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UNDERSTANDING AND USING FORECASTS

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Forecasts are necessary for planning, for decision-making, and for review and understanding of prospective choices. Planning, as a profession, focuses specifically on trying to deal constructively with possible futures. Decision-makers need a clear perspective on the likely consequences of their options. Discussions of alternative plans likewise routinely resolve into debates about whether the most appropriate forecasts were considered. Forecasts are basic.

Unfortunately, however, forecasts are inevitably inexact and debatable. A prediction is not a fact that can be unambiguously measured. The number of passengers ten years hence at any airport is not something anyone can know in advance, or can calculate in the same way we can compute the speed of a car or weigh its load on a bridge. All forecasts are estimates, based on expectations about other factors, derived from some assumptions.

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Any forecast of future traffic is based on a logical house of cards. It can be criticized by using different assumptions, and coming up with a different forecast. And that new forecast in turn is equally vulnerable to criticism. No forecast can be proven to be right in advance. This is the reality that good planners recognize.

Professional planners should thus constantly be reviewing assumptions, adjusting expectations about future conditions, and deriving new estimates, new forecasts of the future. They thus develop a set of projections which they hope fairly represents the range of contingencies that must be planned for. This is exactly what Massport is attempting to do by assembling the forecasts presented in this book.

To increase public understanding of the future needs for airport facilities around Boston, and of the plans to provide them, Massport is now reviewing the results of the recent major attempts to forecast airport traffic over the next generation. This effort should help those concerned with aviation in Massachusetts, both to understand the situation better and to arrive at more informed conclusions.

The purpose of this prologue is to give readers a perspective on how to understand and use forecasts. It covers five main points

and ends with a recommendation:

1. Limits of Forecasts - The reasons why no single forecast of traffic can be demonstrated to be right in advance, which is why planners need always to have a range of forecasts in mind.

2. The Difference between "Supply" and "Demand" Forecasts -These two types typically lead to quite different estimates of future traffic, since they are based both on different assumptions about the goals of public policy, and on uncertainty about the ability either to control the growth of traffic or to increase capacity.

3. Criteria for Evaluating Forecasts - Stressing the desirability of both clear assumptions and modesty about the possibility of accuracy.

4. Summary of Major Forecasts of Airport Activity for Boston - Which clearly indicates the kind of wide range of possible traffic that Massport should consider in planning future airport facilities.

5. Strategic Planning - Bearing in mind the risks associated with the range of potential traffic, the plans need to provide the public with suitable insurance. Action should be taken to make it possible to respond adequately

to the potential higher levels of traffic, without overcommitments in case lower levels occur.

6. Recommendation - That Massport adopt a policy of strategic planning. Specifically this means that it should plan for the possibility of major new facilities, do what is necessary to insure that this option is available if ever needed, but avoid committing to their construction until traffic justifies it.

The prologue specifically does not select any forecast as best. All the predictions presented in this book represent professional efforts that are consistent with their own assumptions. Taken together, these forecasts give a fair view of the potential traffic if, over the long term, the New England economy and aviation continues to grow.

Limits of Forecasts

A traffic forecast is an estimate, based on expectations about other factors, derived from assumptions. If the underlying assumptions are changed, even modestly, a completely different forecast may result. This sensitivity of forecasts to their premises, to judgments impossible to demonstrate conclusively, must be recognized from the start.

Professional forecasts are made through what can be seen as a three step process. The effort starts with some kind of mental image, or model, of how people respond to their environment: how potential passengers react to changes in income or fares, for example, or how airline companies will choose aircraft for their fleets.

Secondly, the initial assumptions, specific to the kind of traffic to be estimated, are coupled with larger assumptions about the overall context, for instance that the regional economy will continue to grow. These more general assumptions provide the basis for estimating the future values of the range of factors that influence traffic, such as: the population of a region, its income, the price of fuel and cost of travel, the type of aircraft being used and so on.

Finally, the expectations about the factors influencing traffic are incorporated into the basic model to derive specific predictions. In short, forecasts of traffic come from assumptions upon assumptions.

