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AGATE

Advanced General Aviation Transport Experiments

The AGATE Goals

The AGATE Consortium is a cost sharing industry-university-government alliance initiated by NASA to create the technological basis for revitalization of the U.S. general aviation industry. It was founded in 1994 to develop affordable new technology as well as the industry standards and certification methods for airframe, cockpit, flight training systems, and airspace infrastructure for next generation single pilot, 4-6 place, near all-weather light airplanes. The AGATE alliance has more than 50 members from industry, universities, the FAA, and other government agencies.

The facilitator for the AGATE Consortium is AAAI,
the **AGATE Alliance Association Inc.**

AAAI Members

AGATE Meetings @ AirVenture '01

AGATE is closely coupled to 5 other NASA programs:

- **Small Aircraft Transportation System**

  The NASA Langley Research Center's General Aviation Program Office has selected 4 SATSLab demonstration teams for negotiations under the CTN - (Competitive Tasking Notice) issued on April 9, 2001, soliciting proposals for the development of state or regional SATS flight demonstration plans.

  Any questions regarding this solicitation may be directed to Ms. Gaudy Bezos-O'Connor at 757-864-5083 or email G.M.BEZOS-OCONNOR@LARC.NASA.GOV.

- **General Aviation Propulsion Program (GAP)**
- **Aviation Safety Program**

  Aviation Weather Information
- **Advanced Air Transportation Technologies**
- **NASA SBIR (Small Business Innovation Research) Program**

small business innovation research SBIR
small business technology transfer STTR

as well as to the **FAA's Human Factors & Training programs run by CAMI**.

AGATE is integral to **NASA's 3 Pillars of Success Strategy**

See NEW AGATE Flight Concept Animation

Warning these are 1.8Meg - 8 Meg video clips & can take long to download

Want a voice in the design of an advanced airplane?
Tell AGATE what you want in the 21st Century Small Airplane

Interested then **Optimal Solutions** requests that you fill their 10 Minute Web based Questionnaire & Survey

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NASA Glenn Research Center

AGATE Work Areas **AGATE FLIER** **Images**
Contact AGATE **Links**

Content Manager : Hank Jarrett
Site Design by AGATE Alliance Assoc. Inc. (AAAI)
Monday, July 16, 2001

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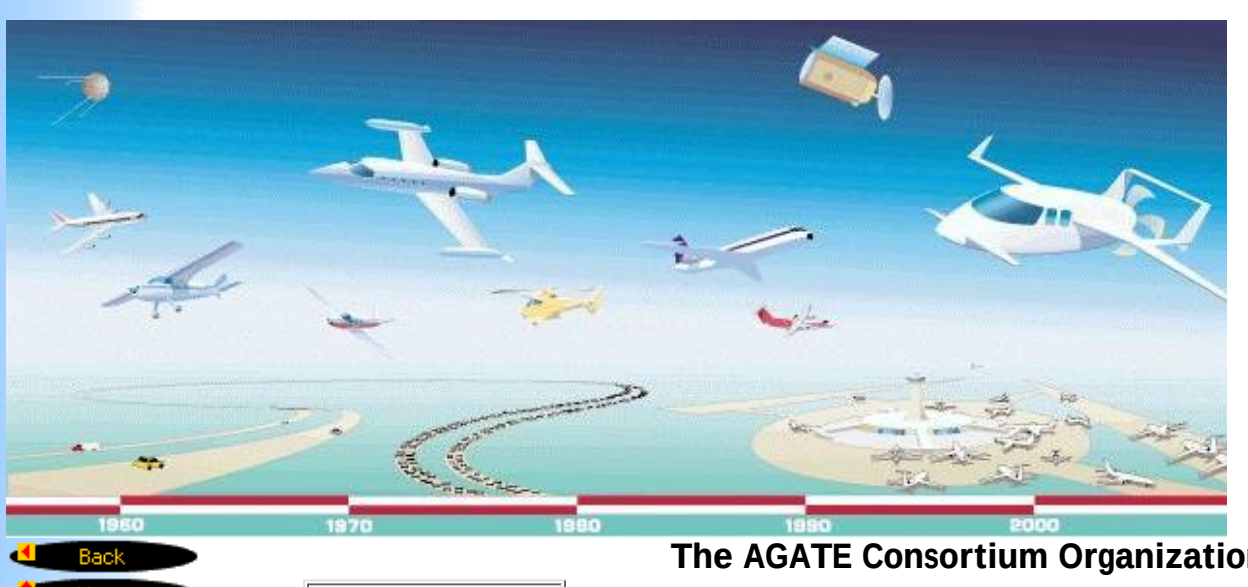

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Executive Council
NASA
FAA
AAAI

List of AGATE Members & their Web Sites

AAAI
Tel: Tel: 757 766 7512 Tel: 757 766 7512 Tel: 757 766 7512
Fax: 757 766 2299
3217 N Armistead Ave
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Executive Director
Jack Sheehan

Program Services
Maureen Sgambelluri

Member Services
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NASA GAPO
General Aviation Program Office

Tel: 757 864 3863
Fax: 757 864 8864

MS 261,
6 East Taylor St.,
NASA Langley Research Center,
Hampton, VA 23681-2199

The AGATE Consortium Organization

The AGATE Consortium is managed by NASA in consultation with the private sector members through the Executive Council

- **The AGATE Executive Council**
  (Elected by Membership)
- **NASA**
- **FAA**

The **AGATE Alliance Association, Inc. (AAAI)** is the facilitator for the AGATE Consortium

Executive Council

Company	Representative
Raytheon	Noel Duersken, Flight Systems
ARNAV	James Meer
Mod Works	Tim Coons, Manufacturing
BF Goodrich Avionics	Ray Wabler, Training
Jeppesen	Sandy Stedman
Honeywell	Dan Johnson, Propulsion
Cessna	Jon Carr, Ice Protection
Government	**Members**
NASA	Henry Jarrett
NASA GAP Program	Leo Burkhart, NASA Lewis Research Center
FAA	Robert Wright
USAF	Lanny Jines, Air Force Research Laboratory
Industry/University	**Associations Observing Member**
AOPA	Bruce Landsberg
CAMI	Mike Dahl
EAA	Rick Weiss
GAMA	Ed Bolen
Maryland Research Foundation	Norris Krone
NAFI	Sean Elliott
NATA	James Coyne
NASAO	Henry Orgrodzinski
NBAA	Jack Olcott
SAMA	Paul Fiduccia
Jeppesen	Sandy Stedman
Honeywell	Dan Johnson, Propulsion

members will be finalized by Jan 31, 2001

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NASA General Aviation Program Office - GAPO

Tel: 757 864 3863 **Fax:** 757 864 8864

Program Manager	Deputy Program Manager	Program Analyst	Management Analyst
Michael H. Durham	Henry W. Jarrett	Tim Warner	Nadine Syrett
	Secretary		
	Helen F. Terrell		

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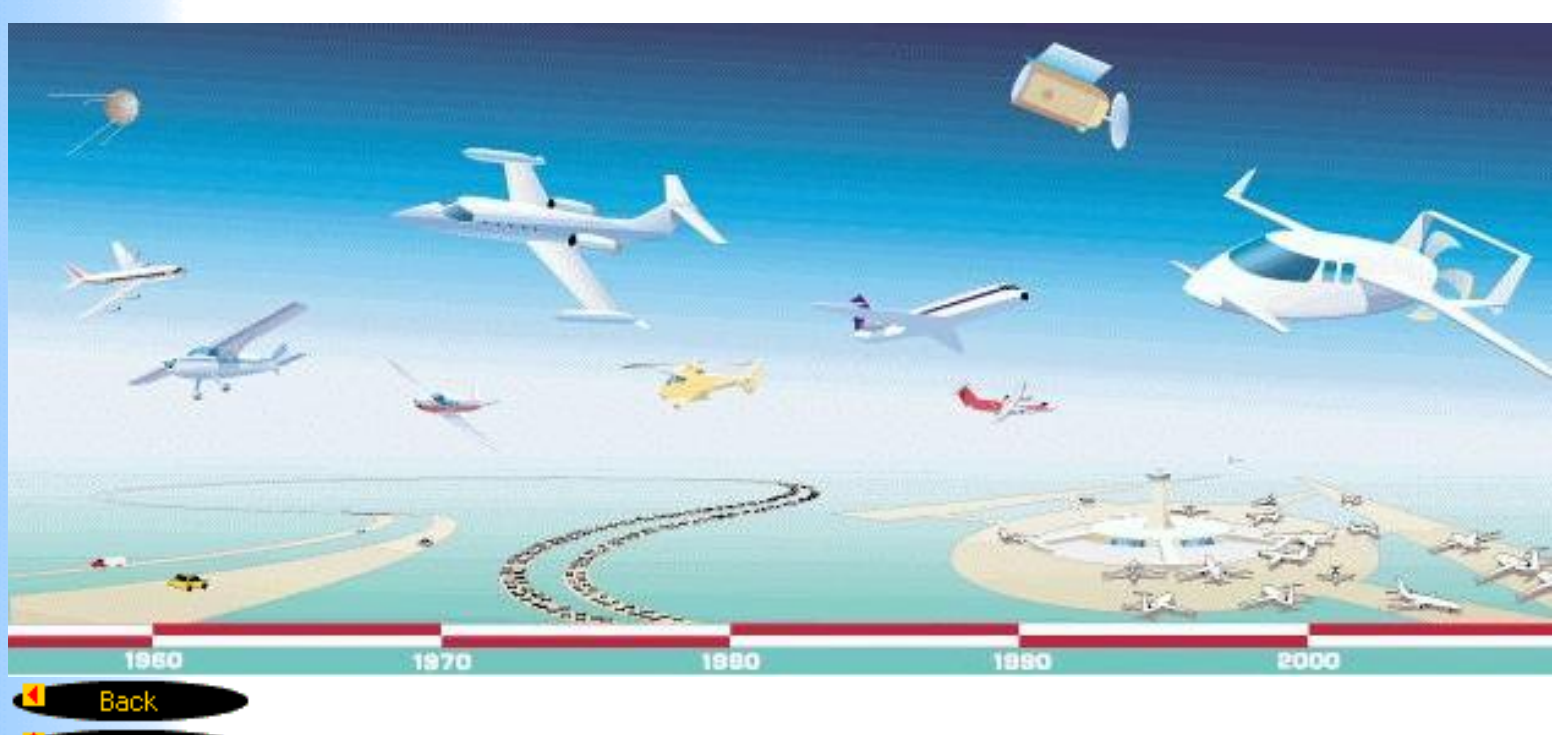
Last Edited on 07/13/01 by Shahid Siddiqi



