



Air Transportation After September 11th

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Terrorist Mass Murder: New 'Weapon of Choice'. Grotesque transformation of airliners into **weapons of mass destruction** stirs profound reassessment of U.S. strategy and national security (*The New York Times*)

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March 2002



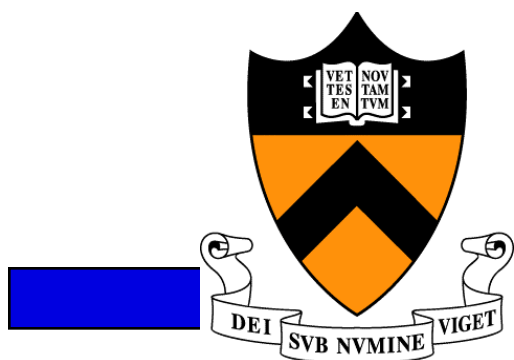
A Critical Assault on Liberty, Justice, Peace, and Freedom of the Skies



**Sixteen of the
19 bombers
were in US
on legal visas**

**Visa extensions sent to 2
hijackers by INS in March, 2002**

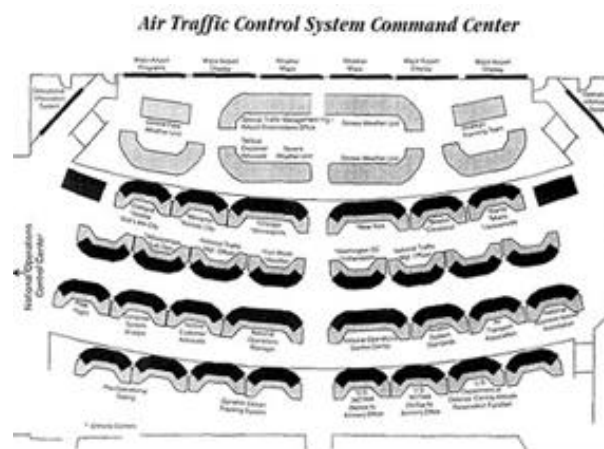
- Conspiracy to carry out criminal acts
- Terrorists took advantage of our open society to cause it great harm
- Instruments of terror were almost entirely of American origin
- Preserving justice and peace may restrict liberty and freedom
- Difficult balance between security and preserving individual rights
- Law enforcement vs. more restrictive laws
- Adapting to the diversity of evil



The Herndon Crisis: 11 Aircraft Unaccounted for *(AW&ST, 12/17/01)*

- 8 am: AAL 11 (B-767) takeoff
- 8:01: UAL 93 (B-757) takeoff
- 8:14: UAL 175 (B-767) takeoff
- 8:21: AAL 77 (B-757) takeoff
- 8:30: Possible hijacking reported
- 8:46: AAL 11 impact on WTC 1
- 9:03: UAL 175 impact on WTC 2
- ~9:15: 11 aircraft with “unusual information”, including AAL 77 and UAL 93
- 9:26: Nationwide departures halted
- 9:41: AAL 77 impact on Pentagon
- 9:45: All aircraft directed to land immediately @ nearest airport

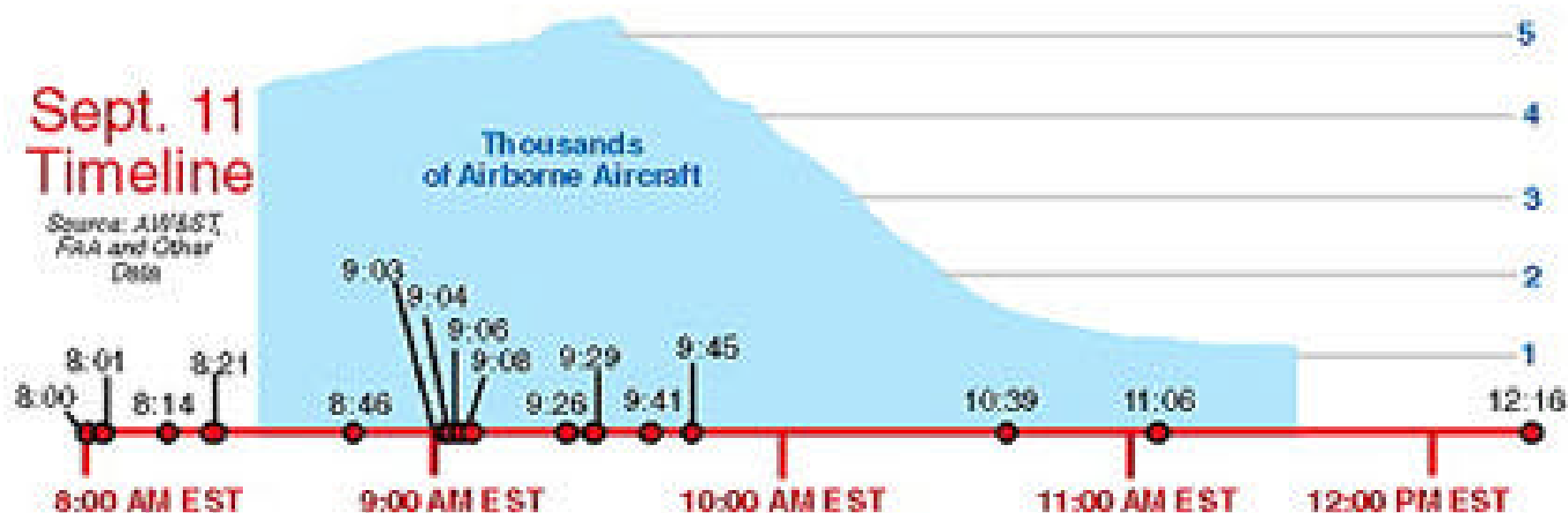
- 10:10: UAL 93 crash in PA --
9 “unusual” aircraft still airborne --
concern for attack on White House
and Air Force One
- 10:39: All airport operations halted
- 11:06: All NAS operations suspended
- 12:16: Airspace is clear, except for
military aircraft





National Airspace Shutdown: Timeline

(AW&ST, 12/17/01)



The FAA reopened the National Airspace System to commercial and private aviation on Sept. 13 at 11 a.m. EDT



Terrorist Threats to Commercial Aircraft



■ On-Board Terrorists

- Trained pilots among passengers
- Personal effects, carry-on luggage
 - » Hand weapons
 - » Explosives
- Air crew
 - » Malicious intent
 - » Suicidal goal

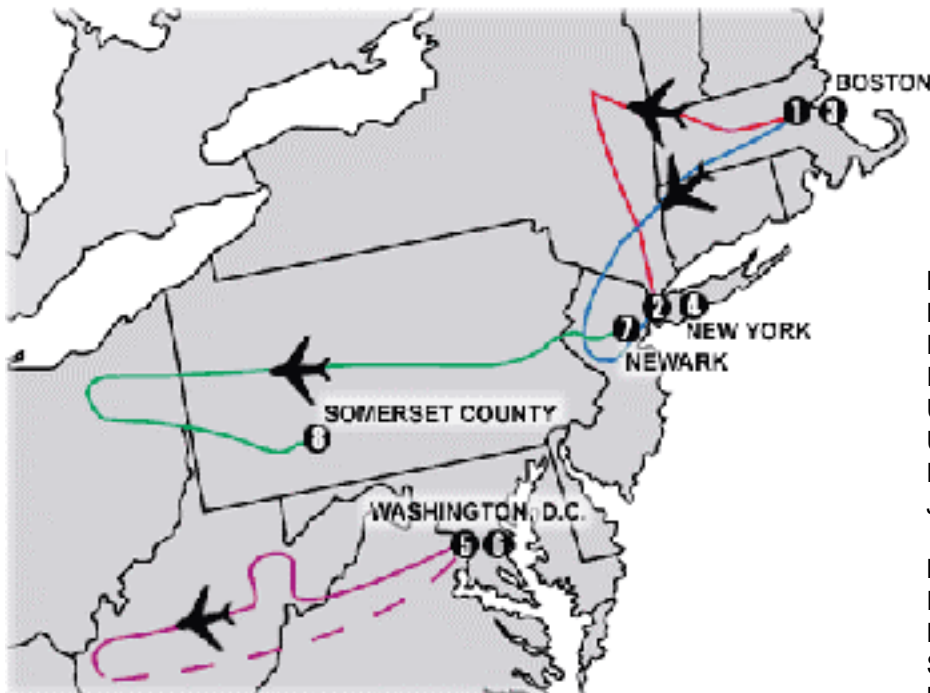
■ External Terrorists

- Service workers
 - » Aircraft maintenance
 - » Food carts
- Anti-aircraft weapons
 - » Stingers
 - » Kamikaze aircraft
 - » Lasers