The best theories and professional judgments are naturally used to arrive at the assumptions that must be made. For example, both economic theory and common sense tell us that as the real price of air travel falls, more people will fly; this feature will be part of any decent model.

Forecasters differ, however, about how to translate theory into the kinds of specific formulas they use. For instance, all will agree that the future price of air travel will affect the number of airline passengers, but there are many ways this phenomenon can be expressed mathematically. Price can be incorporated into formulas in real or nominal values, as a total or an increment, linearly or logarithmically, in dollars or in utility -- the professional literature includes all of these, and there is no consensus about which is best. Furthermore, forecasters do not even agree exactly which factors to include in any forecasting formula.

The staff of Massport's Aviation Department recently conducted an exercise which nicely demonstrates the sensitivity of the forecasts to even minor variations in the formula. Using exactly the same method to obtain unconstrained estimates of the number of domestic passengers a year for Boston in the year 2010, but using marginally different ways to express the effect of income on the demand for travel, they generated forecasts differing by over 6%. Using the same method again, but with an exponential instead of a linear formula, they generated a forecast differing by around 10%.

More significant differences in professional judgments about how to specify a formula lead to even greater variations in the forecasts generated. This is again demonstrated by the Massport analysis cited above: using the same methodology but a slightly different formula to obtain unconstrained estimates of the number

of domestic passengers a year in 2010, Massport arrived at 31 to 34 million whereas Simat, Helliesen and Eichner, Inc. (SH&E) got 43 million (for details, see Chapters 2 and 3). Professional judgments about technicalities led to a difference of around 25%.

Forecasters all attempt to justify their approach by demonstrating that their model, using the mathematical expressions they have chosen, accords with the experience represented by past data. Unfortunately, many different formulations can always be found to match past data. This is amply demonstrated by the forecasts that Massport has assembled for this book: all are as consistent with past data as can be expected, yet all differ from each other.
Statistical justifications of models in no way demonstrate that any one of them is correct, let alone better than the others.

The inability of statistics to discriminate effectively among different forecasting formulas with quite different implications is demonstrated by the details of the Massport and SH&E forecasts cited above. Each of them reports virtually identical, nearly perfect correlation scores of 98 and 99 on a scale of 100.

Looking backwards at past experience is in any case an incomplete basis for anticipating the future. The past may well be prologue, but the past does not define the future. Major events that were not part of past experience constantly occur to reshape the path of history. The War in the Gulf, the recession in New

England, the reorganization of intercontinental air routes associated with the opening of Soviet airspace, the recent history of deregulation, the disappearance of Eastern Airlines, all are current events that may make the pattern of air traffic at Boston differ from historical trends.

Using a statistical model for defining the future has been compared to driving a car by looking in the rear view mirror. While focusing on past trends, it does not prepare us for the changes in direction, for the uncertainties that lie ahead.

The limits of forecasts mean, quite simply, that no single forecast can be trusted as "right". Different experts and observers will have quite different estimates of the possible future, leading to quite different -- and equally legitimate -- forecasts. Prudent planning will encompass the range of possibilities.

These general problems of forecasting are compounded when dealing with aviation. The demand for aviation is especially sensitive to relatively small shifts in the economy. This is because, with few exceptions, air travel is not desired for its own sake. It is a means to attain other objectives, such as taking a vacation or conducting business. It thus competes against other means, such as rail service or electronic communications, and can be greatly affected by shifts in the competitiveness of the alternatives, for example by the relative price of rail travel to

New York.

The Difference between "Supply" and "Demand" Forecasts

It is important, in reviewing projections of traffic, to distinguish between two types of forecasts, based on different assumptions both about the goals of public policy, and about what may be feasible. The "supply" or "constrained" approach to forecasting contrasts with the "demand" or "unconstrained" approach. Both types are represented in the collection of forecasts presented in this book.

The "supply" models basically try to determine the amount of traffic that can be accommodated by the major facilities that already exist. The traffic is thus limited by the major elements of capacity, such as runways, already in place. For airports that are congested, such as Boston/Logan, New York/Laguardia, and Washington/National, this kind of forecast implies relatively low growth, because the limits of capacity "constrain" the traffic that might otherwise occur.

