Demand Management Versus Capacity Enhancement: Which Direction for Air Transportation?

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Summary

The growing mismatch between the demand for air travel and the available airport and airspace capacity promises to generate vigorous policy discussions in the coming years as decision makers evaluate alternative solutions. There are really only two broad possibilities: demand management and capacity enhancement. Within each category there are numerous alternatives, and a continuous range of the two solutions. Most discussions within the ATM community focus on capacity enhancement. In recent months, however, as well-publicized delay problems entered the political arena, the interest in various demand management methods increased. This approach provides many attractions to decision makers: fast implementation; direct, measurable impact; hidden costs; and broad stakeholder acceptance. In comparison, let us identify the principal characteristics of capacity enhancement: large immediate costs with benefits received 5-10 years in the future; high technical and cost risk; and resistance from key stakeholders.

Given this disparity in the political attractiveness of these two solutions to congestion, what information should we provide to ensure that the best options are selected? The obvious answer is that we should examine the costs and benefits of all the alternatives, although this is not the approach typically taken. Within the ATM community, analysis focuses on quantifying the benefits of specific technology investments, and infrequently will assess alternative technologies. Seldom, if ever, are non-technology policies included in the analysis.

This paper presents the results of a preliminary analysis of the costs and benefits of several policies to address congestion within the air transportation system. Building upon previous LMI work, we quantify the benefits of these policies, including outcomes in addition to delay reduction that focus on more comprehensive measures of economic impact. We also provide estimates of the opportunity costs due to lost opportunities for air travel.

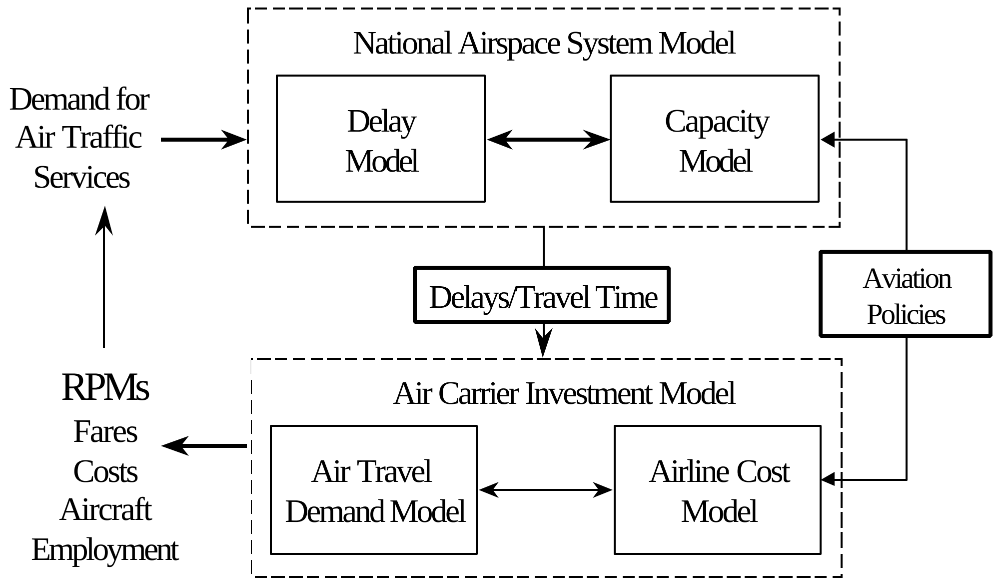
Technical Approach

The approach we will follow builds upon previous work by LMI that integrates air traffic operational models with economic models of the air transportation industry. The resulting approach enables us to analyze possible feedback mechanisms in the presence of air traffic congestion and evaluate the efficacy of various public and private responses to those constraints. Figure 1 summarizes the approach. The analysis begins with an unconstrained forecast of the demand for air travel, such as the Terminal Area Forecast (TAF) generated by the FAA. After turning that forecast into a schedule, we assess the ability of the future airport and airspace system to meet that demand growth with a queuing network model of the National Airspace System. This model, LMINET, addresses capacity and delay at 64 of the busiest airports in the United States. LMINET generates estimates of delay and block times at each of the airports. These delays are then passed on to the Air Carrier Investment Model (ACIM), a supply and demand model of the airline industry. By translating block time changes into airline costs and changes in fares, the ACIM generates a revised demand forecast that is consistent with the industry cost structure, passenger willingness to pay, and available airport capacity. We call this revised forecast a constrained forecast since it explicitly incorporates the effect of system capacity limitations.