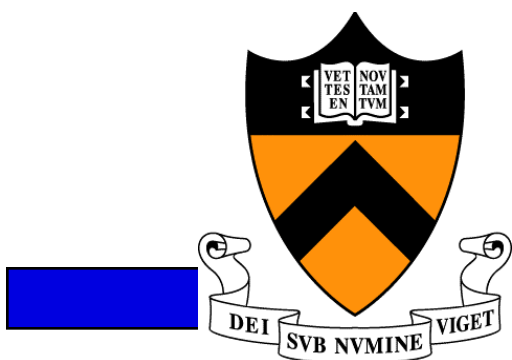


Was the Global Positioning System (GPS) an Enabling Technology for the Attacks?

FLIGHTS OF DESTRUCTION



Battery Life	8-24 hr
Number of User Waypoints	500
Display Size	2.2 x 1.5
Receiver**	12 channel
Unit Size	2.32 x 5 x 1.62
Unit Weight	9 oz
Database Options	Americas, Pacific Intl, Atlantic Intl.
Jeppesen Database***	Full, plus ARTCC and FSS frequencies
Moving Map	YES
Basemap	20 MI
Pixels	100 x 160
Display Type	High-Contrast FTN 4 level gray
Standard Accessories	Dash mnt, batteries
Built-in H.S.I.	YES
IFR or VFR	VFR
MSRP****	\$549 (street: \$475)



Government Security Actions

(Aerospace America 2/02)

- DoT Rapid Response Team reports on aircraft and airport security (10/01)
- Air Transportation Safety and Stabilization Act (10/01): \$5B cash, \$10B loan guarantees, *de facto* re-regulation of recipients
- Aviation and Transportation Security Act (11/01)
- Transportation Security Administration established, separate from FAA and NTSB
 - 10-minute delay (max) at check-in
 - Comprehensive screening of all checked baggage and cargo
 - Several thousand air marshals to be deployed by June 1, 2002
 - New focus on collecting intelligence
 - Federalization of screeners, giving them union protection
- Disparity between Congressional mandates and realistic goals
- Restructuring of INS, need for better cooperation among agencies



Passenger Screening at the Airport

Congressman Forced to Strip at Airport (*NYT*, 1/8/02)



Suspect Walks Off as Explosive is Detected (*NYT* 1/31/02)

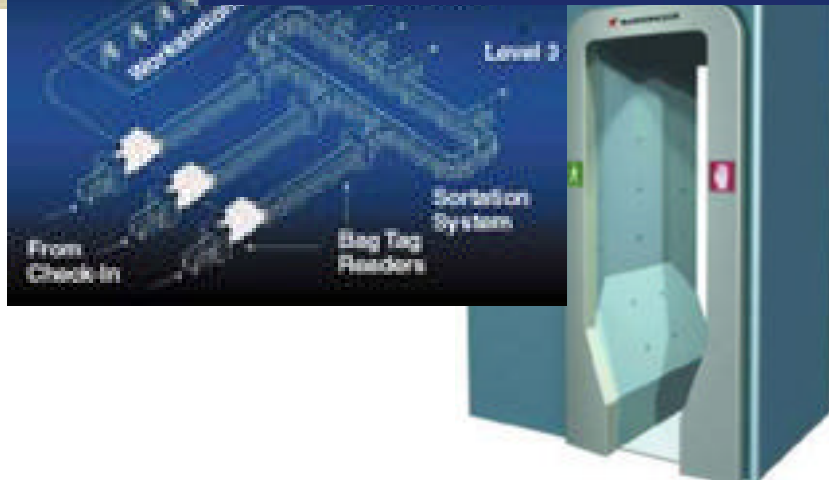
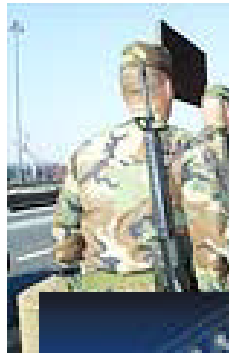
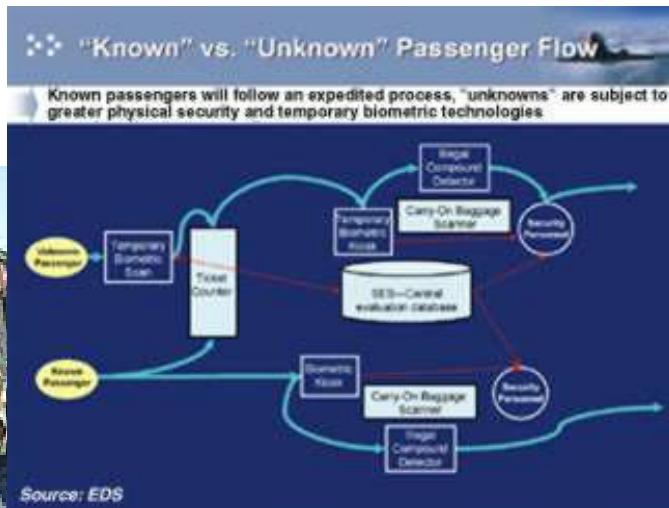


- Increased check-in delays
- Intermittent concourse shut-down and re-screening
- Correct vs. politically correct policies
- Security vs. invasion of privacy and harassment
- Profiling, background check, personal interview (*El Al* experience)
- Cross-over point for short-range trips shifts -- other transportation modes become more attractive

*“Flying simply is not fun anymore.
It’s just too unpleasant.”
Andy Rooney, 60 Minutes, 2/10/02*

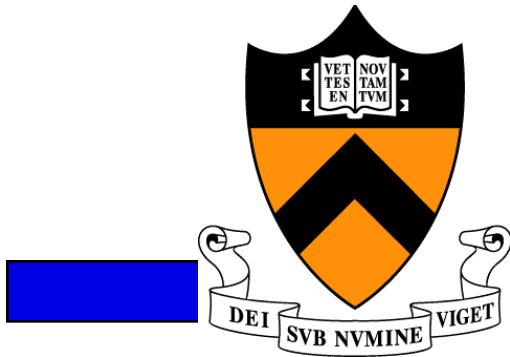


Airport Security Systems and Operations



- Multi-tier check-in for known and unknown passengers
- Security procedures for air crews tailored to their status
- Low-tech solutions: baggage identification, bomb-sniffing dogs
- High-tech solutions: ID cards, biometrics, explosives detection
- No dearth of proposals: which to choose?
- Air terminal renovations for increased security
- Is BIG BROTHER our friend after all?