Thus for Boston/Logan, the "constrained" forecasts lead to estimates of around 37 million passengers by the year 2010, representing about a two-thirds increase over the current level. These estimates are quite inexact, however, since it is in fact extremely difficult to determine the capacity of existing facilities -- and thus the extent of the constraints. For example, the capacity of the runways at Boston/Logan was

estimated in the early 1970's to be around 300,000 aircraft operations a year -- but these same runways served about 424,000 operations in 1990! In any event, the annual rate of increase implicit in these "constrained" estimates is about 3%. This is far lower than the historical pattern which has been closer to 5% annually.

The "demand" models on the other hand estimate the traffic that might occur if there were always enough airport and airspace capacity available, if the ability to fly were "unconstrained" by the lack of adequate facilities such as runways. They are intended to represent the desires of the traveling public, and generally follow historical trends.

Thus the "unconstrained" forecast prepared for Boston/Logan by SH&E estimates that Boston could have about 57 million total passengers, domestic and international, by 2010. This represents an increase of around 150% over 1990. The annual rate of growth implicit in this forecast is around 4.6%, compounded annually from 1991. This is in line with the long term pattern of growth of around 5%.

For congested facilities such as Boston/Logan, the "unconstrained" forecasts naturally lead to much greater numbers than the "constrained" forecasts. For Boston, we are looking at the great difference between around 37 and 57 million passengers a year; the "unconstrained" forecast is about half again as high

as the "constrained" forecast.

The difference between the two kinds of estimates is even more striking when one considers their quite dissimilar implications for public policy. The "constrained" forecasts imply that provision should be made for around 15 million more passengers a year, whereas the "unconstrained" forecasts call for facilities for around 35 million more passengers. The actions required to deal with these two scenarios may be qualitatively quite different.

Whereas the "constrained" forecast is based upon the idea of trying to cope with what is available, and thus implies relatively small, incremental changes, the "unconstrained" forecast implies that a major new airport, comparable to what now exists at Boston/Logan, should be contemplated in the planning process.

This difference between the "unconstrained" and "constrained" forecasts highlights basic policy questions about how government can best respond to public desires. To what extent should the authorities make major efforts to meet the kinds of demands represented by "unconstrained" forecasts, particularly when these efforts may conflict with concerns about the environmental effects of aviation on air quality, ground traffic and local quality of life?

Moreover, everyone needs to recognize that it may be impossible

either to add capacity as desired or to restrain unwanted growth. Because of congestion at other airports for example, "unconstrained" growth may not be able to occur regardless of what one does locally -- there may be a limit to the number of flights that can go to cities such as Washington, New York or Chicago. Conversely, it may be equally to restrain the growth in aviation, or divert to other modes such as rail, through local action --people may not wish to take the train to or through New York, and may insist on flying.

Planners should facilitate public understanding and effective participation in the debate concerning better transportation and better environment. They thus need to look carefully at both sides of the issue, as Massport has done by commissioning both unconstrained and constrained forecasts of air travel for Boston.

Criteria for Evaluating Forecasts

Good forecasts should meet two kinds of criteria: technical and planning. The technical criteria refer to the mechanics and inner workings of the mathematical formulations used to generate the forecasts. The planning criteria are associated with the ability to use the forecasts in an ongoing planning process.

As competent professional forecasters routinely satisfy the technical criteria, they are less important in the context of

this book presenting the major recent forecasts of air transportation for Boston. Each of these efforts appears to meet the necessary standards. For the record, however, the technical criteria require:

1. Acceptable Theory - That the influences on traffic express the right kind of effect, such as traffic decreasing as prices increase.
2. Appropriate Procedures - Some statistical methods are demonstrably more suitable than others in specific circumstances.
3. Correct Mathematics - Without computational errors.
4. Adequate Concordance with Historical Data - The model should fit the more recent data relevant to the traffic.

The planning criteria relate to the ease of understanding the forecasts and adapting them to the ever-changing circumstances planners normally face. Three are worth stressing:

1. Clarity of Assumptions - That the major assumptions inherent in the forecast be easily identified.
2. Adaptability of Model - That the forecasting model can be readily changed to suit different values of its major inherent assumptions.
3. Modesty about Accuracy - A recognition that, because of the uncertainties concerning both the basic assumptions and the values of the factors that must be estimated for the model, the forecasts themselves cannot hope to be

accurate to any significant degree of precision.