The AGATE Flier

PDF format read with Adobe Acrobat

Summer 2000	PDF 680 KB
Winter 1999	PDF 800 KB
Spring 1999	PDF 600 KB
Fall 1998	PDF 390 KB
Spring 1998	PDF 390 KB
Summer 1997	PDF 183 K

AGATE Flier is produced for the AGATE Alliance by Science & Technology Corp.

Titles

AGATE Member News Briefs

LANCAIR delivers COLUMBIA 300 to NASA

Dr. Bruce Holmes, Director of the NASA General Aviation Program Office accepted the keys to the new Columbia 300 from AGATE member Lancair.
"The event was a pinnacle experience for many of us who have toiled for eight years to make it possible to build and deliver a state-of-the-art airplane incorporating virtually every technology that NASA has developed over the past 25 years. To see it with NASA colors and tail number was a moving experience," Dr. Holmes said.
NASA purchased the Columbia 300 so that it would have its own contemporary testbed to evaluate the technologies being developed through its Advanced General Aviation Transport Experiments (AGATE) program and the newly established Small Aircraft Transportation System (SATS) program. The Lancair Columbia 300 is a fully IFR-certified, 220 mile per Lancair has a long association with NASA and its general aviation programs. "I share in NASA's vision for the future of general aviation," said Lancair President and CEO Lance Neibauer. As an industry, we need to continue to push forward in developing technologies that will make personal flying safer, more practical and more accessible. Aircraft like the Columbia 300 are the first step in this, but there is much more to be done and we're proud to be a part of it."

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Satellite Link for Weather in the Cockpit

ARNAV Systems and Globalstar announce partnership for providing satelite link for ARNAV's Weather in the Cockpit products

NY Times Sunday Magazine article about Cirrus

New York Times Sunday Magazine feature article covering small airplanes, the current state of GA and the Cirrus SR-20 airplane

Houston Chronicle

Feb 21, 1999

Article describes AGATE program & Cirrus SR-20

ARNAV in the 1998 Iditarod Trail Sled Dog Race

ARNAV Systems' datalink technology was selected by the Iditarod Trail Sled Dog Race Organizers to track the dog teams as they raced from Anchorage to Nome, Alaska. Each team is equipped with a ARNAV datalink that transmitted GPS position and environmental data via a VHF datalink to race HQ. ARNAV installed VHF datalink towers for the race and also used airplane data relays to provide race organizers with position data on each race team.

> "From Anchorage, in south central Alaska, to Nome on the western Bering Sea coast, each team of 12 to 16 dogs and their musher cover over 1,150 miles in 10 to 17 days"

Race Web Site:
http://www.iditarod.com/iditarod/pr-list.htm

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GA Team 2000 Report for 1997

GA Team 2000 released its 1997 report on "the successful activities of GA Team 2000, which contributed to the eight percent increase in student pilot starts through November 1997". The report.is available from the web site:

http://www.beapilot.com/press/

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Susan Adkins creator of the GA Legacy CD-ROM died tragically in a small airplane accident

Susan L. Adkins was killed in a tragic GA airplane accident on Sunday morning March 1, 1998. She (private pilot) and her friend Martha P. Delles (commercial pilot) met their demise when a Cessna 172-P they were flying crashed shortly after take-off from the Langley Air Force Base, Hampton, VA. Susan & Martha were both pilots and members of the Langley Aero Club, they took-off at 9:30am in calm but misty weather. Susan created the Legacy CD-ROM that contains over a hundred NACA & NASA reports useful to GA.
The preliminary NTSB report of their last flight is:

NTSB Identification: IAD98FA032

Accident occurred MAR-01-98, LANGLEY AFB, VA
Aircraft: Cessna 172P, registration: N62082
Injuries: 2 Fatal.

On March 1, 1998, at 0936 eastern standard time, a Cessna 172P, N62082, was destroyed when it descended and collided with terrain and a building, while maneuvering at Langley Air Force Base (LFI), Virginia. The certificated commercial pilot and private pilot were fatally injured. Instrument meteorological conditions prevailed for the local personal flight that originated at LFI, at 0933. A visual flight rules flight plan was filed for the flight conducted under 14 CFR Part 91. At 0933:48, N62082 was cleared for takeoff from Runway 08 at LFI. At 0935:02, the pilot transmitted: "Langley tower this is 62082, uh...we're going to come back for landing...uh...the ceiling is lower than we thought." The tower controller acknowledged the call and instructed N62082 to report when it reached the base leg of the traffic pattern. The tower controller stated the airplane was over the departure end of Runway 08 when he acknowledged the radio call. He observed the airplane enter a climbing left turn and disappear from view. The controller said the radar display indicated the airplane was at 500 feet. The controller attempted to regain visual contact with the airplane by alternately scanning the radar display and the sky over the northern end of the airfield. At 0935:40, the controller heard unintelligible cries over the tower frequency. He stated: "A 'whoo' sound was made by the [aircraft]. I attempted communication with the [aircraft] on tower frequency and on VHF Emergency Frequency (Guard). I still could not physically see the [aircraft] and the target on the radar went from 500 feet to 300 feet, to no target at all almost instantly." Several witnesses in proximity to the crash site reported they heard the airplane overhead. They reported the airplane could not be seen through the low cloud cover. An Air Force Sergeant and his family were in the parking lot adjacent to the crash site. According to the Sergeant: "I heard the noise of a plane much louder than a normal plane. It was very low but I couldn't see it. The fog was maybe 4 or 5 floors above the 10 story building. When the plane came out of the clouds she was in somewhat of a vertical drop." According to his wife, "We could really hear a plane. It was loud. You knew it was low but the clouds were really dense, really thick. You could put maybe another one-quarter of the [10 story] building on top before reaching the clouds. The engine was running when it came out of the clouds. It sounded like it was

Stop Dreaming

Start Flying

Be A Pilot

too loud. I knew it was going to crash because it was in an awkward position. It never rotated, it came right on down. They must have been totally dependent on their instruments because they couldn't have seen anything." Witness accounts differed in regard to the cessation of engine noise. Several witnesses described hearing the engine run until the sound of impact. Several more said the engine stopped just prior to impact. Two witnesses said they heard the engine sputter. Examination of the wreckage revealed that the airplane collided with an electrical sub-station building in a residential area of the installation, approximately one mile from the center of the runway, in the vicinity of the downwind leg of the traffic pattern. Control cable continuity from the flight control quadrant to the rudder and elevators was confirmed. Cable continuity was also established to the point of left and right wing separation, where the cables appeared to fail in overload. The black propeller with red spinner attached was separated from the engine. The propeller blades displayed similar bending, twisting, leading edge gouging, and chordwise scratching. The spinner displayed torsional damage. Red and black paint transfers were observed on the sub-station wall. The transfers displayed rotational smearing. Examination of the engine revealed no pre-impact anomalies. The engine was rotated by hand and valvetrain continuity was established. Compression was verified using the thumb method. The right magneto was destroyed by impact and the left magneto produced spark through all leads. All eight spark plugs were in good condition and the electrodes were light gray and tan in color. Weather reported at the time of the accident was: measured ceiling 300 feet overcast and 4 miles visibility with mist. Winds were from 060 degrees at 10 knots. The temperature was 50 degrees and the dewpoint was 48 degrees. The pilot in the right seat held a commercial pilot certificate with single engine land and instrument ratings. She had approximately 600 hours of flight experience. The pilot in the left seat held a private pilot certificate with ratings for single engine land. She had approximately 145 hours of flight experience and did not posses an instrument rating.