Security and Surveillance on Aircraft



- In-flight measures: last line of defense
- Strengthened cockpit door, defensive maneuvers, cabin depressurization, crew ID interlocks on controls, guns, Tasers
- Crew vigilance and procedures
- Defensive actions of full-time and “reserve” air marshals, athletic passengers
- Cockpit and cabin video cameras, transponders, ACARS, CVRs, DFDRs: independent power, inaccessible circuit breakers

United Airlines orders 1300 Tasers



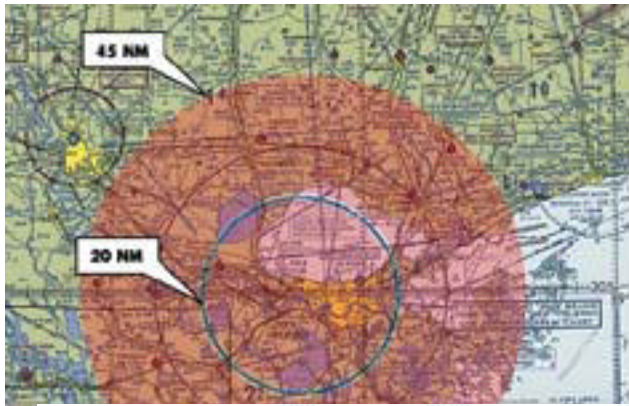
Remote Control of a Commandeered Aircraft is Not a Good Idea



- Frequency of hijacking incidents
- Time to develop systems
- Cost of airborne and ground-based components
- Feasibility of retrofit to older aircraft
- Maintenance of systems
- Training of ground personnel and air crews
- Reliability of systems (e.g., *Predator* and *Global Hawk* losses)
- Likelihood of causing accidents where no terrorism was present



Automated Avoidance of High-Value Sites is Not a Good Idea



- Analogy to ground proximity warning, terrain avoidance, traffic-collision avoidance systems (which assume cooperative crew)
- All of prior concerns, plus ...
- Definition of high-value sites to be protected
- Radius and altitude of protection bubble
- Navigation around contiguous bubbles
- Sensing/estimation of site location
- Definition of safe avoidance flight paths
- Interface between automatic and manual control systems



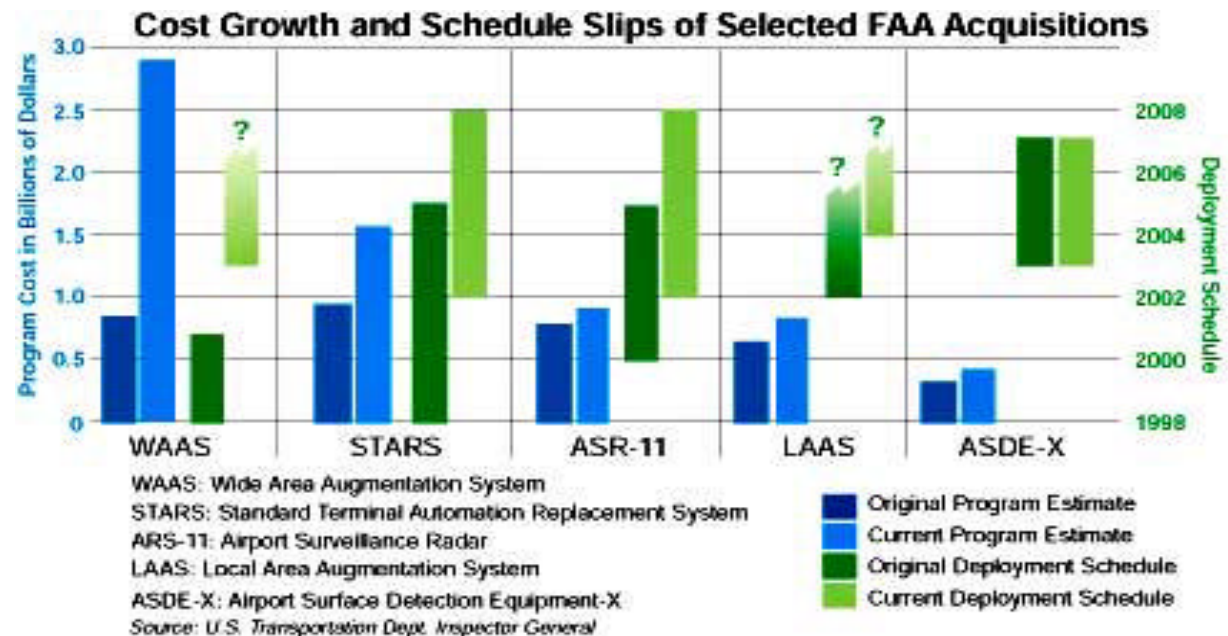
Enhanced Real-Time Monitoring is a Good Idea



- Early warning against use of aircraft as WMD or destruction of aircraft
- Downlink cockpit and cabin video, digital flight data
- Increased knowledge of aircraft intent
- Cost efficiency of 24/7 air patrol vs. “hot” alert
- **But**
- Will fighter/homeland defense aircraft shoot down threatening aircraft?
- Can anti-aircraft installations protect high-value sites?



Air Traffic Control and the National Airspace System (NAS): Present



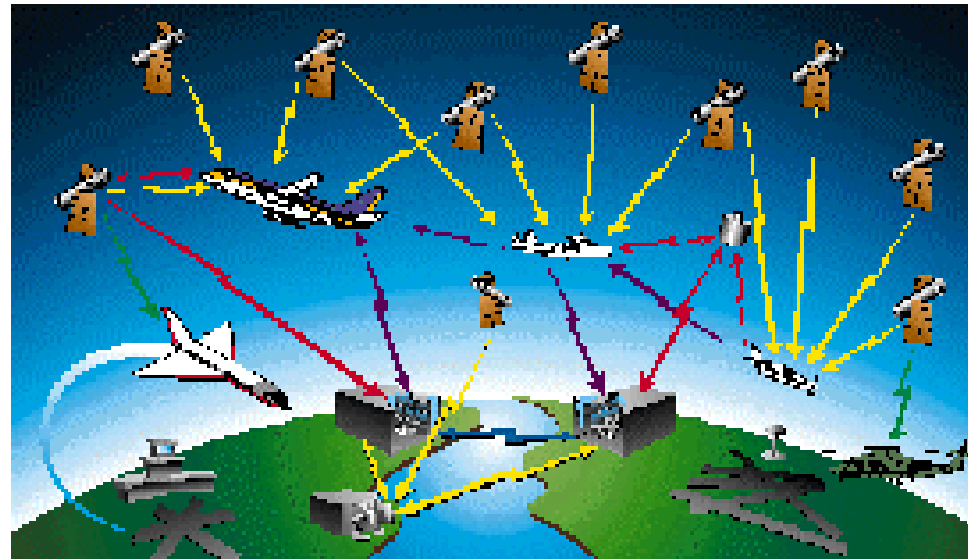
'Huge' Budget Shortfall Looms for FAA

(AW&ST, 3/18/02)

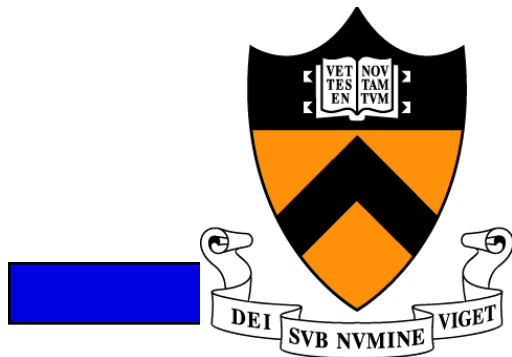
- Reduced number of flying aircraft (-15-20%)
- Short-term (18-month) reprieve for NAS growth rate; capacity crunch by 2010
- Security takes budget priority over advanced ComNavSurv systems
- System development progressing at a glacial pace, though some hardware/software upgrades in place



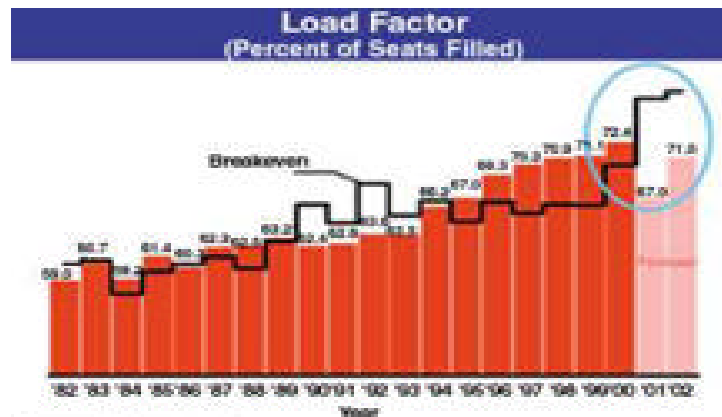
Air Traffic Control and the National Airspace System: Future



