## Measuring Economic Impacts and Assessing the Benefits of Aviation Capacity Enhancements

The National Center of Excellence
NEXTOR
For Aviation Operations Research

NEXTOR MIT Meeting Aviation's Impact on the Economy April 2, 2004

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### Background



- Socio-Economic Demand Forecasting (SEDF) Study prepared for NASA-FAA JPDO\*
- → GRA was part of a team that examined the impact of insufficient aviation capacity on the economy (NASA, FAA, Volpe, LMI and GRA)
- → SEDF focus on system after next: 2015+
- Not a traditional economic impact study
- Work completed and submitted to JPDO at end of CY2003
- → Two analysis years: 2015 and 2025
- → Results not final—Illustrative

\*John Cavalowsky and Lee Olsen, "Socio-Economic Demand Forecast Study Supporting a National Plan to Transform the U.S. Air Transportation and Air Traffic Control Systems (Draft Report)," prepared for the Joint Planning and Development Office by FAA, NASA, Volpe Center, LMI and GRA (January 2004)

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# Impact of Aviation on the Economy



#### **The Value Proposition**

#### **Baseline Measurement**

- Traditional studies
- → National level data
- → Methodology issues
  - Idle resources
  - Substitutes
  - Is a higher economic impact better?

#### Air Transportation and the Economy

- Sectors/linkages
- Impact measures

#### **Assessing the Future**

- → Near-term—Cost and willingness-to-pay for delay reductions
- Longer Term—Impacts on fares, industry costs and other measures



# **Study Purpose**



- The SEDF study was prepared to provide the JPDO with a baseline assessment of the potential costs of insufficient aviation system capacity
- It states the value proposition and describes how air transportation is linked to various economic sectors
- It examines the potential costs to consumers from increased airfares and delays as well as the costs to airlines of increased delays
- It lays the groundwork for subsequent analyses of the benefits and costs of transforming the air transportation system



# **SEDF Study Approach**



### National value of air transportation Start

- Examine economic, quality-of-life, safety and security aspects of civil aviation's place in the U.S. economy.
- Provide an economic valuation.of the air transportation system



# Shortfall: capacity assessment vs. anticipated demand

• Identify critical gaps between today's plans for future capacity and tomorrow's anticipated demand, and identify barriers to meeting that demand.

#### Future air transportation demand

- Projected anticipated growth in aviation demand to 2015 and 2025 using FAA Long Range Forecast Model.
- Identify socio-economic growth constraints and enablers that may affect the growth and patterns of future air transportation demand.
- Identify possible futures for air transportation demand based on interactions of economic growth and socio-economic constraints and enablers.

# **Analysis Components**

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# **The Economic Value Proposition**



The Economic Value Proposition identifies costs to the nation of failing to transform the aviation system and expresses them in terms relevant to decisionmakers

- ✤ Increased air fares
- Decreased passenger trips
  - Commercial aviation
  - General aviation
- Less productive use of time
- Increased costs for goods that are moved by air\*

\*Capacity impacts on air cargo not considered by SEDF.



### **Alternative Ways to Value Air Transportation**



- > Economic impact studies—measure the current "value" of the industry in terms of economic output, GDP contribution, or similar measures:
  - Definition of the industry and static input-output relationships
  - Difficult to tie to demand-capacity relationships at the national level
  - Produces large numbers
- Economic value studies—provide more defensible measures of the benefits and costs of capacity:
  - Model airspace and airport capacities to project impacts of demandcapacity relationships
  - Benefit cost studies based on delay reduction work for short-term analysis
  - > Model industry and economic factors to project industry and passenger reaction to demand-capacity changes:
    - Delay costs
    - Fare and cost changes
    - Foregone travel
    - Induced demand
    - Embedded delays
    - Industry adaptation



# **Traditional Economic Impact Studies**



At national level, many locational benefits disappear

Studies assume availability of idle resources

\* "Employment or output multipliers that purport to measure the secondary effects of government expenditures on employment and output should not be included in measured social benefits and costs."<sup>1</sup>

Studies measure spending or costs

- > Not a benefit measure
- More costs (higher impact) assumed to be better
- Dollar spent elsewhere has same induced impact

Need productivity assumptions to develop realistic future impacts

Results of recent FAA study

- → \$172 billion direct impact
- → \$514 billion total GDP impact (5% of GDP)
- 11.6 million jobs

<sup>1</sup>OMB Circular A-94, p. 6.

<sup>2</sup>The Economic Impact of Civil Aviation on the U.S. Economy—Update 2000. Prepared for FAA by WSA.

