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Airport Planning — The Art of Forecasting

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AVIATION FORECASTING must be considered to be more an art than a science. As long as the basic requirement is to predict human response to a set of uncertain stimuli under unknown socio-economic conditions twenty years in the future, it will always contain a high judgment factor. This basic fact, however, does not negate the primary reason for its existence; future facilities planning cannot be properly carried out unless the projected loads on the system have been defined. This makes forecasts mandatory for any systems planning effort, and well defined forecasts can prevent a great deal of wasted time, effort and money.

An aviation forecast is a static tool in a dynamic environment. It is therefore inaccurate from the day it is made because the relationships it was based upon are constantly shifting. Nothing is of less use to a systems planner than a five year old forecast. This highlights perhaps the key parameter required of a good forecast; it must be flexible. Because the ability to update and revise a forecast, as conditions change, is paramount, the forecast should be both explicit and detailed enough to allow reasonable revisions to be made in a timely manner.

The case with which forecasts can become outdated is best illustrated by Figure 1, which plots a series of Federal Aviation Administration (FAA) forecasts, made over a period of time, of a single variable, passenger enplanements.

The FAA has access to one of the more sophisticated econometric models, and is dealing with national trends, historically a much more stable series than individual airports. The forecast average annual growth rates range from about 3 per cent (1960 forecast) to about 11 per cent (1968 forecast), or, in absolute terms, from about two million added enplanements per year (1960) to about twenty-five million added enplanements per year (1968). Figure 2, taken from a recent NASA report, indicates the degree of uncertainty among forecasts. Obviously, the "science" of forecasting has not yet been perfected.

Nonetheless, this paper discusses some of the attributes of a good forecast, and the reasons therefore, as an understanding of the composition of a set of aviation forecasts is necessary before an analysis of strengths and weaknesses can be developed.

Before going into detail, however, there are several factors which should appertain to almost all forecasts, as long as uncertainty prevails, to permit updating to be carried out as required.

The need for explicitness cannot be stressed too strongly. All relationships between traffic parameters and base conditions must be clearly stated, to allow revisions to be made as circumstances warrant. If a forecast projects a growth rate without explaining why it was chosen, it is difficult to change if, for example, a recession becomes more probable. Without knowing whether or not this was originally taken into account, and to what extent, the user is at a loss to decide how best to amend the forecast to account for the new conditions.

Detail is required for similar reasons, as shifting socio-economic patterns may not affect all traffic segments equally. Take, for example, the Canadian hub of Edmonton. Massive investment at one point, Fort McMurray (development of the Athabaska Tar Sands) implies that Edmonton-Fort McMurray traffic will have different characteristics and growth rates than traffic on other routes over a similar distance (e.g. Edmonton-Saskatoon). Extensive segmentation of a forecast allows alterations to be made selectively, and with more accuracy, than a simple growth rate. This means that the forecast itself, with appropriate revisions, can remain useful for a much longer period.

This leads to another point which bears stressing; the application of common sense. A ridiculous forecast is by definition invalid no matter how extensive the analysis. For example, a projection of Denver traffic which had it exceeding New York totals would fall into this category. This should not be immediately dismissed as an unrealistic example. The author has seen work by an otherwise competent forecaster which projected traffic at a small city (four flights per day, base condition) to exceed 200,000,000 passengers within twenty-five years, by extending a 40 per cent per year growth rate indefinitely.

Finally, a forecast is a planning tool, and liaison must be maintained between the forecasters and the users, to ensure that the parameters being projected are those required. A forecast cannot be constructed in a vacuum, and it ceases