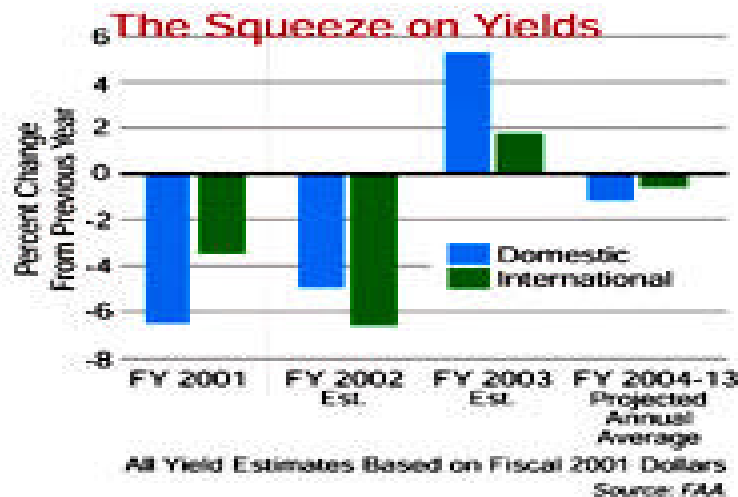
- **Increased reliance on GPS**
 - WAAS, LAAS
 - Selective Availability, level of signal degradation
 - Deprivation of service in national emergency? (e.g., jamming, outage)
- **Russian and European alternatives (GLONASS/GNSS)**
- **Enhanced telemetry (e.g., ADS-B, IFF, Mode S, leading to TCAS-4)**
- **Need for collaborative air traffic management, increased robustness**



Impact on Commercial Airlines



Source: Air Transport Assn.



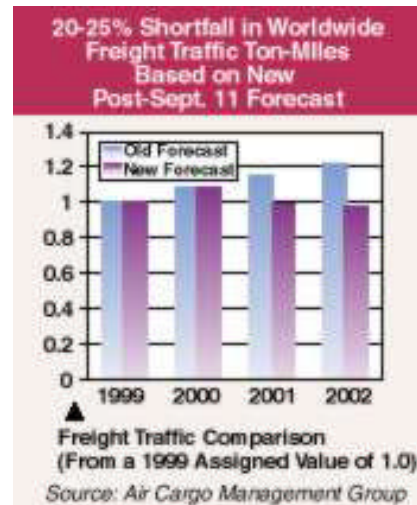
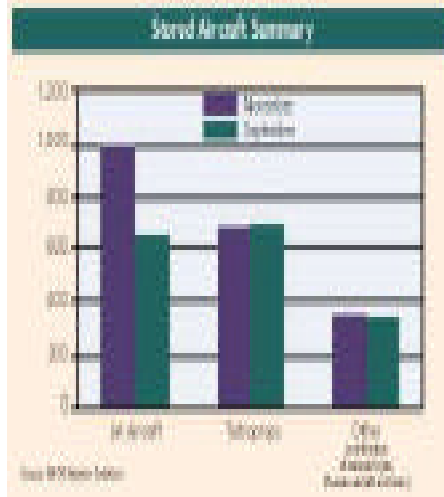
(AW&ST, 3/18/02)

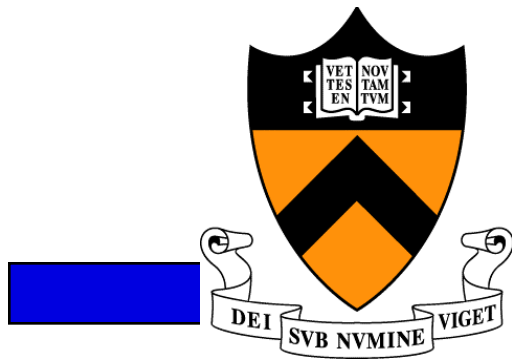
- Fear-of-flying factor
- Schedule reductions of ~15%
- Load factors recovering but still down 20%; downsizing of aircraft in many markets
- Largest-ever losses; layoffs of 90,000, lower fares to lure flyers back
- High carrying costs, low margins, need for high cash flow
- Perennial labor issues, fare wars, etc.
- Alliances, consolidation, and bankruptcy; survival of the fittest
- On-time performance improved: 85% (11/02) vs. 73% (11/01)



Much of the Commercial Fleet is Grounded

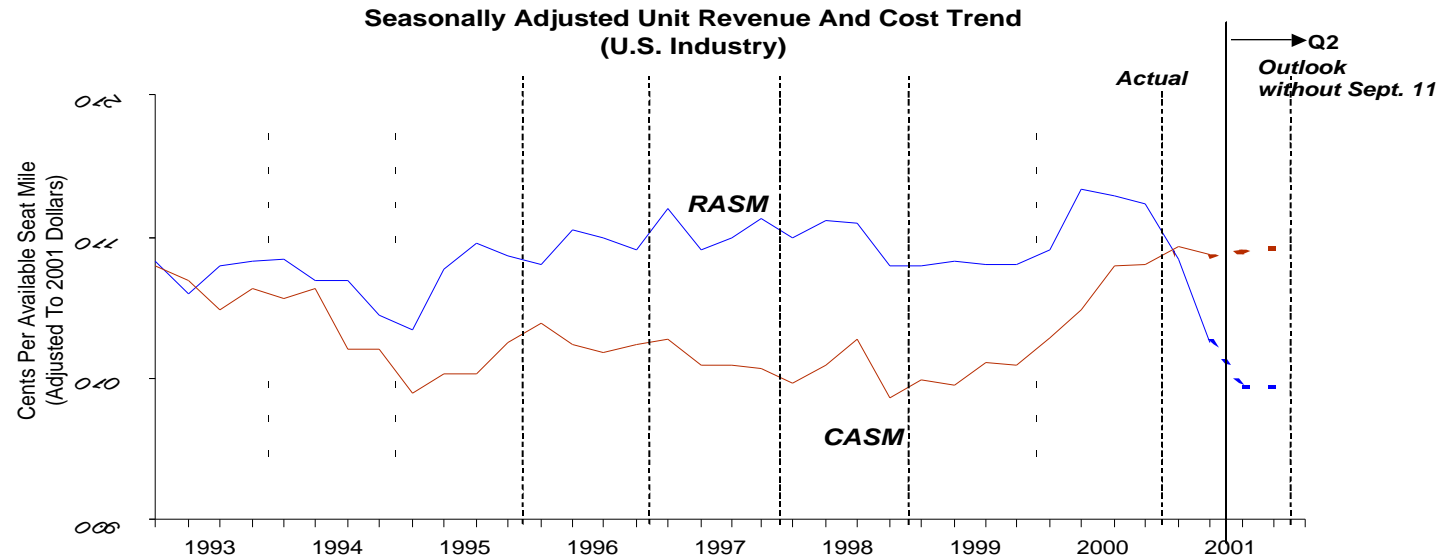
- 7,000 commercial aircraft; airlines park up to 2,000: B-727s, DC-10s, B-737s, MD-11s, DC-9s, MD-80s
- Older, less-efficient aircraft mothballed, put up for sale
- Major upgrade to world's air freighter fleet foreseen