We first exercise the analysis without the feedback loops in order to evaluate how close the NAS is to saturation and quantify the magnitude of the situation. Figure 2, which we call the “Do Nothing” scenario, projects estimates of average delay per flight on good weather days. Current delays, based on the model outputs, are estimated to be around seven minutes per flight.

That number would rise to 18 minutes per flight in 2005, and over 42 minutes in 2010, if airlines and other aviation community authorities did nothing. Of course, such an assumption is completely invalid, as recent actions regarding LaGuardia Airport in New York demonstrate. Airlines cannot operate with such increases in average flight times, even when predictable, and the lost capital and labor utilization would make continued industry growth uneconomical.

Figure 1. Integrating Air Traffic Management With the Economics of Air Travel



To generate a more realistic forecast, we imposed a maximum average delay per flight at each airport. Once the average delay per hour reaches that maximum, no increase in flights are allowed during that period. Several policies could result in such an outcome: self-imposed airline restrictions and airport demand management rules, for example. The objective is to apply plausible limits on the growth in delay or block times, and thereby estimate limits to growth in the NAS. For the busiest airports with significant delays at certain times of the day, the delay maximum is set at the peak hourly delay currently experienced at that airport. For other airports, the delay maximum is set at four minutes for arrivals. Recall that we are only analyzing good weather days, and the limits do not guarantee recovery periods after hours of maximum delay.

The results of the constrained forecast are shown in Figure 3. From current delay averages of about seven minutes per flight, by 2005 this rises to about 10 minutes. Recall that under the unconstrained scenario, average delays approached 18 minutes in 2005. By 2010, average delays for the TAF forecasts reach 42 minutes per flight, while under the constrained forecast that remain at about 10 minutes.

The forecasts depend on several key assumptions, in particular the forecast in average seats per aircraft. In recent years the FAA forecast assumed a reversal of the trend toward smaller aircraft, with a trend increase of about 0.5% annually built into their operations prediction. We use this assumption in the analysis, and compare the results to a scenario with zero growth in seats per departure. With limits on delay, the two scenarios generate similar average delays throughout the NAS, but show significant changes in growth in throughput. Figure 4 shows that under the FAA aircraft size assumption, the growth in revenue passenger miles (RPMs) will fall from around 58 percent by 2010 to about 47 percent. If no change in aircraft size is assumed, the 2010 growth falls to 36 percent above current levels. Put differently, about one-third of the projected growth will be eliminated due to the lack of airport capacity over the next ten years.