U.S. FAA FORECASTS OF NATIONAL PASSENGER ENPLANEMENTS

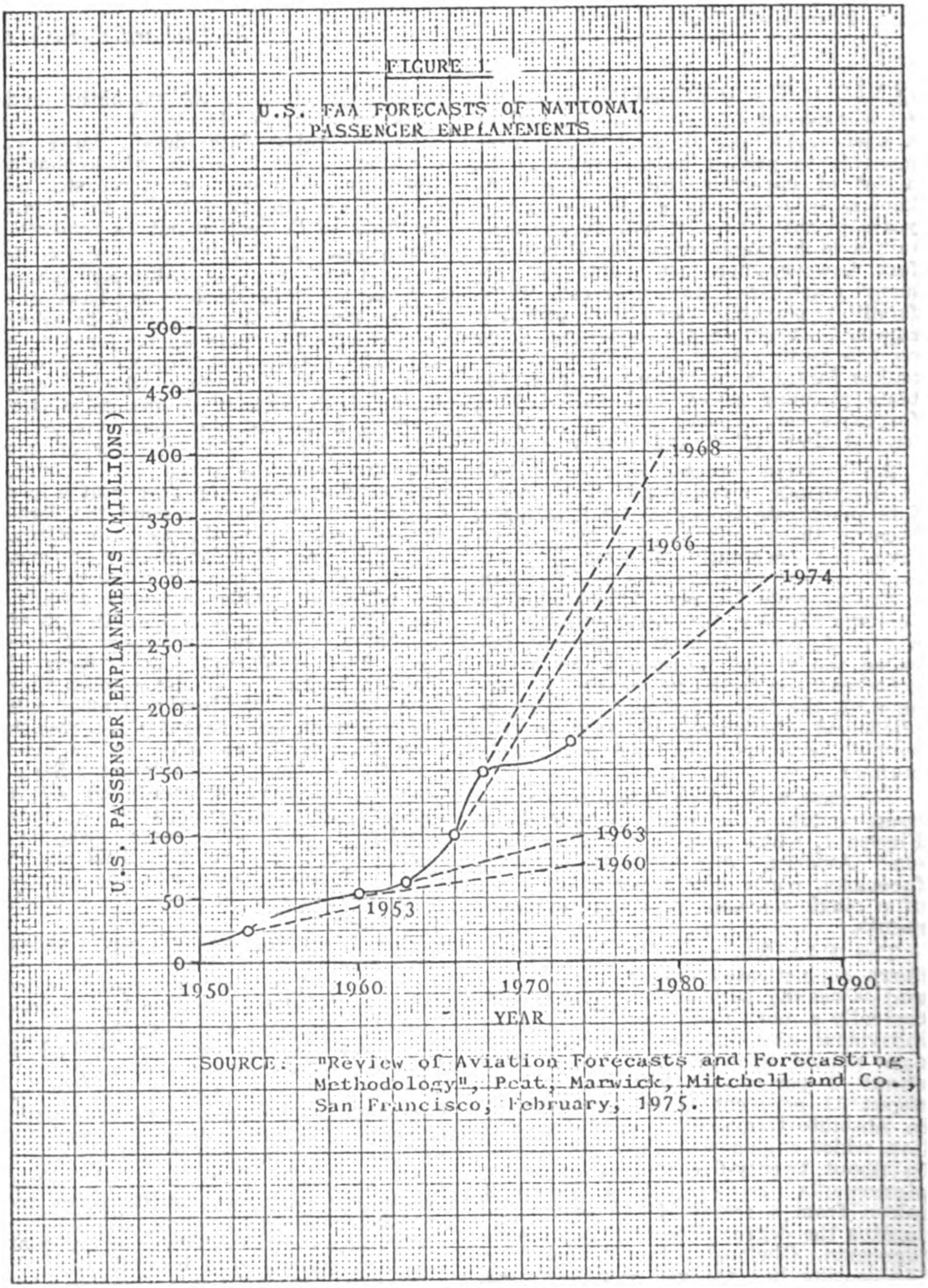
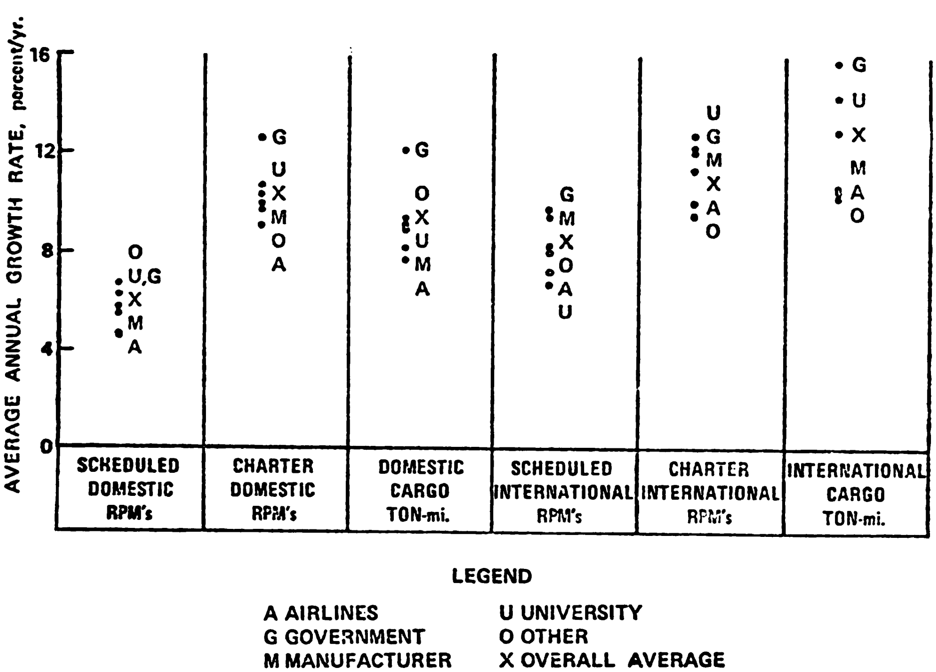