Economic Status of Airlines Before 9/11

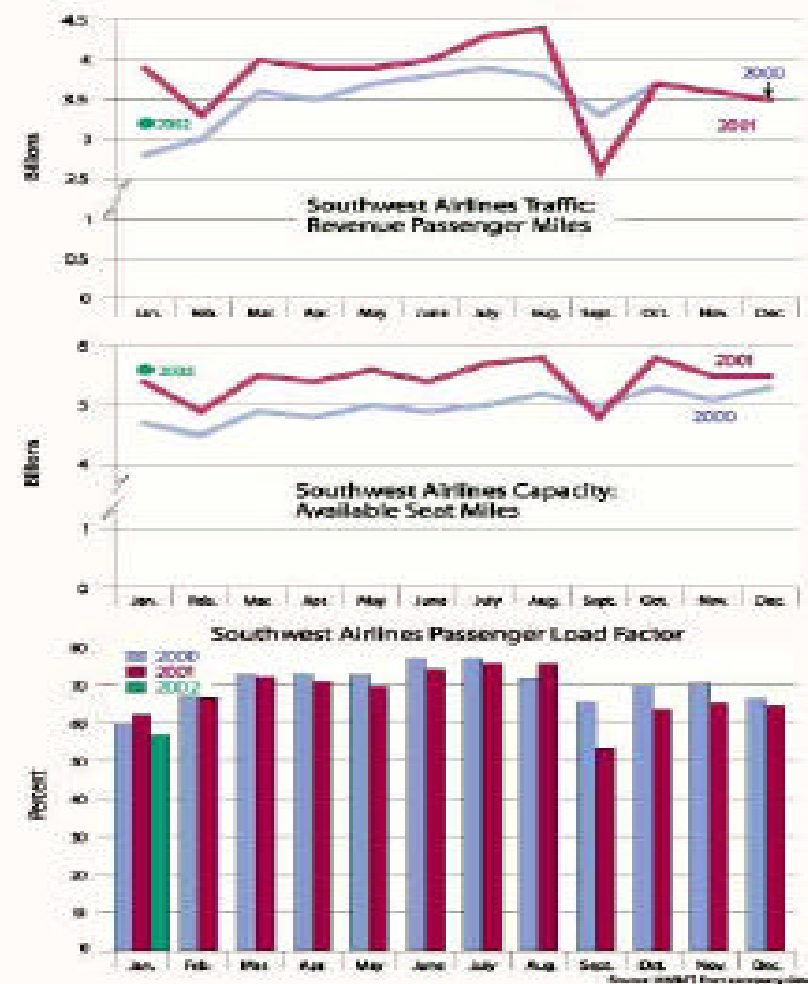
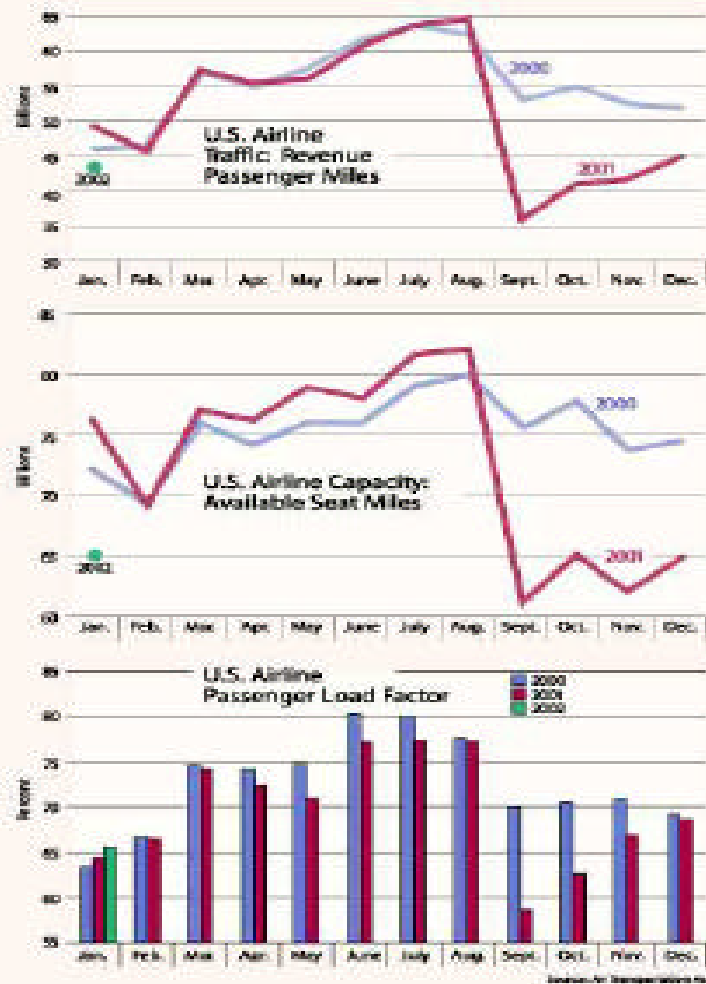
(J. Wangermann, Booz-Allen-Hamilton, 1/02)





Traffic, Capacity, Load Factor: Network Airlines vs. Southwest Airlines

(AW&ST, 3/18/02)

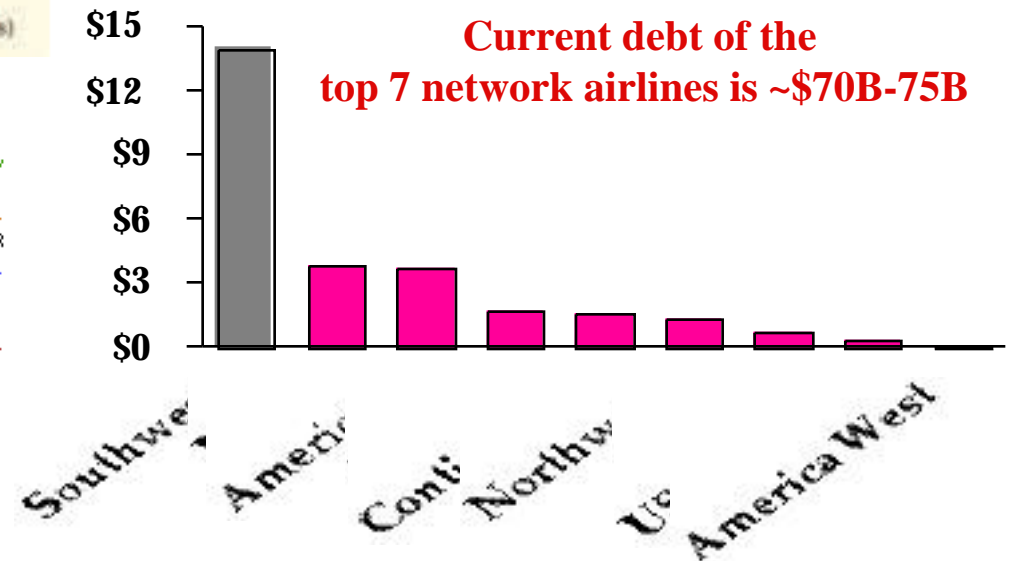
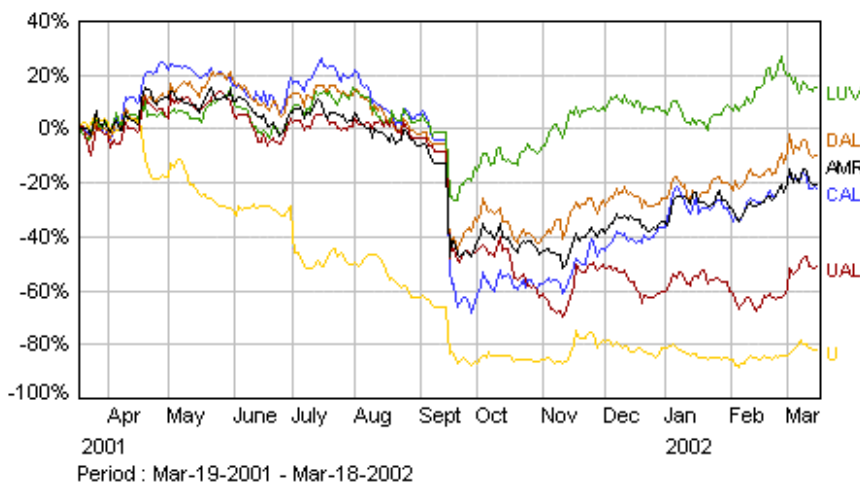