Figure 2. Flight Delay Under the Unconstrained Forecast

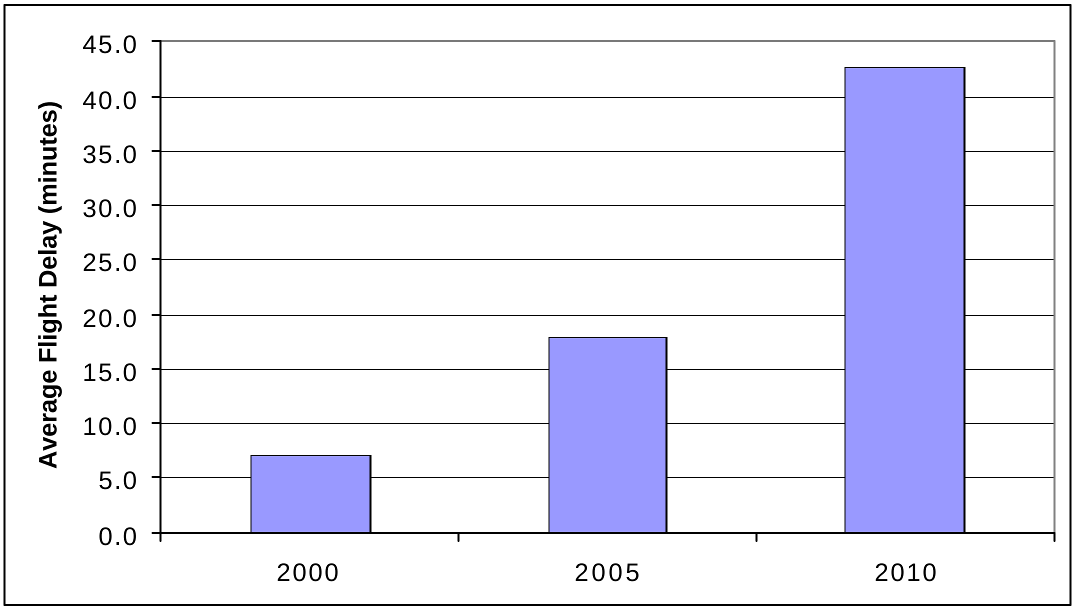
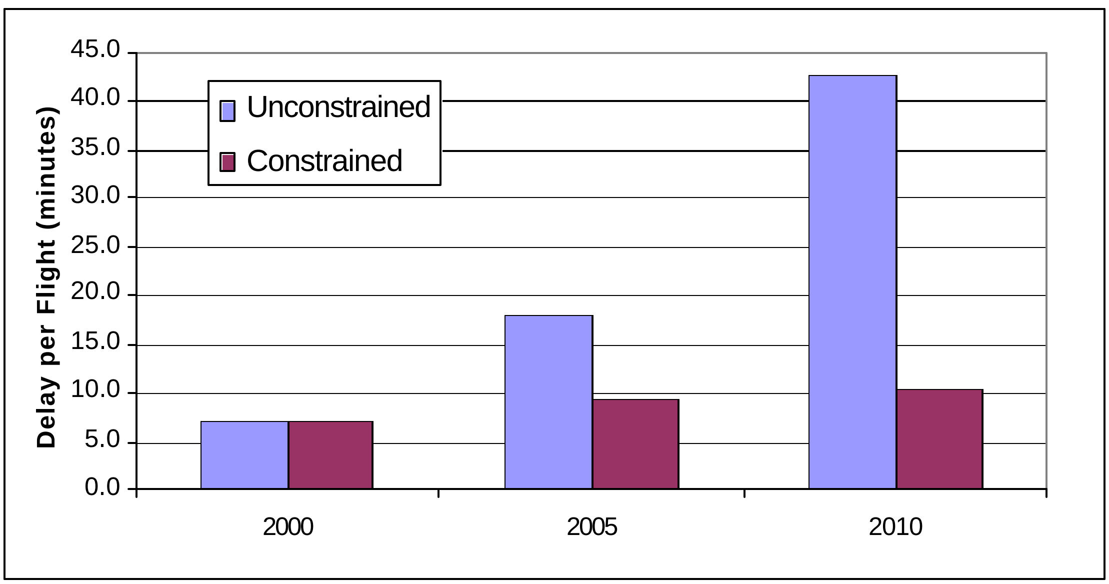


Figure 3. Constrained and Unconstrained Forecasts of Flight Delay



To evaluate the benefits of policies to recapture this lost growth, we considered the responses that we might expect to observe when capacity constraints become even more severe. These fall into three broad categories:

1. Allow demand to grow but ration available capacity through price increases;
2. Impose various demand management restrictions, such as schedule smoothing, aircraft size minimums, or slot restrictions; and
3. Move flights to other airports or uncongested times, such as at night.

We operationalize these policies by modifying the flight schedules, moving flights to different times of the day or to different airports, and by changing the required number of flights depending on aircraft size. The specific policy scenarios analyzed are:

- Establish new hub airports to mitigate congestion at existing hubs;
- Increase direct service to avoid congested hubs;
- Smooth out the schedule at airports by moving flights to off-peak times;
- Increase nighttime operations; and
- Accommodate growth by employing larger aircraft.

Figure 5 shows the impacts of these policies on the number of RPMs delivered in 2005 and 2010, using the FAA assumption of increased aircraft size. We also show a combined policy, which implements all of the above strategies. Two features are worth noting in Figure 5. First, only the combined policy - which requires significant changes in airline scheduling and fleet purchase strategies as well as airport investments - comes close to meeting the increase in demand. Second, the analysis understates the extent of the problem, and overstates the benefits of the policies, because it does not take into account the costs of those policies. Most of those policies require sizeable investments, and may not even be completed within the period analyzed.