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### Air Transportation and the Economy Base Year Measures





### **Air Transportation & Travel Providers**

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### **Gross Domestic Product and Gross Output by Industry in Current Dollars**



Gross Domestic Product by Industry in Current Dollars, 1998-2001 (\$billions)					Source: Robert J.	
	1998	1999	2000	2001	McCahill and Brian C. Mover "Gross Domestic	
Total Gross Domestic Product	8,781.5	9,274.3	9,824.6	10,082.2	Product by Industry for	
Transportation by Air	85.8	90.0	91.9	80.2	1999-2001," Survey of Current Business, November 2002, p.32.	
Percent Air	0.98%	0.97%	0.94%	0.80%		
Gross Output by	Source: Robert J.					

	1998	1999	2000	2001
Total All Industries	15,141.6	16,003.3	17,183.9	17,311.2
Transportation by Air	134.9	142.0	156.6	140.8
Percent Air	0.89%	0.89%	0.91%	0.81%

McCahill and Brian C. Moyer, "Gross Domestic Product by Industry for 1999-2001," Survey of Current Business. November 2002, p.36.

#### Passenger and Cargo Revenue of U.S. Carriers, 1998-2001 (\$billions)

Passenger	1998	1999	2000	2001
Domestic	64.0	67.0	74.0	64.4
International	17.0	17.3	19.5	16.5
Cargo	1998	1999	2000	2001
Freight and Express	10.7	11.4	12.0	11.9
Mail	1.7	1.7	2.0	1.1
Total	93.4	97.4	107.5	93.9

Source: Air Transport Association Annual Reports.

### GA Aircraft Total Annual Operating Cost By Operating Rule



Operating Rules	Total Hours Flown	Crew	Fuel & Oil	Maintenance	Average Hourly Variable Operating Costs	Annual Cost (Average Hourly Variable Costs <i>x</i> Total Hours Flown) (\$ millions)
Part 91	25,233,538	\$97	\$96	\$121	\$314	\$7,929.8
Part 125	659,870	\$684	\$1,058	\$911	\$2,653	\$1,750.4
Part 133	89,789	\$307	\$279	\$753	\$1,339	\$120.2
Part 135	1,880,898	\$211	\$236	\$365	\$812	\$1,527.0
Part 137	1,266,657	\$83	\$86	\$123	\$292	\$370.4
Total	29,130,756	\$116	\$124	\$153	\$394	\$11,463.5

Source: FAA General Aviation and Air Taxi Activity Survey, CY 2001 Conklin and deDecker, Aircraft Cost Evaluator, Spring 2003 http://www.planequest.com/; *Aircraft Bluebook*, Summer 2003 Aircraft Types and Price Guidelines 2002-2003

### 1997 Users of Air Transport Services – Final Demand (GDP) and Intermediate Uses (\$ millions)



#### **Output Approach**

#### **GDP** Accounts (Millions of 1997 \$) Personal Consumption Expenditures \$52,422 Gross Private Investment \$2.519 Changes in Private Inventories \$145 Exports of Goods and Services \$30,591 Imports of Goods and Services (\$14,786) Federal Government \$3.142 State and Local Governments \$4,517 Final Demand (GDP) Uses of Air Transport \$78,549 Air Transport Used for Deliveries to Final Users \$10,428 Air Transport Deliveries to Intermediate Users \$9.106

#### Total

#### \$98,083

Source: Department of Commerce BEA RIMS II Distribution Cost Tables.

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# Industries Using Air Transportation as an Input



Industry	Amount	Percentage
Manufacturing	\$14,127	27.2%
Services	\$11,665	22.5%
Air	\$7,200	13.9%
Wholesale and Retail Trade	\$6,092	11.7%
Finance, Insurance, and Real Estate	\$4,325	8.3%
Communications and Utilities	\$1,926	3.7%
Motor Freight and Warehousing	\$1,843	3.5%
Other <sup>1</sup>	\$1,783	3.4%
Construction	\$1,227	2.4%
Agriculture, Forestry, and Fisheries	\$695	1.3%
Mining	\$425	0.8%
Railroad and Passenger Ground	\$269	0.5%
Pipelines and Freight Forwarders	\$259	0.5%
Water	\$61	0.1%
Own-Account Transportation <sup>1</sup>	\$14	0.0%
State and Local Passenger Transit	\$9	0.0%
Total Intermediate Inputs	\$51.919	100.0%

#### Input Approach

The Transportation Satellite Accounts use of commodities by air transportation, 1996 (\$millions at producers' prices)

<sup>1</sup>"Other" consists of government enterprises (except State and local government passenger transit) and other input-output (I-O) special industries. For a description of I-O special industries, see Ann M. Lawson, "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Make, Use and Supplementary Tables," Survey of current Business 77 (November 1997): 46-67.