Clarity in the assumptions is a most important criterion. This is critical because planners need to be able to understand the sensitivity of the forecasts to changes in the factors influencing traffic: what changes in the regional economy or the aviation industry would lead to significant adjustments of the forecasts? To the extent that management can actually affect certain factors, such as the number of aircraft operations at peak hours, planners also need to know how it might be possible to influence the future levels of traffic.

The adaptability of the model is the complementary feature that permits planners to bring the forecasts up-to-date with new patterns of activity in the industry. If forecasts cannot be easily modified, they rapidly become obsolete. Investments in such forecasts are not cost-effective compared to the alternative.

Modesty about the accuracy of the forecasts is also vital to prevent public misunderstanding and subsequent complications. Numerous retrospective studies, for example by the U.S. Office of Technology Assessment, of the performance of forecasts demonstrate that "forecasts are always wrong" in the sense that they are never accurate (US Office of Technology Assessment, "Airport and Air Traffic Controls Systems", Washington, DC, 1982). A typical result finds that long-term forecasts, of the kind presented in this book, have more than a 50 - 50 chance of

being more than 20% off. This means that only the first two figures of a forecast are significant, at best; the rest are meaningless. That is, when a computer generates a forecast such as 37,463,018 passengers in the year 2010, only the first two numbers, representing the 37 million, are at all credible since we can easily anticipate errors of about 20%. In the same vein, the retrospective studies imply that any forecast should be expressed with a generous high and low range.

The inaccuracy of forecasts is generally apparent whenever one compares the forecasts made a few years ago with the current levels of traffic. For example, the "Revised CHART" forecast prepared in early 1988 predicted that Logan would have 26.2 million passengers in 1990. In fact, the actual traffic in 1990 was 22.9 million. The forecast was 14.4% away from reality after only three years! This is the kind of observation that makes it easy to recognize the likelihood of errors greater than 20% in 20 years.

The inherent inaccuracy of long-term forecasts has furthermore been enhanced by the increased volatility of traffic due to the economic deregulation of the airlines. Since 1978, airlines in the United States have, on short notice, radically changed their routes, moved operations, merged and even gone out of business. Boston's experience with Peoples Express, New York Air, Eastern, and other airlines over the last decade demonstrates this fact.

Summary of Major Forecasts of Airport Activity for Boston

This review covers the four major sets of recent aviation forecasts specifically prepared for Boston. Two each are "constrained" and "unconstrained" forecasts. One of each kind was prepared by Massport and the other by consultants. For completeness, the review also briefly discusses the "terminal area forecasts" prepared by the US Federal Aviation Administration.

After describing each forecast, this section evaluates them according to the planning criteria described previously. A short technical assessment follows for the record,and an overall assessment appears at the end.

The Forecasts: The "constrained" forecasts are:

Chart a revised version of the forecast made in connection with the planning of the **C**ross-**Har**bor **T**unnel. Massport prepared this update in 1988.

LOGIC a forecast developed by the firm of Flight Transportation Associates (FTA) in 1989, in connection with the **Lo**gan **G**rowth and **I**mpact **C**ontrol study.

Both of these exercises assume that "as many passengers as Logan can handle will to use the airport in 2010". They both use the same methodology, but make different assumptions about the

details of airport operations, leading to different conclusions about the capacity of Boston/Logan.

The "unconstrained" forecasts are:

LADS a forecast prepared by Simat, Helliesen and Eichner (SH&E) in 1990 for the **L**ogan **A**irport **D**emand **S**tudy.

MPT a series of alternatives to the above, using different formulas, prepared by Massport as part of their discussions with SH&E.

Both of these two sets of forecasts use the same methodology: statistical analysis of historical data to specify a formula for extrapolating traffic over the next 20 years. They really only differ in that they use different formulas.

The overall results of these forecasts appear in Table 1. The "constrained" forecasts suggest that the total number of air passengers to Boston in the year 2010 will be in the high 30's to low 40's (millions), whereas the "unconstrained" forecasts suggest the high 40's to low 50's (millions).