The analysis also does not address the operational feasibility of the different policies. Schedule smoothing, for instance, requires a dramatic change in the economic basis of the hub and spoke system, which generates substantial economies of scale and resulting benefits to both airlines and passengers.

Figure 4. Congestion Reduces Growth From the FAA Forecast

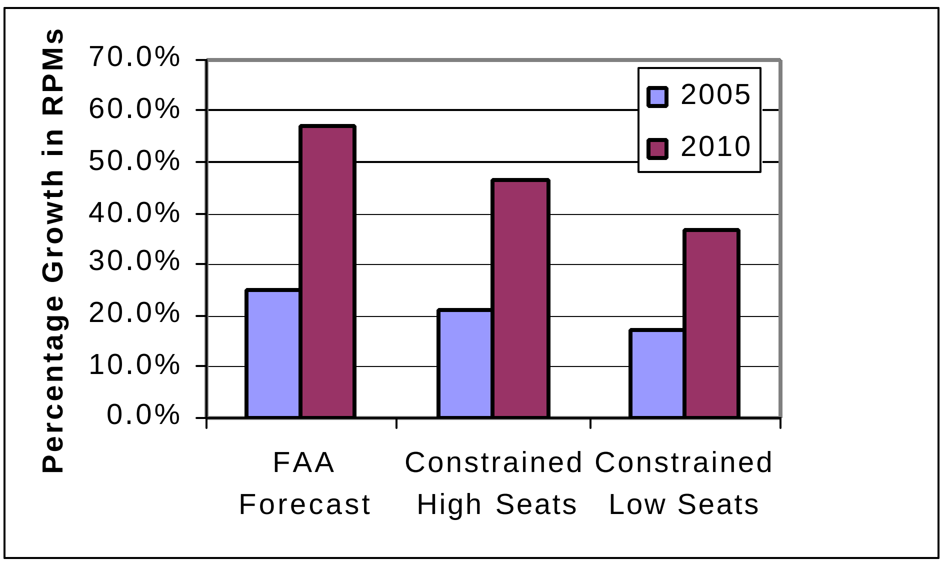
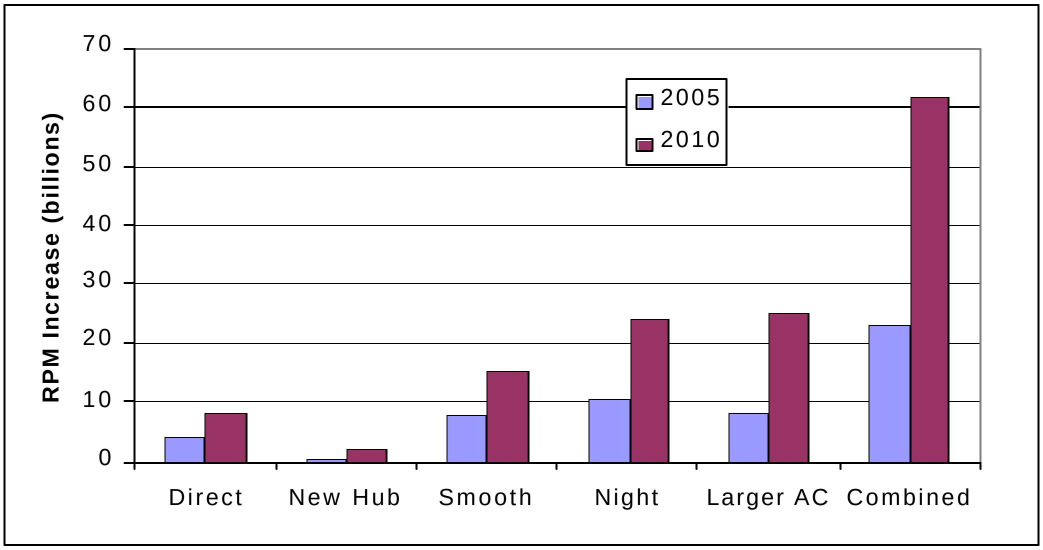


Figure 5. Increase in RPMs Over the Constrained Forecast



Another consideration to note is that average flight delay under each of the policies shown in Figure 5 is about the same 10 minutes per flight, since flights are only added if the average delay is below the threshold. Consequently, if one is comparing the benefit of the policies only in terms of delay reduction, they will show equal (and very little) value. The real value of the policies will be to enable continued growth in air travel. Figure 6 shows the lost RPMs under the two assumptions about aircraft size. Under the low seats per departure, for example, the industry will lose about 140 billion RPMs in that single year due to the capacity shortfall. As Figure 7 shows, the value of those RPMs is about $18 billion, using a yield of 13 cents per RPM. The costs of the greater delay and lost asset utilization should be added to the lost output to estimate the total cost of inadequate capacity.