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PERSEUS B REMOTELY PILOTED AIRCRAFT REACHES 60,000-FOOT MILESTONE AT NASA DRYDEN

The Perseus B remotely piloted aircraft has met a major milestone in its development, reaching an altitude of over 60,000 feet during flight tests at NASA's Dryden Flight Research Center, Edwards, Calif.

The aircraft reached an altitude of 60,200 feet June 27 during the fourth of a series of developmental flights from Dryden. The flight, which lasted just under four hours, occurred in restricted airspace over Edwards Air Force Base.

Aurora Flight Sciences' Perseus B Remotely Piloted Aircraft

Designed and built by Aurora Flight Sciences Corporation, Manassas, Va., the Perseus B is one of several remotely operated aircraft being evaluated under NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program.

Gary Cosentino, Dryden's project manager for ERAST testbed aircraft, hailed the accomplishment as a significant step in the development of the Perseus design and in the ERAST program.

"The achievement of the Perseus B aircraft and the Aurora team is remarkable," he said. "It is a major milestone for the NASA ERAST program and the science community. To have achieved this in only four flights of a new aircraft with only a few minor squawks is amazing and attests to the hard work and dedication of the Aurora team and the great support provided by Dryden."

"This series of flight tests has gone extremely smoothly," added Thomas Milkie, Aurora's Perseus B program manager. "This is the result of a very disciplined ground test program conducted on this aircraft. We completed full structural tests on the wing and tail structure, conducted altitude chamber tests simulating the flight missions and conducted extensive crew training on a flight simulator before flights began."

The current series of four development missions began April 30 with a checkout flight that took the aircraft to approximately 15,500 feet altitude. Subsequent missions took the aircraft to successively higher altitudes until the aircraft reached the 60,000-foot goal. In addition, the Aurora flight crew evaluated the aircraft's propulsion, flight control, avionics and cooling systems during the series of flights. Ken Zugel, the pilot in a ground control station flew Perseus B using on-board video and dual-redundant communications and data links to monitor aircraft maneuvers and systems.

Several planned missions within the next year are intended to demonstrate the Perseus B's ability to carry a variety of scientific and communications payloads. One of these will be a telemetry payload for the U.S. Army Communications Command to demonstrate a communications relay. Another experiment will drop meteorological sensors into storms, and a third is designed to detect lightning within thunderstorms.

The Perseus B, which first flew at Dryden in 1994, is the third generation of the Perseus design. It is intended to perform extended-duration atmospheric research missions in the 60,000-foot altitude range, as well as to serve as a testbed for high-altitude performance and propulsion concepts under ERAST. The design allows the aircraft to carry a payload of scientific instruments in a nose compartment, providing undisturbed airflow to atmospheric sampling sensors.

Perseus B is powered by a conventional four-cylinder 80-horsepower Rotax 912 piston engine driving a rear-mounted pusher propeller. Additional airflow is provided to the engine via a three-stage, four-turbine turbocharger capable of providing sea-level air pressure to the engine in the thin atmosphere at 60,000 feet. The aircraft is designed to cruise at comparatively slow speeds of about 52 knots indicated air speed (60 mph), which is equivalent to a ground speed of about 156 mph at 60,000 feet altitude. Among several refinements made since the last flight tests at Dryden in 1996 is a longer, stronger wing spanning over 71 feet, some 13 feet longer than the original.

Now that the aircraft has achieved the 60,000-foot altitude goal, program officials plan to extend Perseus B's high-altitude endurance significantly within the next year. To meet that objective, Aurora plans to add pods under each wing to double the fuel capacity to 80 gallons, boost the turbocharger output to increase power to over 100 horsepower, make some minor airframe weight reductions and add navigation lights for nighttime operations.

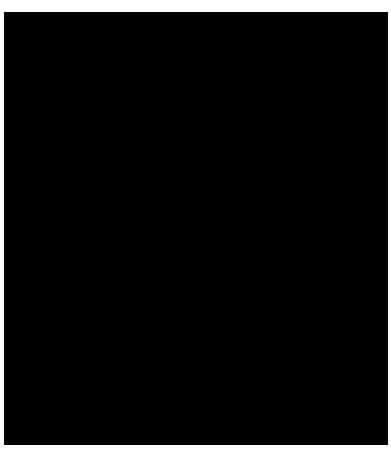
"Now that we have verified operation of the aircraft over its altitude envelope, we need to expand the aircraft capability in endurance, leading eventually to the ability to fly long-range missions," Milkie added. "With those changes, we believe we can achieve six to eight hours endurance at 60,000 feet with this prototype aircraft and up to 24 hours endurance at altitude with a later production version.

"We have already begun working with commercial customers interested in flying payload missions in weather research and atmospheric science. We feel that the Perseus B, because of its high-altitude capability, provides a unique flight opportunity for atmospheric and weather research, remote sensing and telecommunications missions," Milkie concluded.

The ERAST program, led by NASA Dryden, is focused on development of aeronautical technologies that will lead to a new family of remotely piloted aircraft for use in upper-atmosphere science missions. Designed to fly at slow speeds for long durations at altitudes ranging from 60,000 to 100,000 feet, such aircraft could be used to collect, identify and monitor environmental data to assess global climate change. Such aircraft could also be used as

telecommunications platforms, serving much like satellites but at a fraction of the cost of placing traditional satellites in space. NASA's Lewis, Langley and Ames Research Centers are contributing expertise in the areas of propulsion, structures and systems analysis and sensor technology.

[Photos of Perseus B are available at NASA's website: www.dfrc.nasa.gov/gallery/photo/Perseus /index.html or by contacting Susan Must @ Aurora 703 369-3633]



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National General Aviation Technology Roadmap

NASA is leading the development of a National General Aviation Technology Roadmap to guide the Agency's Aeronautics Enterprise investments in General Aviation technologies. The Roadmap uses the concept of a Small Aircraft Transportation System (SATS) as a decision-aiding framework for current and future investments. These investments must be metrics-driven to provide returns for the Public good. The Public good benefits are defined in terms of mobility, safety, environment and airspace capacity. The Roadmap defines the technology opportunities and challenges for investments beginning in FY 2001.

The preliminary list of investment options includes:

1) Quiet, Clean Propulsion,
2) Single Crew Flight Deck Systems, Training, & Operations,
3) Airframe Systems,
4) National Airspace System Infrastructure,
5) Public Standards, Policy, & Regulatory Issues.

Dr. Bruce Holmes' Presentation of NASA's GA Roadmap

Roadmap (a PDF slide show 1.8 MB)

You can assist the National Roadmap Effort by sending us your views via this Questionnaire

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Administrator Daniel Goldin first went to the Experimental Aircraft Association's annual Oshkosh Airshow now AirVenture in 1992. There he met with the GA industry and trade associations as well as airplane pilots, owners, and kit builders. He then initiated NASA's 8 year relationship with the GA industry through AGATE & GAP.

Administrator Goldin's vision is for GA to serve as an efficient, affordable and convenient transportation form the people who live in the nations outlying communities using their small airports. The three speeches linked here articulate his vision for 21st Century GA.

NASA Administrator Goldin's Speeches about the future of General Aviation		
SAE World Aviation Congress San Francisco 1999	ABA Conference Chicago, June 1999	AOPA Exposition Palm Springs, Oct 1998

Member Organizations

AGATE MEMBERS AGATE Alliance Association, Inc. (AAAI)	
A - L	**M - Z**
A&P Technologies	Maverick Air Inc.
Aerocar Llc.	Mississippi State University--Raspet Labs
AGATE Alliance Association, Inc.	Mod Works, Inc.
Airborne Research Associates	Munro & Assoc Inc.
Air Force Research Laboratory	Noegenesis
AOPA - Air Safety Foundation	Ohio State University
ARINC	Raytheon Aircraft Co.
ARNAV Systems, Inc.	Research Triangle Institute
Arthur D. Little	Rockwell Collins Commercial Avionics
Avidyne	Safire Aircraft Company
Avrotec, Inc.	Science Applications International Corp.
B F Goodrich Avionics Systems	Seagull Technology Inc.
Cessna Aircraft Co.	Simula Technologies Inc
Cirrus Design Corporation	STARNET LLC
Echelon Corporation	TeamVision
Eclipse Aviation	Stoddard Hamilton Aircraft Inc.
Embry Riddle Aeronautical Univ.	Teledyne Continental Motors
Executive Jet, Inc.	Toray Composites
Experimental Aircraft Assoc. (EAA)	Touchstone Research Labs
Federal Aviation Administration	United Technologies Hamilton Sunstrand
Fibrecote Industries, Inc.	University of Alabama
Garmin International	University of Illinois Urbana/ Champaign
General Aviation Manufacturers Assoc. GAMA	University of Kansas
Global Aircraft Corp.	University Research Foundation
Harris Corp.	University of Tennessee
Honeywell International./Allied	Virginia Polytechnic Institute
Innovative Dynamics, Inc.	VA Space Grant Consort
Jeppesen Sanderson	Wichita State Univ. (WSU)
Lancair International, Inc.	