The Federal Aviation Administration, contrary to what might be expected, does not provide 20 year forecasts for airports. Their terminal area forecasts really concentrate on the short term, 5 to 6 years ahead, and "are prepared to meet the budget and planning needs of the FAA", not of any city in particular. The extrapolation of the latest FAA forecast for Boston to the year 2010 suggests traffic in the low 40's (millions of passengers).

Table 1: Forecasts of the Total Number of Passengers at Boston in the year 2010, in millions.

Type of Model	Name	Forecast Low	Forecast Medium	Forecast High	Range of Set
"Supply" or "Constrained"	Chart	33.7	**35.5**	37.4	**33 to 43 million**
	LOGIC	35.8	**40.1**	43.6	
"Demand" or "Unconstrained"	LADS	46.3	**56.5**	69.2	**40 to 69 million**
	MPT	39.9	**47.3**	56.4	

Table 2: Evaluation of the Range of the Forecasts.

Type of Model	Name	Range	Comparison with Historical Range
"Supply" or "Constrained"	Chart	+ or - 5%	Much too narrow
	LOGIC	+ or - 10%	Too narrow
"Demand" or "Unconstrained"	LADS	+ or - 23%	Reasonable
	MPT	+ or - 18%	Reasonable

Planning Evaluation of Forecasts: As can be seen in Table 2, the constrained models imply a high degree of accuracy, as indicated by the narrow range they give between their high and low forecasts. There is no evidence, however, that aviation traffic can be estimated within plus or minus 10%, let alone plus or minus 5% as suggested by these forecasts. All the evidence indicates that much broader ranges, such as those offered by the unconstrained forecasts, are more realistic.

As regards the clarity of the assumptions, both the constrained and the unconstrained forecasts are somewhat murky. Major assumptions are implied, whose effects are difficult to appreciate. For example, the constrained forecasts both presume that, when Logan would be operating at its maximum capacity, about 1/3 of the flights would be commuters or general aviation. This might be so, even if it is difficult to believe that the public would long tolerate smaller aircraft crowding out the larger ones with more passengers to this extent. In any case, it is impossible for an outsider to divine the implications of this assumption: since larger aircraft cannot substitute one for one for smaller aircraft in congested periods, the entire constrained forecast would have to be redone to assess its sensitivity to this assumption.

The constrained forecasts are also full of detailed assumptions about patterns of travel and airline operations, and the effects of these assumptions on the forecast are not immediately evident.

Table 3: Evaluation of the Clarity of the Assumptions.

Type of Model	Name	Major Detailed Assumptions	Clarity of Effects
"Supply" or "Constrained"	Chart	Commuters = 1/3 ops Current delays	Not at all Obvious
	LOGIC	Same as for Chart	Ditto
"Demand" or "Unconstrained"	LADS	Traffic = f(US, MA Income, Airline yield)	Yes, but... What else matters?
	MPT	Same as for LADS	

Table 4: Adaptability of Models to Different Situations.

Type of Model	Name	Mechanics of Model	Adaptability
"Supply" or "Constrained"	Chart	Detailed Interactions	Not Easy
	LOGIC	Ditto	
"Demand" or "Unconstrained"	LADS	Simple Formula	Very Easy
	MPT	Ditto	

The unconstrained forecasts are, on the face of it, very clear

about their assumptions since they derive from simple formulas in which the effect of each factor on the forecast can easily be calculated. Table 3 summarizes the comparative clarity of the assumptions of the constrained and unconstrained models. The difficulty in practice is that the assumptions made to determine the future values of such factors as the future yield (that is, profitability) of the airlines are not precisely stated.

Table 4 summarizes the adaptability of the models to different assumptions, situations or new data. The constrained forecasts are relatively difficult to adapt. Because of the complex interactions between various assumptions, such as between the number of general aviation aircraft and the total number of operations, it is not practical, without a computer spreadsheet and precise details that are unavailable to the reader, to determine how the change in any assumption might affect the forecast. With the unconstrained forecasts, on the contrary, it is very easy to calculate immediately the implied effect of any change in the variables in the formula.