FIGURE 1

FORECAST U.S. AIR TRANSPORTATION GROWTH 1975-1985



SOURCE: National Aeronautics and Space Administration (NASA). "Survey of Projected Growth and Problems Facing Air Transportation," Ames Research Centre, August, 1975.

FIGURE 2

being useful when it ceases being understood.

Forecasts and projections are, of course, normally based upon historical data, and there are many areas for which either accurate base data does not exist, or is held on a confidential basis and is not releasable. This problem puts the analyst in the position of having to "Forecast" historical data in some areas, leading to the probability of some errors creeping into the statistical base. Wherever possible, reliance on this type of information should be kept to a minimum.

FORECAST COMPOSITION

In essence, three separate groups of forecasts are required for any airport planning project. These must be performed sequentially, as the outputs from one become the inputs to the next. In chronological order, they are:

— First-order forecasts. Annual projections of basic demand parameters, such as passengers, cargo, and mail, subdivided into Origin Destination (O-D), connecting and transit components, and further segmented into as many subcomponents as is necessary to produce relatively homogeneous responses to external socio-economic stimuli.

— Second-order forecasts. The translation of basic demand components into the units of movement, namely aircraft, on an annual basis. The size and composition of the fleet, as it relates to the airport in question, is established, and is subdivided to conform to whatever segmentation system has been defined earlier.

— Third-order forecasts. Based on the distribution of aircraft movements, the definition of those parameters directly impinging on facilities design. This normally includes peak loadings (however defined) of both first and second-order parameters, as well as indirect relationships such as well-wishers and greeters. In this element, the projections are segmented according to impact on the facility to produce estimates of diverse factors ranging from curb length requirements to aircraft stands. Note that peak-hour parameters are a function of the distribution of aircraft movements, the magnitude of which is in turn dependent on annual forecasts.

Each of the above analyses can be made for differing time periods. Although there is not a clear dividing line between short-term and long-term projections, differing techniques are normally used. A long-range projection, for a ten to twenty-five year term, will concern itself with longer-term general trends and conditions, rather than short-term details. For example, the effects of an airline strike, or the recipient of a new route award, should not affect these long-term trends. However, a continuing trend to higher real fuel prices would have an effect. On the other hand, a strike at an airline will be of primary importance if the job consists of a shorter-term forecast, while higher fuel prices may have relatively minor short-term effects.

FIRST-ORDER FORECASTS

There are four basic methodologies for developing first-order forecasts, although most sophisticated projections contain elements of each. These are historical trend analysis, socio-economic analysis, market share analysis, and judgmental estimates.

The basic rationale behind trend projections is that socio-economic parameters are too complex to provide an accurate basis for a forecast, but that historical analysis of traffic data can provide a progression which already includes these factors, although the cause and effect relationships are unknown. A mathematical curve can be fitted to the data, and a forecast is developed by projecting this trend line.

Socio-economic analysis attempts to provide a cause and effect relationship between air traffic and base conditions, by econometric modeling, or less detailed means. Once the relationship has been established, the basic socio-economic parameters can be projected, and the traffic forecast becomes related to them. This methodology assumes that a more accurate projection can be made of the selected independent variables, than can be done for the traffic itself. If the independent variables are too many, or too obscure, this method may be self-defeating.