Figure 6. Lost Airline Industry Output

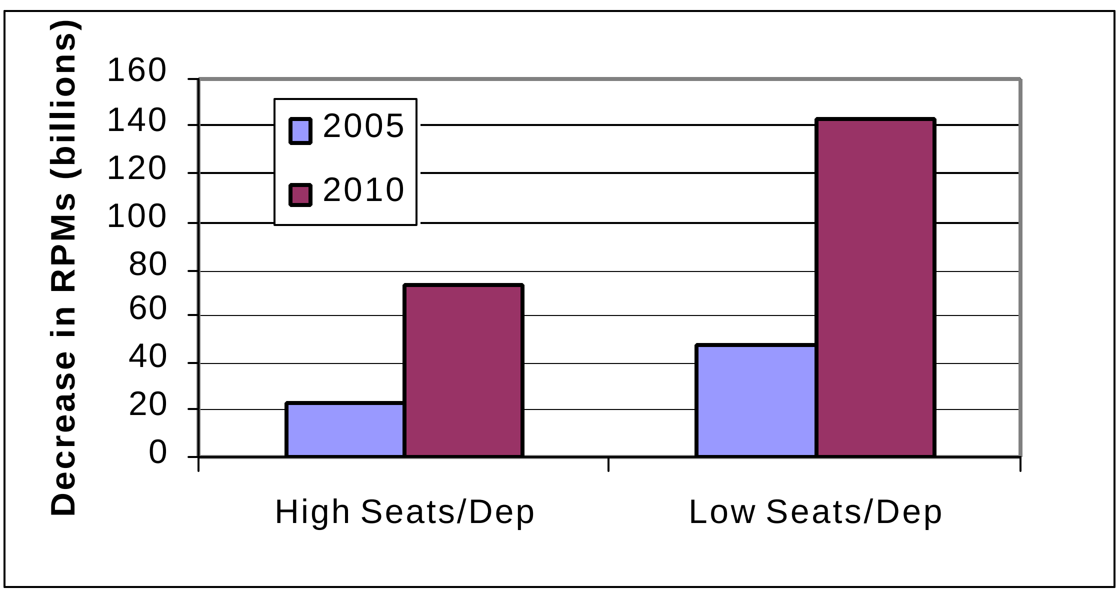
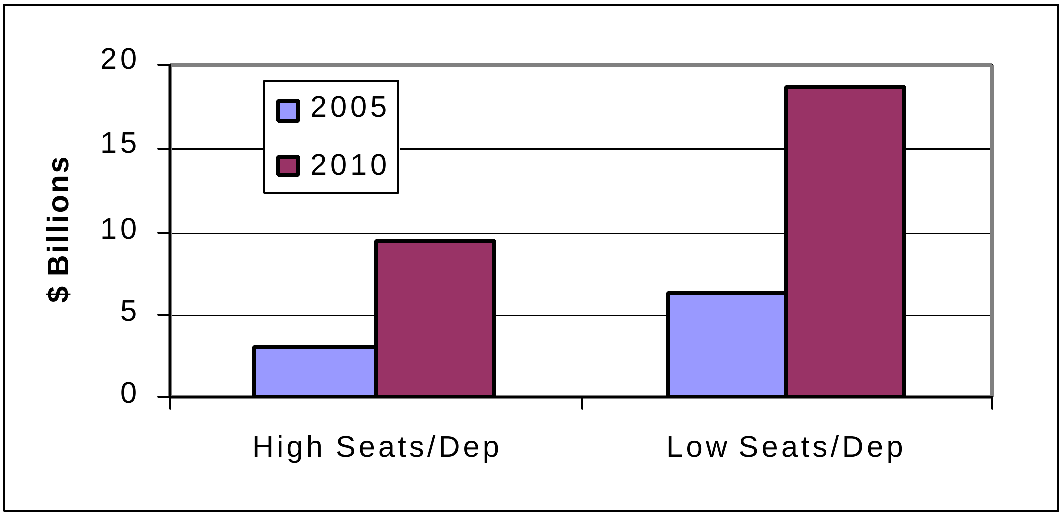
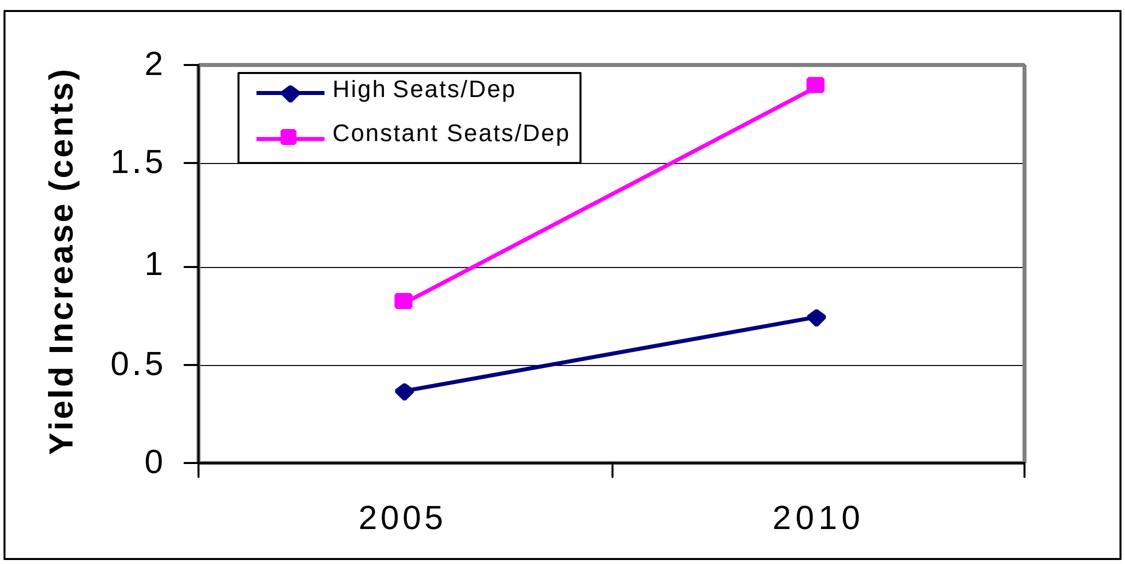


