplied over the fuel required at altitude. A jet transport between New York and Washington never could level off. It would be up and then down like a projectile trajectory."²

The limitations imposed on the user by the turbojet engine have forced the introduction of the other turbine engine to take care of those areas where the pure jet is inefficient. It is in this area that the turboprop engine finds its usefulness; it is here also that the airlines do a large portion of their flying. We find the turboprop engine is capable of matching the requirements for higher speed with load-carrying ability and economy at all altitudes. This will be a 425-450 mile an hour airplane. It can get in and out of small airfields. It

¹ "Airpower," Curtiss Wright Corporation, Woodridge, New Jersey, p. 10.

² Harold H. Dice, "A New Commercial Transport Turboprop Engine the Allison T56 and Aeroproducts Propellers," Allison Division, General Motors Corporation, Indianapolis, Indiana, January 20, 1955, p. 2.

can carry passengers over short and medium ranges comfortably at higher speeds. It can carry payloads of freight and cargo economically.³

The turboprop is very much like the jet with the addition of a propeller and reducing gear train in front of the main engine. The operation of the engine is identical with the jet up to the turbine in the exhaust gas stream. The turboprop turbine removes about eighty per cent of the energy from the gas stream and the twenty per cent remains as jet thrust. This eighty per cent is directed through the center drive shaft to the engine compressor and forward to the propeller. The turbojet turbine supplies power to the compressor only.

The more important characteristics of the jet engine are: high thrust, high speed (particularly at high altitude), shrill noise, and high fuel consumption at low altitudes. The turboprop, on the other hand, has less noise, better efficiency at low altitudes, reverse thrust on runways, shorter takeoff runs, and a slower speed than the jet (about one hundred miles per hour slower).

The turbojet engine will probably be found operating over long distances on non-stop flights. The jet will, in time see service on routes of from five hundred to three thousand miles distance. The shorter limit will depend, to a large extent, on the nature of the short segment flown and its relation to the entire flight. The turboprop on the other hand will eventually be the work horse of the airlines and serve all of the short-haul and intermediate haul flights. They may also enter the long-haul field by operating at a lower fare and carry more passengers per flight than the jet.

As the industry moves further into the jet age, most of these problems are being given careful attention and better and more powerful engines are being developed. At the present time several adverse characteristics are undergoing design corrections and by the time the new transports appear in numbers, about 1960, most of these problems will be eliminated.

The make-up of the jet transport manufacturing industry both here and abroad, will center on those companies active in transport designs. The earliest of these transports will appear some time during 1958 or early 1959. The bulk of the transport orders will not appear on airline routes until 1960 at the soonest. Several turboprop models are flying today, and more advanced versions of these transports will be available to the airlines before the jet models are. The American companies and their aircraft are:

Boeing Airplane Company, Seattle, Washington
Aircraft:

707-120	Available—1958
-220	—
-320 Intercontinental	—1960
707-Junior	—after 1960

³ *Ibid.*, p. 3.

The junior 707 is a new model created to be competitive with the Convair Skylark, a 70 passenger transport. All aircraft are four-engine jets; the 120 is powered by a Pratt & Whitney J57 engine, and the 220, and 320 are powered by P&W J75 engines. Little information is available on the junior 707 at the present time.

Douglas Aircraft Corporation, Santa Monica, California

Aircraft:

DC-8

Available—1959

DC-9 or Junior DC-8

—1961

The DC-8 will be available with the P&W J57 and J75 engines on the domestic aircraft and the P&W J75 and Rolls-Royce Conway Bypass engine on the Intercontinental models. The DC-9 is a competitive model to the Skylark, smaller in size and lighter in weight. All aircraft are four-engine and pod mounted.

Convair Division, General Dynamics Corporation

Aircraft:

Skylark

Available—1960

This is the latest model introduced to the public. A smaller transport, powered by four General Electric CJ 805 (J79) engines, this airplane is designed to operate into and out of all airports used today in commercial aviation.

The foreign manufacturers are more limited and each country is represented by a single company producing a single aircraft. Each has been developed for use by the "flag carrier" of a particular country. They are as follows:

De Havilland Aircraft Company, Ltd. (British)

Aircraft:

Comet IV

Available—1958

The Comet IV, a medium-range four-engine transport, is designed for the route structure of the British airlines operating throughout Europe and the Eastern Hemisphere.

SNCA du Sud-Est (French)

Aircraft:

Caravelle

Available—1958

The French transport is a twin-engine medium-range transport designed for the French airline routes to the African continent.

Tupolev (Russian)

Aircraft:

Tupolev 104

This is the newest of the jet transports to be unveiled to the public eye. The arrival of this transport in London has caused the Western observers to be on guard for further developments from behind the Iron Curtain. The aircraft is of medium-range and has two engines of about 20,000 pounds thrust.