Earnings and Market Value of Commercial Airlines



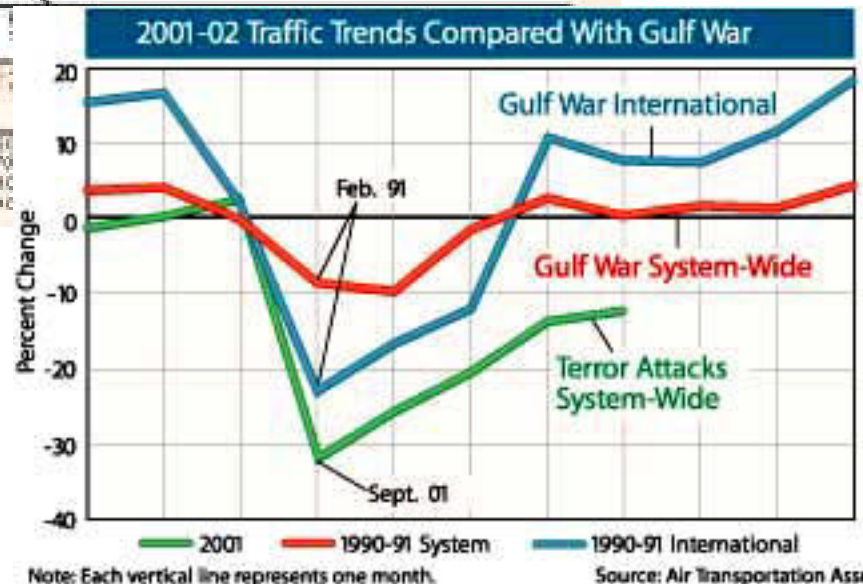
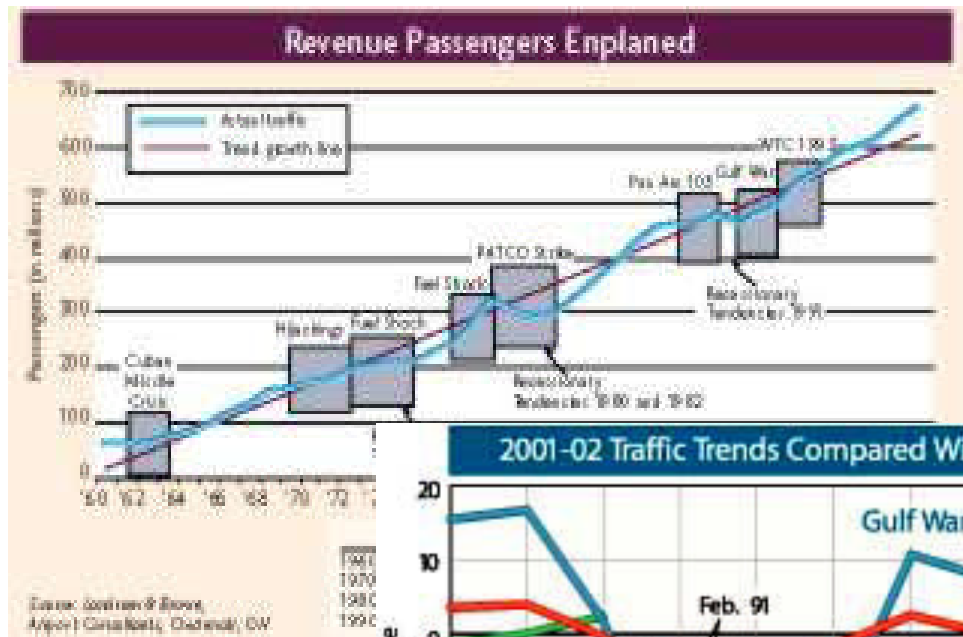
- **UAL earnings/share estimates:** \$10.50 ('98), \$10.06 ('99), \$2.38 ('00), **-\$36.33 ('01), -\$22.28 ('02), -\$7.50 ('03)**
- **AMR estimates:** \$7.52 ('98), \$6.26 ('99), \$4.65 ('00), **-\$3.71 ('01), -\$4.09 ('02), \$2.70 ('03)**
- **LUV estimates:** \$0.52 ('98), \$0.59 ('99), \$0.79 ('00), \$0.64 ('01), \$0.64 ('02), \$0.98('03)





Effect of Major Events on Traffic and Passenger Enplanements

(AW&ST, 11/19/01, 3/18/02)

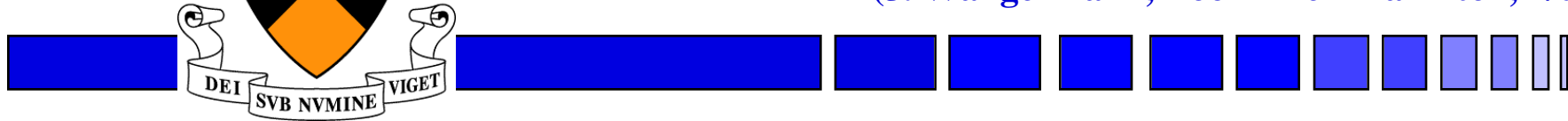


- Historically, traffic rebounds after negative events
- 2-year hiatus in revenue-passenger-mile (RPM) growth foreseen
- Effect of more successful attacks? widened war against terrorists? airline bankruptcies? law suits related to 9/11?
- Substitution of teleconferencing, e-mail, etc. for long-distance travel



Possible Airline Industry Directions

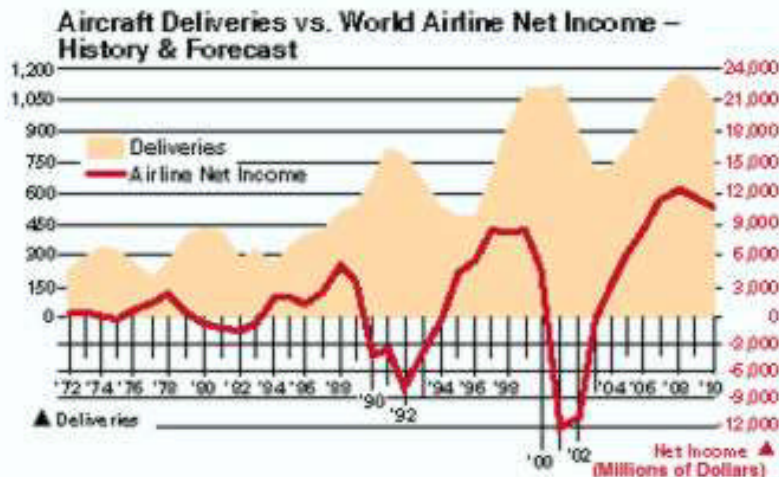
(J. Wangermann, Booz-Allen-Hamilton, 1/02)



- Degree of
"Unbundling"
Required*
- Low**
- Re-think customer segmentation (behavior, trip purpose, actual or potential profitability, not just miles flown)
 - Re-focus/redefine services at each stage of travel on customer segments (reservations, pre-travel, airport, onboard, etc.)
 - Focus delivery mechanisms to counter niche players:
 - Less cross-subsidy across segments
 - High density, no-frills services on larger aircraft
 - 4-class service (First Class, Business, Premium Economy, Economy)
 - Trunk -> Regional shift
- High**
- Create global brand through partnerships



Near-Term Outlook Grim for Airframe and Parts Manufacturers *(AW&ST, 1/28/02)*



Source: The Airline Monitor

Note: Orders and deliveries include regional jets

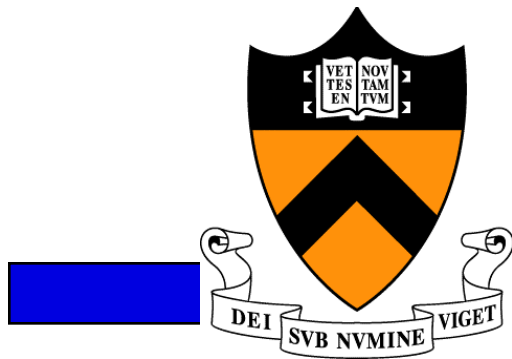
- 5 years to full economic recovery
- Parked aircraft return to service before ordering new aircraft
- “Not a going-out-of-business scenario”
- Most suppliers have a diversified customer base
- Lag between airline turn-around and new aircraft orders
- Bankruptcy of a single large airline would have major effect
- Divestiture, mergers, and acquisitions; Enron effect



How are Airframe and Parts Manufacturers Responding?