Market share analysis attempts to relate traffic for a particular point to national totals, which are presumably easier to project, as individual hub anomalies will tend to balance out. The station forecast is then developed by varying (or holding constant) its share of the future traffic estimates.

A judgmental forecast may not be less accurate than the above techniques, but is normally only used where data is scarce, or where trend and/or socio-economic analysis give patently ridiculous results. An experienced forecaster can bring knowledge of similar situations, and apply it, if and when more conventional methods fail.

The above techniques are primarily applicable to basic Origin-Destination (O-D) forecasts. Projections are also required, however, for connecting and transit traffic, which can provide significant loads on the airport facilities.

Connecting passengers appear in large numbers when there is an inadequate number of direct services over their itinerary, and the airport in question provides suitably convenient alternative flights. Thus, they relate primarily to both airline route patterns, and to the size, complexity and geographical location of the airport in question. Note that the magnitude of this segment is only partially a function of socio-economic factors at the base airport and their projection will most likely require a higher degree of judgmental input than O-D traffic.

Transit traffic is still farther removed from airport related parameters, as it is primarily a function of airline route pattern. Here again, foreknowledge of individual airline routing philosophies and regulatory constraints is more important than detailed socio-economic analysis.

SECOND-ORDER FORECASTS

Second-order forecasts, the development of aircraft movement projections, can be developed through either a macro or micro approach, but, as stated earlier, a combination of both is generally preferable. The key difficulty in this phase is progressing from a passenger analysis, generally measured in terms of O-D desire lines, independent of routing, to fleet composition, which is segmented by route, where the aircraft physically fly.

Airline fleet composition is normally handled on a macro (total airline) basis, according to the planned short-term acquisition program, and longer-term corporate plan, together with manufacturers' plans for future technological improvement. This overview should also take into account the financial viability and marketing strengths of the airlines themselves, which will affect such parameters as seating capacities, and flight timings.

The application of fleet plans to individual routes should proceed cautiously, as there are generally factors unique to each route which will sharply affect aircraft size and composition. For example, Air Canada's physical commitment to Rapidair, between Montreal and Toronto, consisting of four dedicated B-727-200 aircraft in a unique seating configuration (144 all-economy), almost guarantees that average fleet size distribution on the Montreal-Toronto route will be significantly different from either the fleet average, or from other domestic routes over similar distances.

In a similar vein, aircraft (or airlines) serving different passenger markets, may have quite different characteristics over the same route. As an example, consider Vancouver-Seattle. Pacific Western services it as part of a business-oriented local service system covering Western Canada, while United Air Lines serves it as the first stop on a tran-continental system aimed at both California and Eastern markets. It is therefore not surprising that service patterns are quite different. As of March 1, 1977, PWA's schedule showed an average aircraft size of 57 seats with a range of 44-95. United, on the other hand, averaged 149 seats, with a range of 95-256. Clearly, the same forecasting factors cannot apply to both segments, although both airlines technically serve the same route.

In summary, clear market segmentation, according to unique subsystem requirement (homogeneity of forecast elements) is a necessary requirement for a full, understandable, forecast package.

THIRD-ORDER FORECASTS

The third-order forecasts, the establishment of peak demand parameters are the most critical, as they directly affect facility sizing, and the most complex, as they are seriously affected by many extraneous factors.

While total peaking factors for a large airport can be related to annual ones by regression techniques, individual loadings relate specifically to individual schedules, which may require individual analyses. As an extreme example, Air France pairs its Toronto services with Los Angeles. Scheduling constraints delay the westbound Toronto arrival long enough to superimpose it on the eastbound departure peak, adding to terminal congestion. According to current schedules (March, 1977) Air France requires two 747 gates at the same time, a significant peaking effect for an airline which averages less than one daily flight.

This example is not meant to suggest that macro analysis is wrong, but only to indicate that full analysis requires a detailed individual examination of specific problems.

THE RELATIONSHIP OF FORECASTS TO AIRPORT PLANNING

In the author's experience, most publicity is given to, and therefore most effort is spent on the development of first-order forecasts, which have little direct relationship to the airport planning process. The fact that ten million people may be projected to pass through a particular facility in a particular year is meaningless, as airports are simply not sized or designed for annual traffic. The important parameters relate to design peak periods, and facility usage; how many people will use which portions of the airport during the design hour. Are they returning from vacations with two or three large bags each, or are they coming on a shuttle flight with only a briefcase? Do they require health, immigration and customs clearance? Are there a large number of well-wishers associated with the flight? These are the questions which are important, as these are the parameters for which the facilities must be designed, or the behavior patterns which must be altered to more effectively use limited resources.