Last Updated Tuesday, March 06, 2001
By Shahid Siddiqi
Email: s.a.siddiqi@larc.nasa.gov

The AGATE program work was organized into ten technical work packages, two of them, Propulsion & Icing are finished while the remaining eight are underway:

Work Packages	Work Package Leader (Govt)
Flight Systems	Walter S. Green 757 864 3355
Propulsion Sensors & Controls	Robert McKnight 216 433 2034
Integrated Design & Manufacturing	W. Tom Freeman 757 864 2945
Ice Protection Systems	Robert McKnight 216 433 2034
AGATE Integration Platforms	Dan DiCarlo 757 864 3870
Flight Training Curriculum	Tom Glista, FAA 202-267-7922
National Airspace Infrastructure	FAA
Program Assurance	Michael H. Durham 757 864 3863
Systems Assurance	Stewart A. Cooke 757 864 3863
Program Analysis	Michael H. Durham 757 864 3863

Work Package Missions

Flight Systems

Develop **affordable** Flight Systems that allow near all weather flying capability for light GA airplanes. Develop **affordable,** low work load, intuitive Cockpit Display technologies that provide improved situational awareness, weather & traffic information to the pilot are being pursued. Design guidelines & Certification standards for these technologies are being developed.

Go back up

Propulsion Sensors & Controls

Develop design guidelines & certification standards for electronic engine controls & diagnostics that provide lower direct operating cost, reduce emissions and lower noise.

Go back up

Ice Protection Systems

Develop design guidelines & certification standards for new ice protection systems that are compatible with laminar flow wings. Conduct research to improve airframe ice formation prediction models.

Go back up

Integrated Design & Manufacturing

Works to reduce airframe and propeller cost and weight by work in the following 4 areas:

Low Cost Design & Manufacturing Methods
Non-Destructive Testing
Composite Material Properties
Crash Worthiness

Go back up

AGATE Integration Platforms

Develop & conduct Simulation & Flight Test tasks with mature projects emerging from the other AGATE work packages. The aim of the tests is to develop a technology database for validation and for the development of design guidelines & certification standards.

Go back up

Flight Training Curriculum

Develop & validate advanced training technologies & techniques that take advantage of emerging technologies such as integrated cockpits, single lever power control, weather in the cockpit, etc. The aim of the work is a FAA FAR Part 141 certifiable program that reduces the time & cost of obtaining and maintaining an IFR rating.

Go back up

National Airspace Infrastructure

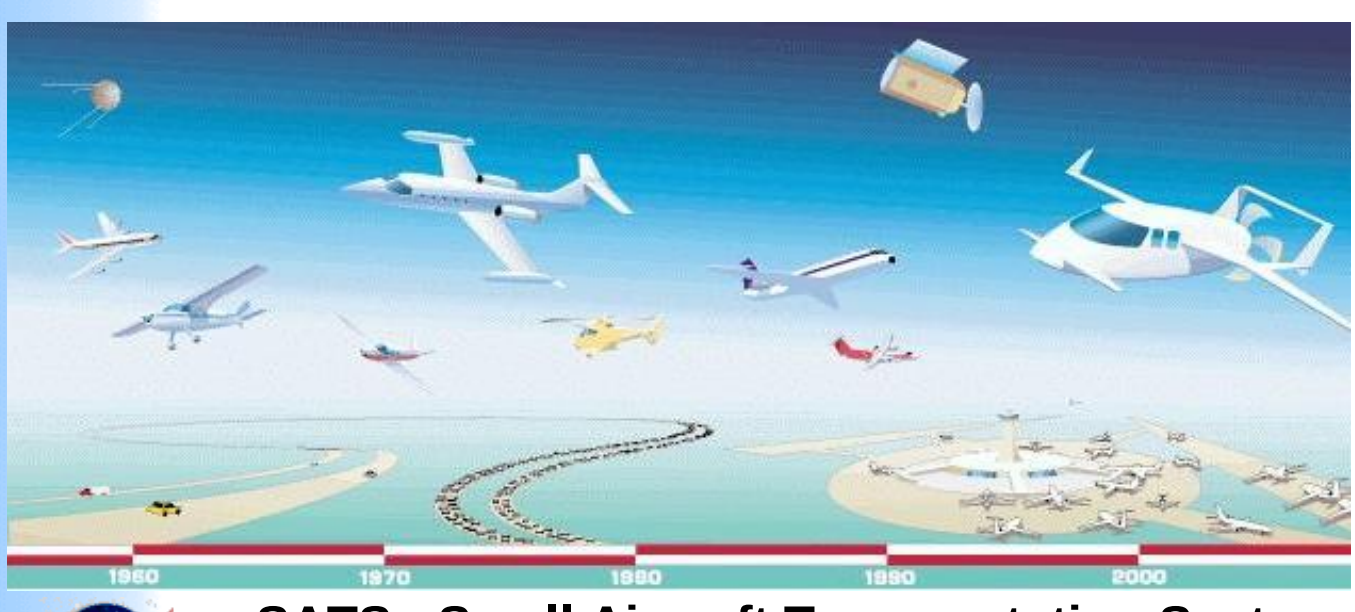
Development of Air & Ground infrastructure for small airplanes that fits into the FAA's new airspace plans - Flight 2000 & Free Flight. The goal is more efficient enroute travel and traffic management for small airplanes.

Go back up

Program Analysis, Assurance & Systems Assurance

The aim is to ensure that the AGATE work package technology development and design guidelines & certification standards work progresses towards the goal of **affordable** technologies for small single engine airplanes. The program result should be rapidly commercialized technologies that revitalize the US General Aviation Industry.

Go back up



SATS - Small Aircraft Transportation System

"The Small Aircraft Transportation System is a safe travel alternative freeing people and products from today's system delays, creating access to more communities in less time"

"Turn Left at Cloud 109" By James Fallows
11/21/1999, The New York Times Magazine
© 1999 New York Times Company

On a business trip this fall I had what is becoming the standard airline experience. Nine p.m., arrived at Detroit's main airport, then waited until 10 p.m. for the baggage to appear. Next night's flight out of Detroit was delayed two hours -- and eventually canceled, around midnight, followed by a stay at the airport hotel and a 6 a.m. departure. An air trip from one off-the-main-route location (Allentown, Pa.) to another (Hartford) took longer than it would have by car, because of hub-and-spoke routing through Philadelphia. Plus, there was the traveling person's toll of Dead Time: the hours lost in taxis to and from airports, in lines at the check-in counter and security gate, in the aisle of the plane itself, waiting for victors to emerge in the battles for space in the overhead racks. Need I mention mini-pretzels as meals?

I know, travel complaints are boring if they're not happening to you. And complaints of any kind can seem unfair. The airlines are so safe. Their fares can be so cheap, if you're able to book weeks in advance and not change your plans. When everything goes smoothly -- no lines, no delays, no behemoth in the seat ahead of you reclining into your lap -- it can seem miraculous to be transported so far so fast.

But while trapped on a behind-schedule plane it can be tempting to dream of another possibility. Suppose there were an efficient way to travel that departed as soon or as late as you desired and went directly where you wanted to go (rather than to the Major Airline Hub that is least-far-distant from your destination). A way that didn't involve the hours of padding time to allow for unexpected lines and hassles at the airport. A way that didn't require the Gulf Streams or other multimillion-dollar corporate jets that now spare the rich the annoyances of commercial travel.

A tiny company based in Duluth, Minn., named Cirrus Design believes that it can offer a glimpse of such a new, futuristic transportation system. The company was founded by the Klapmeier brothers, Alan and Dale. Their basic idea is to build small airplanes that ordinary people will find simple and safe enough to fly, that are fast enough to beat the airlines on door-to-door speed for short- and medium-length trips and that are inexpensive enough, relatively speaking, to appeal to those who already constitute the market for fancy cars, expensive R.V.'s and vacation homes.

The oddest aspect of the vision may be that the United States government has implicitly embraced it as a feasible next step in avoiding transportation jams. Interstate highways are saturated; the hub-and-spoke airline system is overloaded, too; trains are suited mainly to densely settled corridors like Boston-Washington. NASA, the agency best known for explorations of space, is quietly advocating an "Interstate SkyWay" network, the name conjuring images from "The Jetsons."

"A small-aircraft transportation system," says Bruce Holmes, a senior NASA official, could "satisfy a large portion of the demand for Information Age mobility and accessibility, effectively unleashing the new economy's potential for standard of living and quality of life."