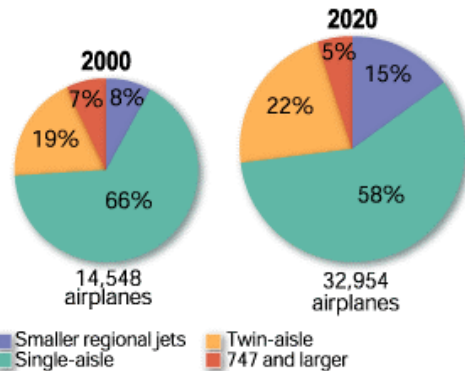


- **Boeing** cuts delivery estimates by 150 aircraft in next 15 months; layoffs of up to 30,000 people, proceeds with *Sonic Cruiser*; backlog of 980 aircraft (through 2002); diversification strategy: smaller percentage of earnings from commercial aircraft
- **Airbus** does not cut back, proceeds with *A380*, forecasts 15% earnings growth; backlog of 1,714 aircraft (through 2004)
- With engine manufacturers and suppliers, 100,000 layoffs likely
- **USAF** may lease 100 transports (B-767, A330?) as tankers

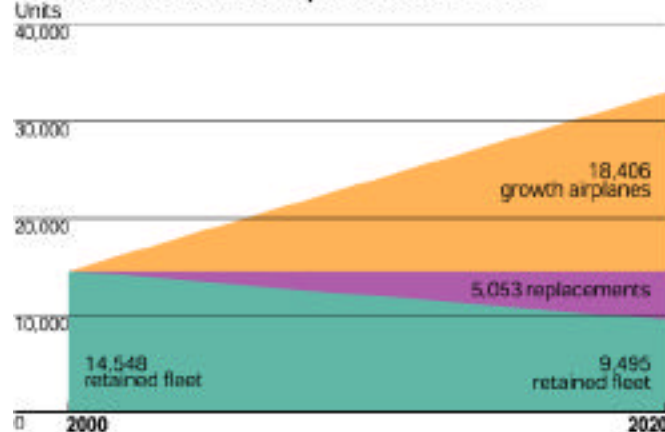


Boeing Prediction of Total Commercial Fleet (pre-9/11); ATA, CSFB Delivery Estimates

The World Fleet Will More Than Double Over the Next 20 Year



Additions and Removals Impact the World Fleet



Order Backlog and Aircraft Production Forecast*



Source: Company data, Credit Suisse Furst Boston estimates

*Estimated for 2001-09

(AW&ST, 3/18/02)



DEI SVB NVMI NE VIGET

The Boeing Airliner Strategy



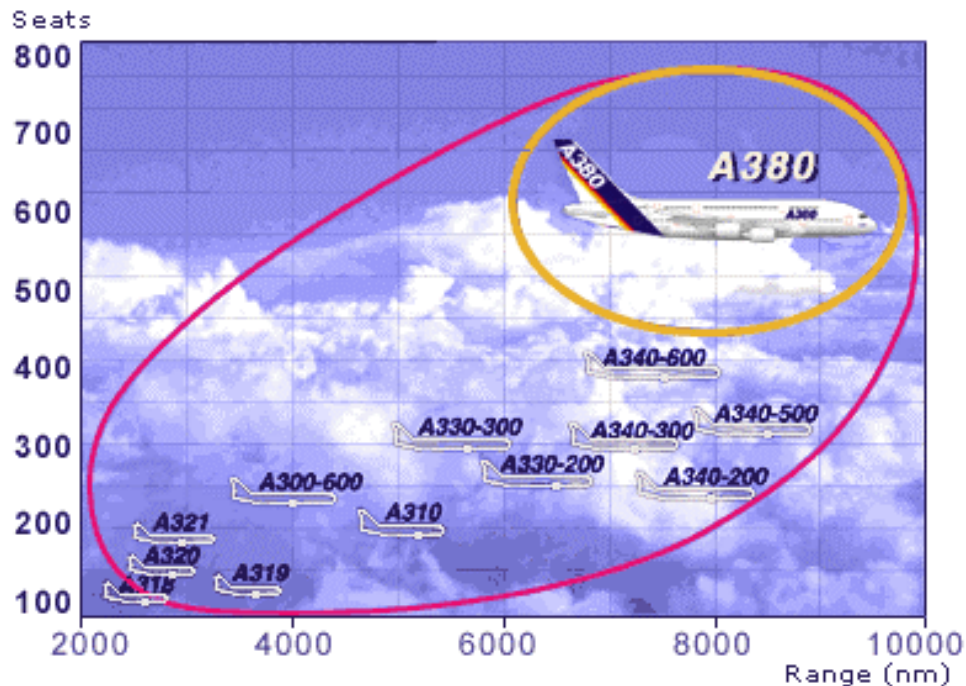
- Focus on point-to-point comfort and convenience
- Address need for more, smaller aircraft
- Reduce travel time for high-end market



Sonic Cruiser



The Airbus Airliner Strategy

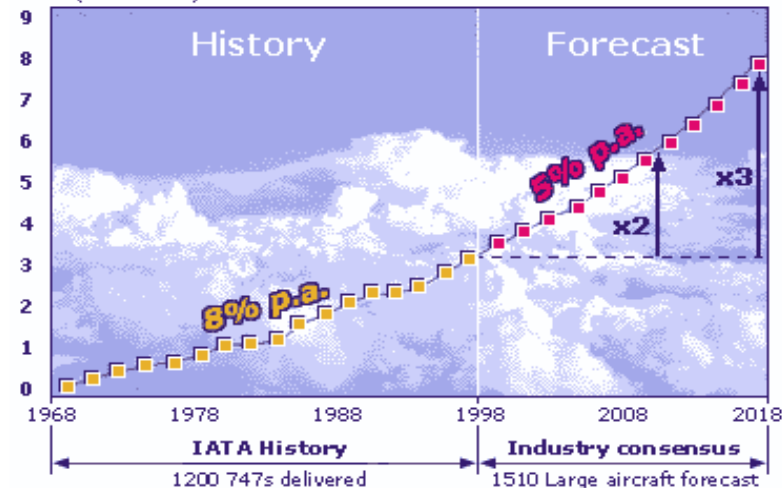


- Capture market for very-large passenger aircraft
- Address need for very-large freighter aircraft
- Maintain spectrum of aircraft

WORLD TRAFFIC

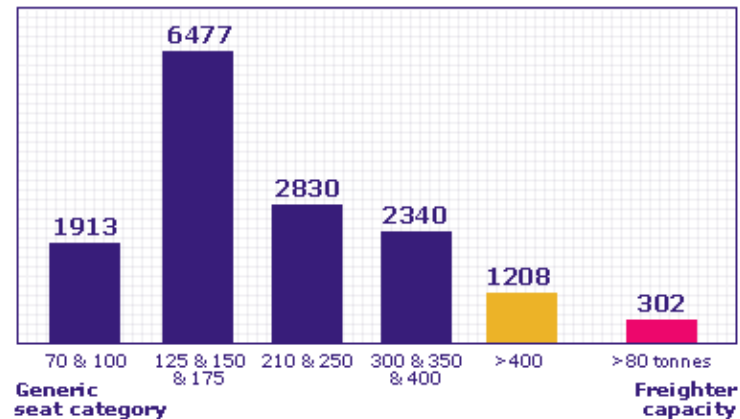
Source: Airbus Industrie Global Market Forecast 1999

RPK (Trillions)



OPEN MARKET

Source: Airbus Industrie Global Market Forecast 1999





General Aviation: Part of the Solution or Part of the Problem?