Source: Bingsong Fang, Xiaoli Han, Sumiye Okubo, and Ann M. Lawson, "U.S. Transportation Satellite Accounts for 1996," *Survey of current Business*, May 2000, p. 16.

### Financial Summary Commercial Service Airports



### (FY 2001, \$ billions)

Revenues	
Aeronautical operating revenue	\$5.3
Non-aeronautical operating revenue	\$4.7
Non-operating revenue	\$4.5
Total Revenues	\$14.5
Expenses	
Operating expenses	\$6.2
Non-operating expenses	\$2.7
Depreciation	\$2.4
Total Expenses	\$11.3
Net Revenues less Expenses	\$3.2

Source: FAA Form 5100-127, Operating and Financial Summary for Airports with Commercial Service; many of these fees are paid for by commercial and general aviation and may be reflected in their costs.



# FAA FY 2002 Budget and Trust Fund



Budgets of FAA Programs	Amount (\$millions)
Airport Improvement Program	\$3,173
Facilities and Equipment	\$3,006
Research, Engineering and Development	\$245
Operations and Maintenance	\$7,076
Total	\$13,500
Other Data	
Total Tax and Fee Revenue	\$9,031
Trust Fund Interest	\$860
FAA Budget from Trust Fund	\$12,699

Source: FAA APO Trust Fund Analysis. Most aviation excise taxes are not included in the costs of commercial aviation providers.



### **Tourism Demand by Commodity in 1997** (\$ millions in Purchasers' Prices)



Commodity	Tourism Demand 1997	Percentage
Hotels and Lodging Places	\$74,103	16.07%
Eating and Drinking Places	\$61,022	13.23%
Passenger Rail	\$1,296	0.28%
Passenger Bus and Other Local Transportation	\$4,841	1.05%
Taxicabs	\$4,298	0.93%
Domestic Passenger Air Fares	\$64,856	14.06%
International Air Fares	\$45,156	9.79%
Passenger Water	\$4,384	0.95%
Auto and Truck Rental	\$21,092	4.57%
Other Vehicle Rental	\$485	0.11%
Arrangement of Passenger Transportation	\$3,766	0.82%
Recreation and Entertainment	\$32,202	6.98%
Participant Sports	\$5,311	1.15%
Movie, Theater, Ballet and Musical Events	\$6,511	1.41%
Sports Events	\$1,763	0.38%
Travel by U.S. Residents Abroad	\$53,451	11.59%
Gasoline and Oil	\$14,371	3.12%
Personal Consumption Expenditure Nondurable Commodities Other Than Gasoline and Oil	\$52,745	11.44%
Parking, Automotive Repair, and Highway Tolls	\$9,514	2.06%
Total	\$461,166	100.00%

Source: David I. Kass and Sumiye Okubo, "U.S. Travel and Tourism Satellite Accounts for 1996 and 1997," *Survey of Current Business*, July 2000, p. 10.





Air Cargo by Value Accounts for a Large Share of Merchandise Trade

	Total Weight	Weight by Air	Percent Air Weight	Total Value	Total Value by Air	Percent Air Value	Value per Pound: Air
Imports	817,418	3,557	0.44%	\$811,241	\$273,176	34%	\$77
Exports	316,913	2,118	0.67%	\$378,462	\$195,040	52%	\$92
Total	1,134,332	5,675	0.50%	\$1,189,703	\$468,216	39%	\$83

Source: U.S. Department of Commerce, U.S. Imports and Exports of Merchandise 2002, February 2003.



### U.S. International Travel Transactions Year 2001 and Year 2002 (\$ millions)



	2001	2002	Change: 2002 less 2001				
Exports of Goods and S	Services and Inc	come Receipts					
Travel by foreign residents to U.S.	73,119	70,320	-\$2,799				
Passenger fares paid to U.S. carriers for international flights	18,007	17,443	-\$564				
Imports of Goods and S	Imports of Goods and Services and Income Receipts						
Travel by U.S. residents to foreign countries	-60,117	-59,303	\$814				
Passenger fares paid to foreign carriers for international flights	-22,418	-20,993	\$1,425				
Trade Balance							
Travel	13,002	11,017	-\$1,985				
Passenger Fares	-4,411	-3,550	\$861				
Trade balance	8,591	7,467	-\$1,124				

Source: U.S. Bureau of Economic Analysis, "U.S. International Transactions: Fourth Quarter and Year 2002," News Release BEA 03-07.