But before small planes can join the car in the family garage, they'll have to seem roughly as safe as the car, especially in the wake of prominent recent crashes. On July 20, after the United States Coast Guard shifted from a "rescue" to a "recovery" mission for John F. Kennedy Jr. and the Bessette sisters, Cirrus delivered the very first model of its SR20, the plane that it hopes will begin a new era in personal transportation, to its very first customer.

The Cirrus SR20, which was created by the Klapmeier brothers, does not have a perfect record. In March, Cirrus's chief test pilot, Scott Anderson, died in a crash as he put the SR20 through torture-test maneuvers before it went on sale. The company identified and corrected the defect that killed Anderson, a widely respected figure in Duluth, and received federal approval to go ahead with deliveries of the plane. Still, despite this disaster, the Klapmeier brothers can plausibly claim that the Cirrus SR20 is designed to be safer than any small plane now in service.

The contradictory elements of small-plane flight -- its inherent freedom and peril -- were intensified for me, as for everyone, by Kennedy's death. I had learned to fly about the time he did and took the check ride for an instrument rating four days after his crash. I had followed Cirrus's development for several years in the aviation press. The more I heard about their plans, the more I wanted to believe that they had, at last, created an aircraft that was fast and fun to fly, but exposed pilot and passengers to substantially less risk.

And so, in late September, I took a commercial flight to Los Angeles (90 minutes ground delay, air-traffic pileup at LAX), and prepared to fly halfway across the country in an SR20.

On my arrival in Los Angeles I was met by two men from Cirrus, Gary Black and Tom Bergeron. Black, the company's director of flight operations, is in his mid-40's; he's tall and lanky, with short black hair and the demeanor of a Navy flyer, which he once was. Bergeron, a Cirrus salesman, is in his early 50's, with wavy hair and an aggressively friendly air. He drove us a dozen miles inland from LAX to El Monte Airport, where the plane waited.

There are roughly 4,600 public airports in the United States that are open to anyone but have no scheduled commercial flights (versus the 46 big airports that account for 75 per cent of all airline traffic, and the 660 total that airlines serve). El Monte resembled a big shopping center -- one whose main Sears or Sports Authority buildings had somehow been vaporized -- with a vast paved lot, part of which was marked as a runway. Like other small airports, it looks like the aviation version of an antique car show.

Most of the 190,000 small planes still flying in the United States are aging veterans, and the typical small airport is lined with Cessnas that were designed 40 years ago or more -- like the stolid 172 Skyhawk, with its hammered sheet metal and its old-fashioned high wing -- and have been kept running through loving maintenance ever since. They are reliable but inelegant. Small propeller planes occupy a strange economic gray zone. New ones are quite expensive -- $150,000 and above for the humblest Cessna, half a million dollars and up for fast, fancy planes like the newer version of the Piper Saratoga that John Kennedy flew. But the great majority of sales are for used planes, typically 20 or more years old. And these can cost not much more than a fancy car or R.V. -- from $30,000 or $40,000 up to the high five figures.

A new Cirrus was initially priced at $144,500, with options, and has since risen to $179,400. In the airplane world, that is seen as cheap. The Cessna available for about the same price is much slower and less comfortable, and the Mooneys or Bonanzas that fly as fast cost twice as much. Another all-new plane soon to go on sale, the Lancair Columbia, is faster but more expensive.

There on the tarmac at El Monte, the SR20 was the general-aviation equivalent of an Audi A4 or BMW. The shape was streamlined, constructed of fiberglass rather than metal. The cockpit windows were big and bulbous, almost like those of a helicopter. The wings were low and set slightly behind the cockpit, with a little cuff, or change in the wing shape, halfway out along their length.

Gary Black opened the Cirrus's semi-gull-wing doors and got in the left-hand, pilot's seat; I got in the right. Bergeron, flying commercial back to Dallas, waved goodbye. Inside, the plane was curved and sleek, like today's best cars, using new material and geometry to maximize space and visibility.

"Most metal airplanes are made like mailboxes," says Mike Van Staagen, who oversaw the design of Cirrus's interior. "They're two-dimensional curves, and they're kind of hammered together with harsh angles." The effect of a hundred details make the Cirrus cockpit seem like a first-class seat, compared with the Aeroflot coach seat of the typical aging small plane. With a console between its leather seats, the plane has that new-car feeling. And where the classic aluminum airplane has the narrow shape of a cigar tube, the Cirrus takes a raindrop approach. The cabin is significantly rounder -- wider and taller -- but it still moves through the air with less drag. It is aerodynamic enough that the Cirrus can cruise at 160 knots (184 miles per hour) on the same 200-horsepower engine that takes a Piper Arrow only to 138 knots (159 m.p.h.). Because of its "slipperiness" in the air, it gets better gas mileage than some cars, cruising at 19 miles per gallon.

No one at El Monte seemed to know what this thing was: the control tower addressed each of the planes waiting to taxi by its model and number. "Cessna Two Charlie Bravo, cleared for takeoff on runway one-nine." When the controller got to the Cirrus, he said: "Uhhhh, you in the low-wing plane, follow the Cessna on takeoff. Bonanza Six Nine Sierra, give way to that other plane."

"That other plane" pulled to the start of the runway and was cleared to go. Black smoothly pushed in the throttle lever, the Cirrus reached its rotation, or liftoff, speed of 65 knots, and we began our aerial survey of Los Angeles. The plane climbed and turned easily, controlled by a little side stick, as in a military fighter, rather than a large yoke, as in most planes. A computer panel, like one in an upscale laptop, showed us where we were at all times with a "moving map" of obstacles, features and airports ahead.

Airline travel has been so utterly drained of romance that it is startling how interesting flight can seem when you are 2,000 or 3,000 feet, instead of 35,000, above the surface and you can look all around at scenery as it comes at you, rather than just out a little pane to the side. As Dale Klapmeier put it: "Visibility is a surprisingly large part of comfort. You're far more 'comfortable' flying in an airplane you can see out of than one where you're trying to get your head up over the panel."

We headed east over the Los Angeles Basin, seeing how freeways stitched its component cities into one great sprawl, following the visible marks of fire, flood and tectonic strain. We deviated south for a few miles to fly over the town where I grew up, circling until I was sure I'd picked out my parents' house -- and then headed straight for the San Bernardino Mountains, which separate the basin from the Mojave Desert. In the clear skies, we were operating under "visual flight rules," responsible for seeing and avoiding other planes.

An hour out of El Monte, we saw the towers of Las Vegas to our left, surprisingly concentrated and small-looking in the vast desert. Airliners descended past us from overhead toward the airport. We were like scuba divers watching giant fish swim past. Over Boulder Dam, blazing white against the serpentine blue lake, the controller alerted us to the waves of sightseeing planes headed toward the same destination at the same altitude. We moved across higher terrains, toward the canyon lands of Utah.

After circling over colorful rock formations for pictures and a view, we decided to stop at Bryce Canyon Airport, landing on what seemed an inexplicably long runway, suitable for LAX or J.F.K. Gary Black doesn't like to make hotel reservations. He enjoys the spontaneity of landing where he wants and seeing what's there. We taxied to a hangar that looked like a barn. Local pilots came out of the building to inspect this new plane.

The Klapmeier brothers were both obsessed by flight from an early age. Alan, the older of the two, says he dreamed of being a military pilot and cried when he got glasses in third grade and had to give up that fantasy. Nonetheless, he took flying lessons in high school. When Alan went to college, he bought a 1947-vintage Cessna airplane, and Dale and his parents also took lessons. "Dale is one of the few people who got to use the family airplane before he used the family car," Alan says.

Alan, now 41, has a stocky build and squarish face and a tendency to make wisecracks. Dale, 38, is taller, with a longer face and more sober air. By the time both were out of college, the brothers decided to start their own business building "kitplanes." Kitplane makers sell components of airplanes to hobbyists who then spend hundreds or thousands of hours welding and bolting them together. The brothers set up shop in a barn behind their parents' house, which was then near Baraboo, Wis. They searched scrap yards for spare parts, borrowing money from their parents.

Their first plane was a futuristic-looking cigar-shaped craft with one huge propeller in the back of the plane. It was made of fiberglass, which allowed a more aerodynamic shape, making the plane faster than standard metal planes. The brothers trekked from air show to air show, confident that when people got a look at this VK-30 quasi-rocketship, they would rush to buy the kits. Almost no one did.

"We were looking for people with a couple hundred thousand dollars to spend and the skill and time to put years of work into it," Dale Klapmeier now says. "Those people are not out there." The brothers stayed in business by designing a similar version of the plane for a company in Israel. And they started over, determined this time to tie their vision to market demands.

Perhaps the biggest problem facing the brothers' aspiring airplane company was the dwindling supply of customers. During World War II, vast numbers of Americans received flight training, and as that generation matured and prospered, the total number of active pilots rose to a peak of 827,000 by 1980. Then it began falling steadily, to a low of 616,000 in 1997. The only thing falling faster was the production of new planes. In 1978, Cessna, Piper and other companies sold a total of nearly 18,000 new aircraft. By 1994, their annual production was below 1,000. Although it has nearly doubled since then, the 192,000 planes in the general-aviation fleet are on average very old, since so few new ones have been built in the last 20 years.