The turboprop powered transports under development are at present restricted to the United States and Great Britain. The British have been the pioneers of this type transport and only recently has an American company shown interest in this design. The companies presently engaged in production of this transport are:

Lockheed Aircraft Corporation, Burbank, California

Aircraft:

Electra

Available—1958

The Electra is the only American turboprop at present. It is four-engine and is designed for medium-range work.

Vickers-Armstrongs Ltd. (British)

Aircraft:

Viscount 700D

Available—1956

810-840

—1957

Vanguard

—1958

This Viscount, a four-engine medium-range airplane is the most widely used turbine engine powered transport today. The larger version, the 800 series, is fitted with more powerful engines and carries more passengers than its predecessors. The Vanguard is a new design with all the knowledge of the Viscount built into it.

Bristol Aeroplane Company, Ltd. (British)

Aircraft:

Britannia

Available—1957

Bristol 197

—1962

The Britannia is a long-range transport aimed at the British air routes to Africa and Australia. This aircraft will eventually appear on the Atlantic route when the longer range version is delivered. The 197 is a new design incorporating many new developments.

Two other airplanes deserve mention here because they may find their way into the hands of the scheduled airlines. They are both cargo transports designed for the Air Force and both are powered by turboprop engines. The first of these transports is powered by the Allison T56 engine developing about 2,500 shaft horsepower. The aircraft is designed to transport twenty-five tons of cargo over three thousand miles at speeds of over 350 miles per hour. It is the C-130 built by the Lockheed Aircraft Corporation. The other airplane is the C-133, built by Douglas Aircraft Company and is designed to carry 25 tons of cargo over thirty-five hundred miles at speeds of over 350 miles per hour. This airplane is powered by the Pratt & Whitney T-34 turboprop engine developing 6,000 shaft horsepower.

The American manufacturers are the only ones competing amongst themselves and with the foreign companies. The foreign entries are backed by their respective local governments and airlines; the airlines being national in character. Almost half of the available transports are American entries and the back log of orders is heavily weighted in our favor. In a short time, the American industry has forged ahead to lead the world in jet powered aircraft.

In order to evaluate this new transport, selected operating performance data is tabulated for the leading designs.

OPERATING PERFORMANCE DATA

Aircraft type:	DC-8 D	DC-8 I	707 D	707 I
Performance Data:				
Gross Weight T/o Ldg	265,000#	287,500#	225,000#	280,000#
Engine number	4	4	4	4
Engine type	P&W JT3	P&W JT4	P&W JT3	P&W JT4
Engine power		10,000#		10,000#
Wing area	2,758 sq. ft.	2,758 sq.ft.	2,400 sq. ft.	2,900 sq. ft.
Wing span	139'9"	139'9"	130'10"	146'6"
Passenger Cap.				
tour.	144	144	125	146
std.	122	132	104	124
Fuel Capacity	17,600g.	21,615g.	17,400g.	21,200g.
Range	3500-4000m.	4400-4800m.	3500m.	5000m.
Cruising Speed	560mph.	580mph.	590mph.	600mph.

Aircraft type:	Comet IV	Caravelle	Tupolev	Skylark
Performance Data:				
Gross Weight T/o Ldg	152,500#	90,400#	100,000*	170,000#
	113,000	79,200	150,000**	115,000
Engine number	4	2	2	4
Engine type	RR Avon	RR Avon	?	GE CJ 805(J79)
Engine power	10,000#	10,000#	20,000 App.	10,000#
Wing area	2,121 sq. ft.	1,580 sq. ft.	?	?
Wing span	115'	112'6"	?	118'
Passenger Cap.				
tour.	76	91	70	99
std.	58	70	50	80
Fuel Capacity	8,750Imp.g.	3,960Imp.g.		10,000g.
Range			2,000m.	?
Cruising Speed	435knts.	415knts.	450-500mph.	580mph.

* Takeoff weight approximately 100,000 to 150,000 pounds.

Aircraft type:	Viscount	Electra	DC-7C	1649
Performance Data:				
Gross Weight T/o Ldg	60,000#	112,000#	125,000#	156,000#
	54,000	93,400	102,000	123,000
Engine number	4	4	4	4
Engine type	RR DartDA6	Allions501	WrightEA2	WrightEA2
Engine power	1600shp	3,750shp	3,250hp	3,400hp
Wing area	?	1,300 sq. ft.	?	1,850 sq. ft.
Wing span	93'8"	99'	117'6"	150'
Passenger Cap.				
tour.	40	88	88	
std.	59	44	55	64
Fuel Capacity	1,950 Imp.g.	5,250g.	6,260g.	9,600g.
Range	1,425m.	3,000m.	4,600m.	5,000m.
Cruising Speed	320mph.	400mph.	400mph.	400mph.