On balance, the unconstrained forecasts may easiest to use for planning purposes. This is not because they are unconstrained, or more realistic, but because they are both clear about their assumptions and easily adaptable. In using this approach it is obvious how you can change test other assumptions and fit new data. Technical Evaluation of Forecasts: From a purely technical point of view, the only thing perhaps worth commenting on are the

statistics. It can otherwise be presumed, as indicated by an overall inspection, that the models combine acceptable theory, appropriate procedures and correct mathematics.

The unconstrained forecasts are the only ones that extrapolate trends overtly, and are the only ones to use statistics. Table 5 shows some of their key values. For those who do not know how to interpret these numbers, it can simply be said that:

1. Both sets of models fit past data very well, scoring 98 out of 100 on the correlation. This is to be expected in this kind of data, and is in fact very easy to achieve, even with spurious correlations.
2. The LADS forecast does better on the t-statistic than the Massport study, but worse on the Durbin-Watson statistic. Which is to be preferred is a matter of professional judgment, on which there is no consensus.

Overall, there is not much to choose between the models on a purely statistical basis. Both give substantially different forecasts, well within the normal range for exercises of this kind.

Table 5: Statistical Parameters of the Forecasting Models.

Type of Model	Name	Correlation Coefficient	t stat	Durbin Watson
"Supply" or "Constrained"	Chart	---	Not applicable	---
	LOGIC	------	Ditto	------
"Demand" or "Unconstrained"	LADS	0.98	1.75 to 3.75	0.92
	MPT	0.98	1.21 to 7.98	1.69

Summary Assessment of Forecasts: The recent forecasts available to Massport collectively provide an excellent basis for planning aviation facilities for the Boston area. Taken together, they give a much better view of the planning issues than any single forecast could. Any particular forecast is inescapably affected, in some way, by the assumptions and detailed technical judgements of its creators. But the collection of forecasts, by contrasting their differences, defines the effects of the various professional judgements.

Furthermore, forecasts of aviation traffic have historically been too high about as often as they have been too low. In recent years, for example, forecasters generally underestimated the growth at hub airports, and overestimated traffic elsewhere. Planners can thus chart a reasonable middle course, fully aware

of the possible range of outcomes.

The forecasts are naturally all now somewhat deficient in that they are out-of-date. They do not reflect either the current downturn in the regional and national economies, or the collapse of Eastern Airlines and the associated restructuring of airline service. So some revisions are necessary.

Because of the expense and difficulty of trying to revise all the forecasts individually, and because the range of forecasts is so great, it may be most cost-effective to concentrate attention on revising the range of forecasts. Whenever Massport feels the need to update its forecasts, for example to support a new bond issue, this could be done fairly simply and inexpensively.

The revised forecasts, however achieved, can be expected to give a similar result: the future number of passengers for Boston in the next 20 to 25 years could easily be anywhere within a wide range, as between the 37 to 57 million passengers a year currently forecast.

Strategic Planning

Because of the unreliability of long-range forecasts, it is necessary to work with a broad range of possible futures. It

might be more convenient to plan on the basis of a single forecast, but this would be highly speculative. It would also seem inappropriate for a public agency, which should act prudently and responsibly. How should planning be done when the future is so uncertain?

It may be best to plan around several broad scenarios rather than any particular forecasts. This has two complementary advantages. First, the concept of "scenarios" emphasizes the speculative nature of anyone's ideas about the long-range future, and thus focusses attention on the need to deal with the real risks. Conversely, it avoids basing the planning process on any forecasts which, as already discussed, cannot be unambiguously justified in any detail.

The procedure for using a range of scenarios in planning can be characterized by two aspects:

1) Mainline Planning - which uses the middle of the range as the basis for preliminary long-term planning; and

2) Contingency Planning - which anticipates the possibility that the extreme scenarios might occur, and develops plans that can adjust smoothly to these eventualities.

This planning for the uncertain future differs significantly from the traditional master planning process. It starts from the

premise that the main plan may have to be adjusted significantly to deal with uncertainties. It thus builds flexibility into the facilities themselves, emphasizing adaptability of the spaces and smaller, incremental construction. It also builds flexibility into the decision process.