Figure 7. Value of Lost Industry Output



There is another important consideration to complete the analysis. As Figure 6 showed, industry output will be considerably less than the demand the industry expects to face in 2010. Since that demand will not disappear, the most likely result will be rising fares to reduce that demand and decrease the number of passengers and flights. Using the ACIM model, we estimate that under the low seats per departure scenario, yields will be nearly two cents higher on average. This increase, shown in Figure 8, is large enough to reverse the trend toward declining yields since the start of commercial air service. In practice, we expect to observe a reduction on the number of economy fares offered, driving up average yields.

Figure 8. Congestion Increases Fare Yields



In the broader perspective, not all of the news will be viewed as negative by key stakeholders in aviation. For airlines, while we predict their operating costs to rise, their fares will rise even more rapidly. With total system throughput significantly reduced from the levels forecasted by FAA and others, the airlines will not require as many aircraft. By 2010, our analysis predicts that the airlines will need about 600 fewer aircraft under the constrained forecast, and about 84 thousand fewer workers. Of course, other stakeholders may few view these predictions with a different perspective.

Conclusion

The recent focus on demand management in response to increases in system delays threatens to detract attention from the broader impact of airport and airspace congestion. While delays are certainly important and generate severe disruptions and increase costs, a narrow focus on delay reduction by policy makers threatens to sidetrack the need for sustained attention on growing capacity. Delay metrics do not capture the true economic benefits of ATM investments, which are to enable growth in air travel. Until the ATM community expands its metrics and focuses on benefits that can justify the required investments, it will continue to experience difficulty acquiring funding for system improvements.

Author Biographies

Peter Kostiuk is the Program Director for Technology Assessment at the Logistics Management Institute. His research in recent years has focused on quantifying the operational, safety, and economic impacts of aviation technology. He holds a B.A. from Rutgers University and received his Ph.D. in economics from the University of Chicago in 1986.