The big aircraft companies insisted that liability-insurance premiums were the main cause of the production drop. And in the mid-1990's, Congress, backed by the aviation industry, pushed through the General Aviation Revitalization Act, which put an 18-year limit on manufacturers' liability for accident claims involving their airplanes. Since Cessna and Piper had sold virtually no small planes in the preceding 18 years, this greatly reduced their liability.

But the Klapmeiers reasoned that insurance was only part of the problem. "They weren't giving people a reason to buy," Alan says. Year after year, the manufacturers offered the same planes -- the Cessna 172, the Piper Archer, the Beech Bonanza -- each essentially the same as the year before, only more expensive.

"It was simply a value question," Alan says. "Somewhere in the late 1970's, you got to a situation where you could buy a new airplane for X dollars, or you could buy a 2-year-old version, with 200 flying hours, for one-half X. The lack of product improvement simply added up to bad value." The problem, he says, was like Detroit's in the 1970's -- without any invigorating challenge from the Japanese.

The Klapmeiers decided to become the Japanese. Three great obstacles, they argued, were keeping an increasingly prosperous public from buying planes -- cost, comfort and safety. And the perception that flying was unreasonably dangerous was keeping people out of the sky.

The next morning, at Bryce Canyon, it was my turn to sit in the left seat. As I taxied,I suddenly understood the runway's enormous scale. The elevation of Bryce Canyon's airport is nearly 7,600 feet, one of the highest in the United States. At that altitude the air is so thin that the plane had to struggle to find enough air to support it. We rolled down the runway, using 1,000 feet of distance, 2,000, 3,000, enough that the plane would have been aloft anywhere else. Finally it was going fast enough to build sufficient air pressure for lift. It edged up, and we headed toward the surrounding peaks.

For the next three hours, thin air and mighty peaks were the theme. Finally, as turbulence picked up from a storm moving through the northern Rockies, we went to 15,500 feet -- an altitude at which we were required to breathe oxygen. Objectively we were fine -- 4,000 feet over the nearest mountains, in a strong new plane just purring along, but the nonobjective part of my brain began to worry. The peaks below were menacing; in my mind, I started ticking off the safety features of the plane.

Over the last 50 years, small airplanes, like big ones, have become far more reliable mechanically. Year by year, the number of deaths in general aviation has declined. In 1998, there were 361 crashes, killing 621 people. The fatal-accident rate per hours flown was the lowest ever, 1.35 per 100,000 hours. So far in 1999 there have been fewer deaths, with more hours flown. Mechanical failures account for about 10 percent of all fatalities. The great majority of people who die in small planes die the way John Kennedy apparently did: by suddenly getting into "instrument meteorological conditions" -- flying inside a cloud, in haze, over water or unlighted terrain at night or in some other way that prevents a pilot from seeing the horizon -- in which a mechanically sound plane can no longer be controlled. For reasons that sound unconvincing until you try it yourself, it's impossible to keep an airplane level when you can't see the horizon -- unless you have been trained to comprehend the artificial-horizon and other instruments in the plane.

There's an assumption in aviation that if you don't like these potential hazards, you should stick to cars. But the Klapmeiers disagree. "No matter how good a pilot is, he's inevitably going to make mistakes," Alan says. "The cost of the mistakes shouldn't be death." The question for the Klapmeiers, as they tried to design a new plane, was how to make one that reduced both the opportunities for human error and the fatalities when errors unavoidably occur.

One way was to reduce the "pilot workload" -- all those switches to flip and gauges to check -- involved in flying a plane. Therefore the Cirrus was designed with fixed rather than retractable wheels (to avoid the "My God, did I lower the gear?" panic just before landing) and a variety of other simplified controls. The cuffs on the Cirrus's wings, the first Federal Aviation Administration-approved application of this concept, which was developed at NASA, allow the pilot to worry less about putting the plane into a stall or spin. And the large, vivid "moving map" in the center of the control panel enables pilots to take in their position in a single glance instead of through a variety of laborious calculations.

Accidents that do happen are also potentially less damaging, thanks to changes in the airplane's structure. The Cirrus has different, better seat belts, seats engineered to let the occupant survive as much as a 26G vertical drop and a fiberglass construction that affords crumple space to absorb shock, like modern car bumpers. And it has a parachute -- for the entire plane.

The parachute is the most radical and weirdly controversial feature of the Cirrus. Old-school pilots grumble that they'd rather have the extra 83 pounds (for the chute and supporting structure) for their own payload. But in his early days in flying, Alan Klapmeier was involved in a midair collision -- another small plane, taking off into the sun, hit his and knocked off a portion of the plane's wing- and he thought it was a miracle that his instructor steered the crippled craft to the runway for landing. "The effectiveness of the parachute had been demonstrated with experimental airplanes," says Paul Johnston, Cirrus's chief engineer. "But it was really Alan promoting the idea to us, because of his experience."

After some 40 test drops with parachutes -- first attached to big barrels of sand and eventually to real airplanes -- Cirrus developed a reliable parachute that should lower the plane to a survivable landing when all other options are exhausted. The plane would be severely damaged, but occupants should survive. "Veteran pilots will come up and tell me, 'Well, I'd never pull that thing,'" says Johnston. "But most people say, 'What a great idea.' To the uninitiated, it's a way to take the terror out of flying." As Alan puts it, "Even if no one uses the chute, there is a value in peace of mind."

Private planes, even ones with parachutes, may not be for everyone, any more than fancy R.V.'s are. But there is more in common between planes and luxury R.V.'s, Alan Klapmeier claims, than most people assume. An airplane lasts at least three times as long as a car, he says; it can be financed over at least three times as long a period; it retains considerable resale value when it is 20 or 30 years old, as cars do not. Therefore, by his calculation, the capital cost of owning and maintaining a Cirrus is roughly that of a $60,000 car.

Nevertheless, that's expensive. "But in 1997," he points out, "there were 965,000 automobiles sold in North America that exceeded $40,000 in cost. A great number of those people could have afforded to buy airplanes. So the reason people don't buy airplanes is not cost; it's that we haven't shown that they're practical."

The United States government seems to agree that personal aircraft, made fast, comfortable and safe, could be a practical alternative to our currently overloaded transportation systems. In a recent speech, Daniel Goldin , NASA's administrator, claimed that the impending saturation of the hub-and-spoke air network had already made airlines inefficient for all but the longest trips. On journeys of 300 to 400 miles, for instance, the effective "doorstep to destination" speed for airline trips, he says, now averages a mere 50 to 60 miles an hour. Using small airports can often increase this speed, because in cities, they are generally closer to business districts, and there are more of them in rural locations as well. Small planes are far more subject to weather delays than big planes, but weather permitting, they can go when the passenger wants, and can go more directly, avoiding hub-and-spoke connections. It is for such trips, of between 100 and 500 miles -- New York to Buffalo; San Jose to Santa Barbara; a nonhub site like Columbus, Ohio, to another one like Rochester -- that even slow small planes

can be better than any alternative. Or at least better for some people: it is hard to imagine great throngs being prepared to take up flying just to avoid long lines at the check-in counter.

After lunch at Scott's Bluff, Neb., we took off again and came up on a large cloud system. Passing though little wisps of cloud on a clear day is exhilarating, because the swirling mists give you a sense of how fast you actually move. But entering a full cloud bank changes all the perceptions. The air is suddenly rougher. The windows seem covered by cotton. Your attention switches exclusively to the instrument panel. We activated an instrument flight plan, and I tried to keep the plane on course.

The Cirrus was designed for instrument flight, but it was not designed to handle ice. Even a quarter-inch layer of ice on the wings can affect a plane's ability to fly -- a reminder that weather is a fundamental source of risk in flying. Inside the cloud, the air temperature fell below zero Celsius, and Gary Black kept checking the wings for the first sign of rime. When he saw it, I called the controller, below us as we passed over South Dakota, to request a descent to air warm enough to melt the ice. The controller handled the transaction with brisk, formula-phrase efficiency. Then he asked if this was really a Cirrus SR20. When assured that it was, he suddenly shifted out of controller-speak to human discourse. "I have wanted so much to see that plane," he said, "Maybe some day I can get to fly one. Come on back!"

Sixty minutes later, 1,700 miles and 10 hours of flying time after we left El Monte, we landed in the twilight near Lake Superior.

Cirrus must now convince people that flying its planes is a safe, viable alternative to other means of transportation -- no small challenge. More immediately, the company must gear up production. The factory in Duluth is a spare, white-painted, modern-looking structure, with vastly more floor space than is needed for current production levels. The Klapmeiers established the factory here in 1994 in large part because there was a huge airstrip available from a decommissioned Air Force base, and because the city was willing to offer some $2 million in investment and incentives. Since the summer of 1994, when the first mock-up of an SR20 was unveiled at an air show, Dale Klapmeier has been Mr. Inside, keeping the design, testing and production moving, and Alan has been Mr. Outside, endlessly working the hustings to raise the $70 million the company has spent on testing, development and production facilities.