Strategic planning is the consequence of this process for dealing with the future risks. It has two main features:

1) A flexible approach - firm decisions are made only for the first stage: actions in subsequent stages are left open, to be determined based on future developments; and

2) Insurance - in that plans will incorporate extra features that will make them perform well over a broad range of possibilities, rather than being narrowly optimized for a particular future and then incapable of performing well in other situations. Usually, this insurance involves a cost premium.

A strategy is quite different from a master plan, which is the usual basis for planning airports. Master plans attempt to lay out the best long-term development of facilities. In fact, as guides to practical action, they turn out to be largely exercises in futility: most of the projects in master plans are not implemented.

These limitations of master plans were demonstrated by a recent

retrospective study of airport master plans in New England: after 15 years, the master plans had correctly anticipated only about one-third of the actual projects (Jaime Maldonaldo, "Strategic Planning: An Approach to Improving Airport Planning under Uncertainty", Master of Science Thesis, MIT Technology and Policy Program, Sept. 1990).

The demonstrated irrelevance of master plans to what happens 15 or more years hence is especially significant when it comes to thinking about long term forecasting. Many forecasters will say, when confronted by their inability to anticipate short-term traffic, that these fluctuations are irrelevant because (1) long-term forecasts look at overall trends, and (2) the anticipated traffic will eventually occur in any case. The fact is that the traffic generally does not occur as forecast, and this is why the master plans are inappropriate.

The forecast traffic sometimes arises so much faster than expected that it swamps the existing plans; this is what happened at New York/Kennedy airport as transatlantic traffic grew ten-fold from 1950 to 1970. Sometimes the traffic does not occur at all, as was the case for Montreal which is now stuck with a white elephant of an airport at Montreal/Mirabel.

Most often, the traffic that does occur is quite different from that expected, so that although the number of passengers is

attained, they have very different needs than those originally anticipated. The "International" terminal at Boston/Logan airport illustrates the phenomenon: built to serve transatlantic passengers, about half of its passengers over the years have travelled to domestic destinations, and have required facilities quite different from those originally planned.

Recommendation

Massachusetts should develop a strategic plan for its air transportation. It needs to position itself to be able to do what is required, take the first steps that will insure that desirable future options will be available, but withhold long-term commitments until necessary.

The strategy for Boston should, based on the range of the forecasts, anticipate a possible annual traffic in the middle of the forecasts, that is, of approximately 45 million passengers by the year 2010, with the chance that the actual traffic could be as much as 10 million passengers greater or less. This implies:

1) A minimum requirement - to plan the expansion of the Boston/Logan airport to its probable maximum capacity (based on current estimates) of between 35 and 45 million passengers at a reasonable level of service; and

2) A potential capacity gap - between the capacity available at Boston/Logan at a reasonable level of service and what may be required or desired by 2010. The

size of this capacity gap might, for planning purposes, be anywhere between 0 and 20 million passengers a year (the difference between the lower constrained forecast of 37.5 million and the higher unconstrained forecast of 56 million).

How to provide for the potential capacity gap is the essential problem in developing the strategic plan for Boston's future aviation needs over the next generation. To what extent should this desire for air transport be managed through pricing or other forms of resource allocation? Should traffic be encouraged to use regional airports or to shift to off-peak hours or the day? Should it be diverted to other modes, such as high speed rail where applicable? Or should it indeed be served by some sort of airport facilities?

If the airport at Boston/Logan is to be supplemented by some other facilities, what might they be? One or more of the existing facilities in or outside of Massachusetts? A major second airport? Or possibly a relatively smaller airport designed for 20 million passengers, or about half the maximum anticipated for Boston/Logan?

Most importantly, what should be done now to enable Boston to meet its future transportation and environmental requirements, intelligently and prudently? What steps should be taken to

permit the development of some kind of second airport when and if needed, without overcommitting to a project that could conceivably prove inappropriate? As a prudent manager facing an uncertain future, what insurance should Massport develop to deal with the potential risks?

These are the kinds of questions that need to be addressed in the development of a strategy for Boston's aviation future.