- **General Aviation:** business and private aircraft, professional and amateur pilots
- **Fixed-Base Operators (FBO),** flying schools, traffic reporters, banner tows, crop dusters
- **Disturbed individuals crash on White House lawn (1994) and fly into Tampa building (2001)**
- **Alleged hijackers received pilot training in the US**
- **Large bizjet could be a WMD**
- **Crop duster could spread toxic material in urban area**



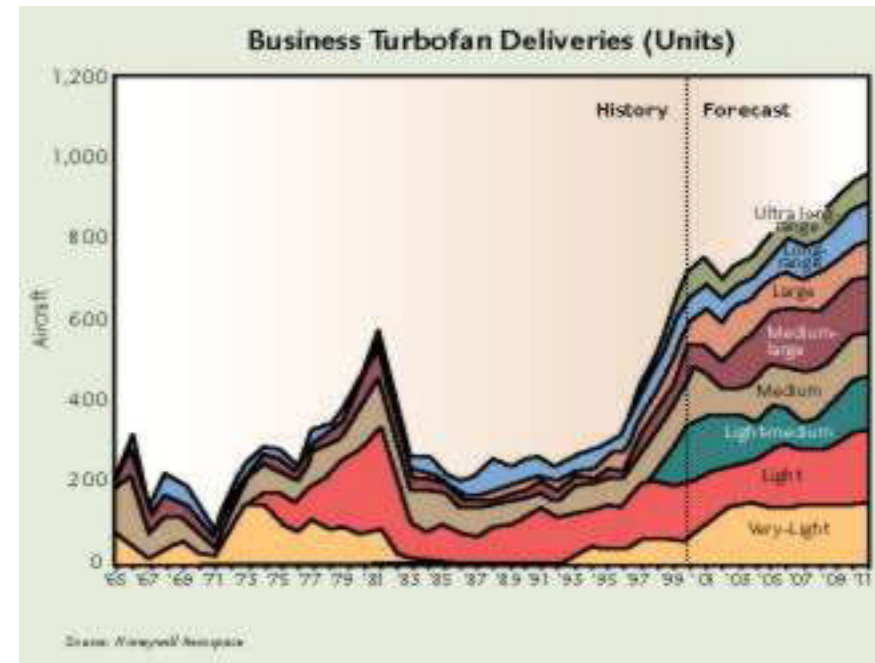
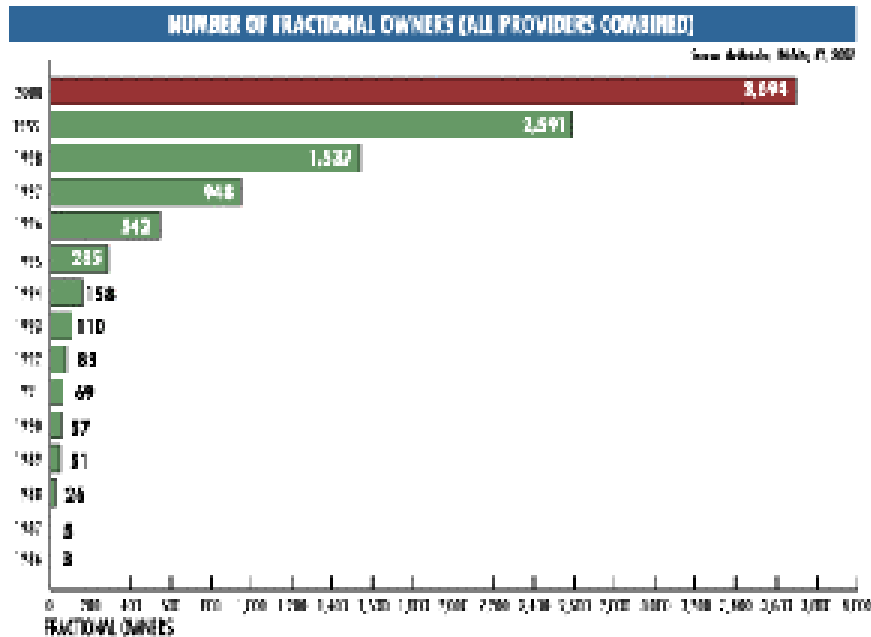
Rational Response for General Aviation



- Increase security at 4,500 public-use airports
- Tighten FBO procedures
- Require IFR-like flight plans near all urban areas
- Conduct thorough background checks for pilot training and license
- Adopt airline-like security for business aircraft operations

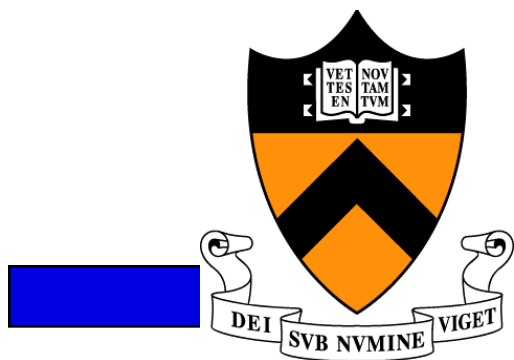


Prognosis for General Aviation



- Increased delays at commercial air terminals favor increased use of GA
- Explosive growth in the use of business jets and the market for fractional shares, charter flights
- Continuing need for safe, reliable, “user-friendly” small aircraft

Research Areas for the FAA, NASA, and Academia



*Joint University Program
for
Air Transportation Research*

■ FAA

- Prevention of incidents before boarding
- Communications of aircraft intent
- Cooperative air traffic management
- Alternative airline economics

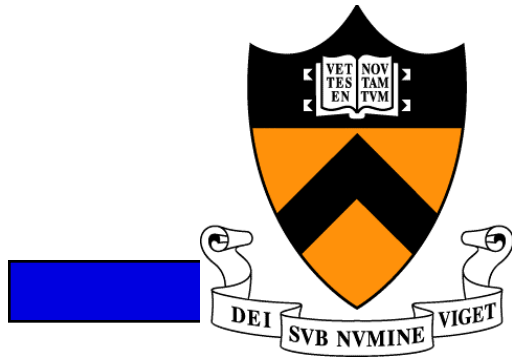
■ NASA

- Aircraft design and operational issues
- Human factors of crew response to terrorist attack
- High-technology development

■ Princeton/MIT/Ohio University

(<http://www.princeton.edu/~stengel/JUP.html>)

- Exploration of high-risk/high-payoff alternatives



Recommendations: Security and the National Airspace System

Security

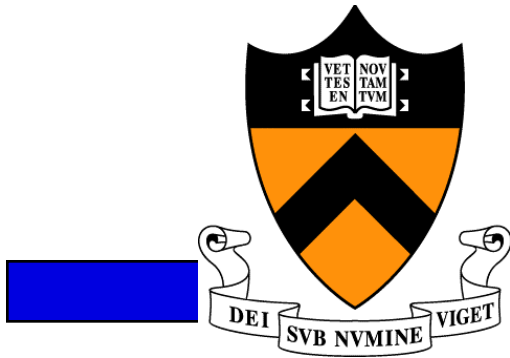
- Lock the barn door before the horse is stolen
- Distinguish between ideas - words - posturing - effective action
- Focus 90% of effort on 90% of threat
- Audit agency and individual accountability for security
- Prevent hijackers from boarding aircraft
- Keep truly hazardous devices off aircraft
- Preserve liberty, peace, justice, and freedom
- Maintain **Eternal Vigilance**: the next threat will be different

Harassment \neq Security

National Airspace System

- Support for security and vigorous program of NAS improvements
- Address economic as well as security issues
- Provide seamless connection between civilian and military air traffic assets

Recommendations: Airlines and Aerospace Industry

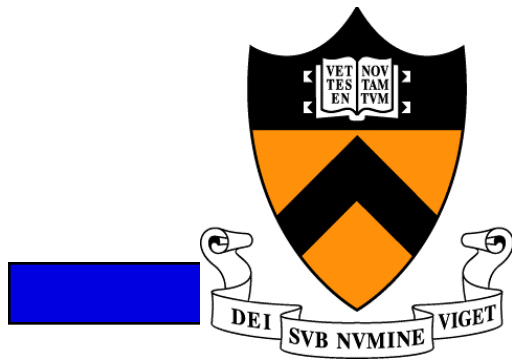


Airlines

- Improve crew response to terrorist threat
- Accept re-regulation of critical aspects of airline operation
- Adopt back-to-basics approach: simplified operation, rational yield management, supportable route structure, optimal aircraft types
- Develop new modal infrastructure
- Integrate trunk and regional jet service

Manufacturers

- Diversify products beyond commercial transports
- Consolidate where synergies are real; divest where links are illusory
- Focus on manufacturability, reliability, maintainability, and product improvement



One More Time ...



Eternal Vigilance