The company has bounced from one financing emergency to another, the latest and potentially most threatening occurring after Scott Anderson, the test pilot, was killed. Although he had flown the test planes for Cirrus's parachute-drop tests, routine flight tests were conducted without a parachute.

Cirrus and the National Transportation Safety Board quickly located the problem. In certain maneuvers that put high stress on the wing -- and that would probably not occur except in deliberate tests -- the aileron (which makes the plane bank left or right) could become jammed against the wing. Cirrus redesigned the aileron and ran countless tests. Gary Black took the plane up for its first postcrash flight. At the time of the accident, the company had 249 "contract holders" for the SR20 --people who had put down a $15,000 nonrefundable deposit for the right to buy a plane when it came off the line. Four months later, when the first plane was delivered, the list numbered 333. In early November it reached 400. People on the list operate their own Web site, where the few who have taken delivery tantalize the others with accounts of the trips they take.

The brand-new plane in which I flew was the ninth SR20 built. The company is hoping to produce a plane every four days by the end of this year, and a plane every working day by next fall. That would move them through the current customer backlog in about two years.

When Tom Bergeron, the Cirrus salesman, dropped us off at El Monte, he asked me, "So, have you put down your deposit yet?" I laughed him off. "Come on, I'm still paying college bills!" I protested. But as I turned for a last look at the plane while driving away from Duluth, I thought: If I put down a deposit now, I wouldn't really have to start paying for at least two years. And my kids will be finishing college then.

Photos: Highway in the sky: A small company in Minnesota is betting that its Cirrus SR20 single-engine plane will transform civil aviation.; The flyboys of general aviation: Dale Klapmeier, above left, and his brother Alan founded Cirrus Design in 1984. Their factory in Duluth, right, produced the first SR20 for market last July. (Photographs by Paul Shambroom for The New York Times); Seeking safer skies: Scott Anderson, above center, was killed while piloting an SR20 prototype during a test flight in March. The finished product features a parachute, right, in case of mechanical failure. (photographs by Cirrus Design)

July 2000

The AGATE Flier

Information on developing technologies for business and personal transportation aircraft

Volume VI, Issue 1

The Datalink Infrastructure Facility (DIF) for AGATE

Ground stations, developed as part of the AGATE Program and designed to support special flight-testing, are now becoming operational. Initial experimental capabilities are being established at the NASA Langley Research Center in Hampton, Virginia, which include a fixed site and a transportable trailer that can be used at selected sites. "Installation of the fixed ground station at Langley and verification of its operational capabilities were successfully completed in May 2000. The first DIF Research Trailer was also delivered to NASA Langley in May and will be undergoing setup and acceptance testing with the fixed ground station throughout the June/July time period," said Dan DiCarlo, AGATE Integration Platforms Work Package Leader.

Both the ground station at Langley and the portable trailer have been designed as research tools, based on the future communications, navigation, and surveillance (CNS) systems needs for general aviation aircraft as established in the AGATE Program. According to DiCarlo, "What remains to be accomplished with the DIF stations, as part of AGATE, is to utilize these facilities to educate the public and demonstrate the basic capabilities of such a research system that will be available to other NASA programs. Such programs include the Small Aircraft Transportation System (SATS) Program, the Advanced Weather information (AWIN) Element of the Aviation Safety Program, the Advanced Air Transport Technologies (AATT) Program, and others."

The fixed ground station and the trailer include a wide assortment of equipment.

"One element of the equipment installed in both facilities is an array of radios, transmitters, receivers and transceivers, and accompanying antennae, to provide for both the standard analog Very High Frequency (VHF) radio as well as the digital VHF Data Link (VDL) capabilities. The VDL systems include multi-mode radios for both VDL Mode 2 (data only) and VDL Mode 3 (data plus voice) capabilities. Other components in the DIF stations include a Differential Global Positioning System (DGPS) for approach navigation and guidance, an Automatic Dependent Surveillance-Broadcast (ADS-B) Service, and a Local Weather Station," said DiCarlo.

Tim Coons
Chairman, AGATE Alliance Association, Inc.

"The AGATE effort has produced exciting new product innovations creating a path to a national Small Aircraft Transportation System. New technology must be tested and evolved to insure safe implementation. The DIF provides an environment to test and evaluate this new technology at a minimum risk . "

The DIF stations will also provide additional capabilities to new and existing airports and airplanes. DiCarlo added, "These

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DIF console in the fixed DIF central facility at NASA Langley Research Center in Hampton, Va. The console is outfitted with equipment intended to assist in flight communications and flight monitoring.

DIF Research Trailer. The DIF trailer offers the same capabilities of the fixed DIF central facility, but is a transportable facility.

From the desk of the Program Manager

Dr. Bruce J. Holmes, NASA Langley Research Center

The AGATE research program ends in just over one year from the date of this publication. The life cycle of the AGATE Alliance will have been eight years from beginning to end. In addition to the lessons we have learned in design and operations of public-private collaboration, one of the many lessons we are learning is the need for an exit strategy, a plan for completing the work of the Alliance, in preparation for what comes next. In our case, we face the challenge of implementing an AGATE exit strategy that also creates the transition strategy for the beginning of the Small Aircraft Transportation System (SATS) research. The AGATE exit strategy and SATS transition includes three key elements: ***new stakeholders, new outcomes, and new partners.***

New Stakeholders. The transition from AGATE to SATS is at one level very logical: we are moving from a focus on the aircraft (with aviation industry as the stakeholders) to a focus on airspace and airports architecture and new operational capabilities (with the states as stakeholders). However, this transition is critical to understand in that our new stakeholders are the states. This means that our technology priorities are driven by transportation accessibility for the purpose of economic opportunity. State economic development, transportation and other civic leaders have taken the lead in promoting SATS. They recognize that the states are the beneficiaries of SATS transportation technologies, which enable accessibility and mobility and therefore create economic opportunity. This means that our technology investments in SATS will be prioritized in the interest of creating near-all-weather accessibility for every community in the nation, not just the 10-15 percent with precision approach ILS systems today.

Let me share a recent experience that illustrates the kind of energy that surrounds the notion of accessibility-driven economic opportunity that SATS represents to the states. The Economic Development Council of Weatherford, Oklahoma recently hosted the "First SATS Exposition" on June 23 at their local airport, Stafford Field. Weatherford is a mid-sized western Oklahoma town, with a population of 10,000, 75 miles west of Oklahoma City, on historic Route 66, the home of General Tom Stafford (Gemini and Apollo), the OK Southwestern University Fighting Dawgs, and the State Championship Football Team; a proud town! Their airport has neither the resources nor the land for traditional lighting and runway protection zones to afford traditional ILS-based precision approaches. Yet their airport director made it clear to me in my recent visit that the need is great for more access in more weather conditions.

The purpose of the SATS Expo was to educate the Oklahoma political leadership and local population on the value of the SATS concept to western Oklahomans. The event was attended by several state and local dignitaries, including U.S. Senator Jim Inhofe, Lt. Gov. Mary Fallin, General Stafford (for the dedication of his air & space museum at the airport named after him), Mayor Gary Rader, Oklahoma Aerospace Commission Director Dr. Bill Miller, and several state legislators, in addition to several hundred local residents. I am told that over 15, 000 people attended the two-day event. The event included numerous industry exhibits, as well as a NASA AGATE and SATS exhibits loaned by Langley.

Congressman Frank D. Lucas (6th District) invited me to participate and present NASA's vision for SATS. As part of the event, I presented the $10,000 award to the University of Oklahoma winning team for the National Design Competition in the "Design It, Build It, Fly It" category. The Mayor presented me with the Keys to the City. Oklahoma City as well as local media covered the event.

The response of western Oklahomans to the SATS vision was very supportive. This part of the Midwest lacks air accessibility. In their words, they want SATS "so that their sons and daughters can have high paying jobs in the cities like Dallas, Oklahoma City, Tulsa, or Wichita, and yet live and raise their children in their hometown." They recognize that the SATS vision is a long-term endeavor, and that they need to take a leadership position for the concept to take root in their locale. The vision for this event was the work of Mr. Ordis Copeland, their Economic Development Director. The Weatherford SATS Expo illustrates the value of air access as the necessary ingredient to complement web-enabled eCommerce in the information age. It also illustrates the nature of our new stakeholders in planning SATS research investments and partnerships.

New Technologies. AGATE established the essential technology foundations for SATS. Where AGATE explored the means to raise the technology deployment capacity of the industry and government working together, SATS will explore new technologies aimed at changing the way we think about airspace architecture, air traffic management, separation, sequencing, instrument approach procedures, and operations in non-radar airspace, and at non-towered airports. The partners in AGATE can take a bow: without the progress of the AGATE Alliance, we would not be in a position to consider the development of SATS research investments.