The implication of this reasoning is that as disaggregated third-order forecasts are of primary importance, budget should be allocated to allow sufficient emphasis to be placed on disaggregation, and on peaking characteristics.

Unfortunately, this is an area which requires more professional judgment, and one which is more open to criticism, particularly from a relatively uninformed public. From a defensive point of view (and projections are becoming more and more defensive as the planning process is becoming increasingly open to public scrutiny) it is easier to retreat to a complex mathematical model, than it is to defend a belief based on informed judgment. Thus, more and more planners are investing more time and money in econometric modelling of first-order parameters which does not necessarily provide more useful forecasts, although it does make them easier to support.

As an example, the forecasts for one major international airport development study were based on a complex travel propensity model, which in turn required a massive passenger survey to develop the base information. Travel propensities were developed for numerous socio-economic segments, and the population was grown for the forecast period to develop detailed projections over time assuming the propensities remained constant.

This technique required a great deal of time and money, and produced, without a doubt, an extremely "accurate" picture of air travel habits. Unfortunately, the choice of methodology had a number of disagreeable side effects.

— There was no historical series, therefore no way of ascertaining whether or not the propensities themselves were varying with either time, cost, or other unknown parameters.

— The cost of repeating the survey to update the forecast is so excessive, that it has not been done. Thus, a 1971 forecast was still being used as of this date.

— Because of the extensive socio-economic segmentation, further division into detailed airport-related parameters was almost impossible, as the individual sample sizes became too low. Although six segments were finally defined, they did not correspond to detailed route, or airline, segments.

— As the propensity survey did not take fare increases into account, the output had to be amended to cover the effect of increased fuel prices. As Figure 3 shows, this is a factor with a potential large margin of error. The result was a fare elasticity calculation, and an associated estimate of fare increases, which could reasonably be expected to vary the basic forecast by up to 25 per cent, applied to a projection believed to be accurate to much lower tolerances.

— As traffic was not subdivided into homogeneous segments, factors which became apparent only after the original forecast had been developed could not be easily incorporated into revisions. One such example is the recent development of advance purchase fares on the North Atlantic, (APEX and CCF) which significantly reduced minimum fare levels on selected scheduled international services.

As stated earlier, from a theoretical point of view, this was an excellent forecast. From a practical point of view, it left much to be desired, as it was not responsive to the specific needs of airport planners.

CONCLUSIONS

The author suggests that several points should always be kept in mind when developing airport forecasts. Adherence to these principles may require less original research, and may not contribute to the advancement of the state of the art. On the other hand, they should assist in the development of pragmatic useful forecasts.

1) Remember at all times that forecasts are by definition incorrect. It is far more important to produce revisable projections, than it is to develop an additional decimal point of accuracy.

2) State what has been done clearly and succinctly. The purpose of a forecast is to assist planners, not to enhance the professional reputation of the forecaster.

3) Subdivide the forecast as much as possible, into segments which relate to actual route patterns, and homogeneous traffic groupings. This will greatly assist in any subsequent revisions of the work which may be required.

4) Relate the work effort to the importance of the forecast being produced. Third-order forecasts are much more important to the planner (and much more difficult to justify) than first-order ones.

5) Retain a sense of humour. As almost all forecasts are now open to public scrutiny, someone, somewhere, somehow is going to attack the work professionally, and perhaps attack the forecaster personally, probably on an irrational basis. The ability to maintain a sense of proportion may not solve the problem, but can contribute to personal survival.

FORECAST FUEL PRICE INCREASE IN 1985 PERCENT INCREASE IN CONSTANT DOLLARS RELATIVE TO 1975

AFFILIATION	NUMBER OF RESPONSES	DOMESTIC JET FUEL PRICE	INTERNATIONAL JET FUEL PRICE
Airline	12	100.5	112.6
Manufacturer	8	30.3	23.1
University	9	24.7	11.0
Government	8	29.0	33.9
Other	5	69.6	92.5
ALL	42	53.6	56.4

SOURCE: "Survey of Projected Growth and Problems Facing Air Transportation," Ames Research Center, NASA, August, 1975.

FIGURE 3