### **Employment and Revenues in the Air Transportation Sector (1997 Data)**



Sector	Employment	Revenues (\$millions)
Airport Operations <sup>1</sup>	62,138	\$3,293.6
Air Traffic Control <sup>3</sup>	502	\$43.5
Other Airport Operations	61,636	\$3,250.1
Other Support Activities for Air Transportation <sup>1</sup>	53,318	\$5,856.6
Flight Training <sup>1</sup>	12,260	\$921.3
Large Certificated Carriers <sup>2</sup>	656,243	\$109,567.6
Air TransportationAll Others <sup>1</sup>	89,125	\$20,249.0
Scheduled Air Transportation	65,988	\$16,284.9
Nonscheduled Air Transportation	23,137	\$3,964.1
Total	873,084	\$139,888.1

Source: <sup>1</sup>http://www.census.gov/epcd/ec97/us/US000 48.HTM and <sup>2</sup>http://www.bts.gov/oai/employees/1997emp.html

<sup>3</sup>Excludes FAA, NASA AND DOT employment providing inputs to air transportation

### FY 2004 Transportation Security Administration Budget Proposal



Aviation Security Passenger Screening Baggage Screening Security Direction & E	Enforcement	\$1.80 Billion \$944 Million \$1.47 Billion	\$4.22 Billion
Administration, Intelligence, and Other Modes	R&D	Total	<u>\$506 Million</u> <b>\$4.82 Billion</b>
Proposed TSA Workford	ce		
Passenger Screeners	6	29,800	
Baggage Screeners		18,300	
Other Employees		<u>10,900</u>	
	Total	59,000	





Year	RPMs (billions)	Load Factor Percentage	Seats Per Aircraft	Real Yield (2002 \$)	
Domestic					
2000	512.3	70.5%	129.6	\$0.1470	
2015	780.8	74.5%	128.5	\$0.1084	
2025	1,116.3	75.0%	134.6	\$0.0964	
International					
2000	181.8	76.0%	230.6	\$0.1095	
2015	293.3	76.6%	229.4	\$0.0909	
2025	446.6	76.5%	231.7	\$0.0882	

Source: Adapted from FY 2003 FAA long-range forecast model



# **Economic Methodology Overview**



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# **Estimating Changes in Surplus**

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- A "constrained" schedule is produced in which not all of the demanded flights actually materialize
- The flights that were eliminated have economic value
- We translate the lost flights into lost seats (revenue passenger miles)
- We value the lost RPMs using the concept of "consumer surplus"
- We also quantify the cost of the delay that will exist due to capacity shortages
  - → Airline variable operating costs
  - Passenger value of time



# Average Delay per Flight with Unconstrained Demand





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### **Capacity Shortfall Impacts**



### Percentage Reductions of Flights and RPMs (Single Scenario Day) Baseline Demand Forecast



	<b>Domestic Air Carrier</b>		International Air Carrier		<b>General Aviation</b>	
	Flights	RPMs	Flights	RPMs	Flights	RPMs
2015	6.34%	4.86%	1.13%	0.75%	4.55%	2.96%
2025	15.75%	14.54%	3.90%	1.59%	9.14%	6.21%

Source: LMINET analysis

# Baseline Annual Results (\$ billions) in 20015 and 2025



Future NAS Performance and Shortfall Metrics	2015	2025
Lost value from foregone flights for domestic air travel (domestic consumer surplus)	\$3.30	\$13.14
Lost value from foregone flights for international air travel (international consumer surplus)	\$0.25	\$0.80
Lost value from foregone flights for general aviation	\$0.07	\$0.18
Total annual lost consumer surplus	\$3.62 billion	\$14.1 billion
Additional cost to passengers due to increased delays	\$2.91	\$5.52
Total annual loss	\$6.53 billion	\$19.6 billion

Source: LMINET analysis

Notes: 1) Assumes impacts on producers offset by resource cost changes

- 2) Changes in consumer surplus depend on elasticity
- 3) Uses constant 2002 dollars, undercounted



### Annual Passenger Impacts (2015-2025) Baseline Demand Forecast (constant 2002 \$ billions)



Source: Extrapolation from LMINET analysis

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Cost to nation of capacity constraints can be large

Costs and impacts will not materialize all at once; rather they will come through gradual increases in fares along with diminished service quality

→ Results reflect work to date; analysis can be refined

→ Questions?





## Backup



# **Consumer Surplus**





Setting (S',P',Q') and Capacity Accommodated Setting (S,P,Q)

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