The specific projects proposed for SATS research include (1) Virtual Visual Meteorological Conditions (VMC), (2) High Density Operations, and (3) Automotive Synergies. The first two are technology development efforts, while the third, Automotive Synergies, would provide a technology systems integration approach for the program. We envision the U.S. automotive industry as potential key partners in SATS research.

Virtual VMC research will explore the limits of the use of panoramic virtual displays of airport and runway environments in

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Highway-in-the-Sky (HITS) Development Progresses on Schedule

The AGATE Highway-In-The-Sky (HITS) system is progressing on schedule and promises to revolutionize General Aviation cockpit and aircraft operations. The much-anticipated system was demonstrated to the public in the cockpit of a Lancair Columbia 300 aircraft at this year's Sun-N-Fun Fly-In at Lakeland, Fla. At this demonstration, AGATE Flight Systems Work Package Leader Walter Green formally accepted the Phase I portion of the system.

Early evaluations of the system from the public have been positive. "The people trying out the system were surveyed at the demonstration and data was collected with regard to pilot acceptance of the new glass panel displays for GA airplanes, which was favorable," said Green.

According to Green, the Phase II HITS is progressing. Phase II for AGATE HITS displays is on schedule as planned for completion in August 2001 despite some minor support glitches. The high risk for the project is our ability to certify new technologies in the short time remaining to complete the AGATE Project, such as the Attitude, Heading Reference System (AHRS) and the Databus availability to HITS team participants. Risk mitigation techniques are being applied to minimize these risks," he said.

Despite the risks that still lie ahead, AGATE's HITS development efforts are setting a precedent. "The AGATE work in HITS displays has spurred the general aviation avionics industry to develop competing systems that will change the standards for flying and controlling airplanes of all sizes. HITS technology presents graphic information directly to the pilot. This information includes the position, attitude, and location of the airplane, as well as air traffic and weather obstacles along the intended route. There will no longer be the need for pilots to gather data from discrete instruments and form a mental image of the situation and react. This graphic interface with the pilot provided by HITS will enhance flight safety and assist in preventing accidents that are attributed to a pilot's loss of situational awareness leading to loss of control," said Green. The plans for HITS in the future are as ambitious as those set for the system in Phase I of the project. "It is planned that the AGATE HITS Phase II display system will become the industry standard in the near future, and that the certification efforts will be successful," he said. □

HITS Phase II Lancair Columbia 300 Installation

HITS Phase I glass panel displays: (left) navigational display showing horizon and relative altitude and (right) weather display showing weather obstacles.

NASA General Aviation Program Office Director Dr. Bruce Holmes shows NASA Administrator Dan Goldin the HITS system at Marshall Space Flight Center.

University of Oklahoma Wins Design It, Build It, Fly It Competition

A group of student engineers from the University of Oklahoma in Norman, Oklahoma working to create safer, more crashworthy seating for General Aviation passengers has won the Design It, Build It, Fly It award of the National General Aviation Design Competition. The student team, working under the guidance of faculty advisor Karl Bergey, will receive a $10,000 grant to take the team's highly innovative seat designs through a proof-of-concept phase. The students will also receive an award of $500 from the Experimental Aircraft Association (EAA), the award co-sponsor, upon presentation of the final results of their work at the EAA's AirVenture 2000 in Oshkosh, Wisconsin.

The National General Aviation Design Competition, which is sponsored by NASA and the Federal Aviation Administration, encourages university student teams to participate in a national effort to revitalize general aviation. This category allows students to take a well-evolved design to a proof-of-concept phase. The University of Oklahoma award is the second to be made in this category. An earlier version of the seat design won the Design with Best Retrofit Potential award in the 1999 General Aviation Design Competition, which was sponsored by the Aircraft Owners and Pilots Association (AOPA).

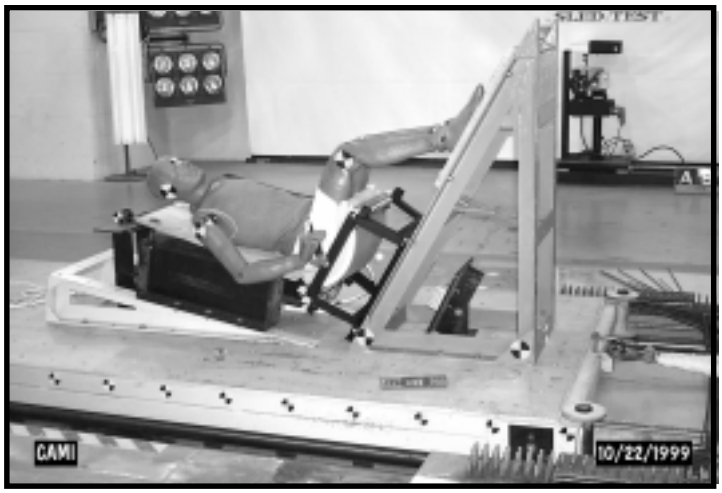

photo courtesy of University of Oklahoma

Energy absorbing aircraft seat developed by University of Oklahoma team rigged for testing.

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NASA SBIR Technologies in Retrofit Market

Evidence of the success of the AGATE/Small Business Innovation Research (SBIR)/Small Business Technology Transfer Research (STTR) partnership is clear in the general aviation (GA) retrofit market. The application of advanced technologies developed through this partnership is helping to revitalize the GA industry.

A major success story of the AGATE/SBIR/STTR partnership has been in the area of cockpit information technology systems. Through a NASA SBIR Phase II contract, ARNAV Systems, Inc. of Puyallup, Wash. has developed graphical Weather in the Cockpit information that can be transmitted from the ground to the cockpit via low cost datalink. The ARNAV Weather in the Cockpit System utilizes GPS navigation, graphical cockpit displays, and wireless datalink equipment. Weather in the Cockpit is being used in the AGATE and AWIN programs for a weather display on a moving map that enhances situational awareness and in two-way datalink communications and a cockpit display of traffic. In the commercial market, sales of datalink and display products surpassed $2.5 million in 1999, with expected orders in excess of $30 million over the next 5 years.

Another AGATE partner, AvroTec, has done pioneering work in the area of cockpit display systems through a NASA SBIR Phase II contract. The company has developed an open architecture PC-10.4 inch color, sunlight readable display for GA aircraft cockpits, which has been applied in the form of a moving map navigational system installed and certified in the new Lancair Columbia 300 series of aircraft.

A NASA SBIR Phase II agreement has helped Ballistic Recovery Systems (BRS), Inc., of St. Paul, Minnesota, introduce parachute recovery technology that will enhance safety in the GA market. BRS has worked to develop new lightweight and more durable recovery parachute systems for stabilizing and safely returning an aircraft to the ground in the event of a problem or mishap. BRS's recovery parachutes are being applied to the new Cirrus SR20 series of aircraft. One hundred SR20s are being sold each year with a backlog of 600 to date.

AGATE member Cirrus Design of Duluth, Minn. has benefited tremendously from its partnership with NASA, developing a low cost design and manufacturing method for composite control surfaces under an SBIR Phase II agreement. The design and manufacturing method is being used to produce the Cirrus SR20 series of aircraft.

AGATE member Mod Works of Punta Gorda, Florida has made a major impact on the GA retrofit market. Under a NASA SBIR Phase II contract, Mod Works developed low cost design and manufacturing technology for ergonomic small airplane cockpits. Using the technology, direct female molds are produced from 3D computer models. The instrument panel has resulted in decreased pilot work load and labor required for installation. Commercial sales of the Mod Works technology totaled $500,000 by 2000 and are expected to reach the $1,000,000 level on an annual basis by 2002. Mod Works has formed a partnership with Stoddard-Hamilton to manufacture and sell low drag cowlings using the technology.

Vision Micro Design Of Bellingham, Wash. developed

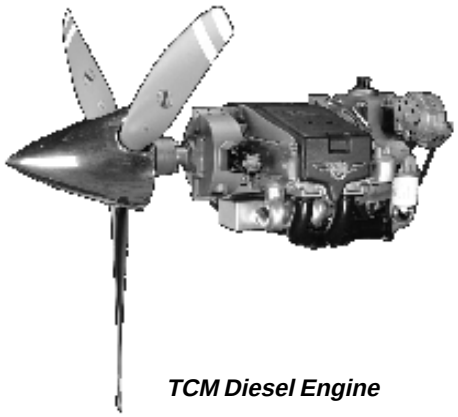
(Continued on page 7)

General Aviation Propulsion (GAP) Program Efforts Shift into High Gear

Efforts to develop revolutionary propulsion systems for general aviation aircraft are shifting into high gear under the auspices of the General Aviation Propulsion (GAP) Program. The products of these efforts, an advanced turbofan engine for jet-powered aircraft and an advanced diesel engine for propeller-driven aircraft that promise greater efficiency, enhanced safety during flight, and much lower costs, are nearing completion and are being awaited by GA consumers with great anticipation.

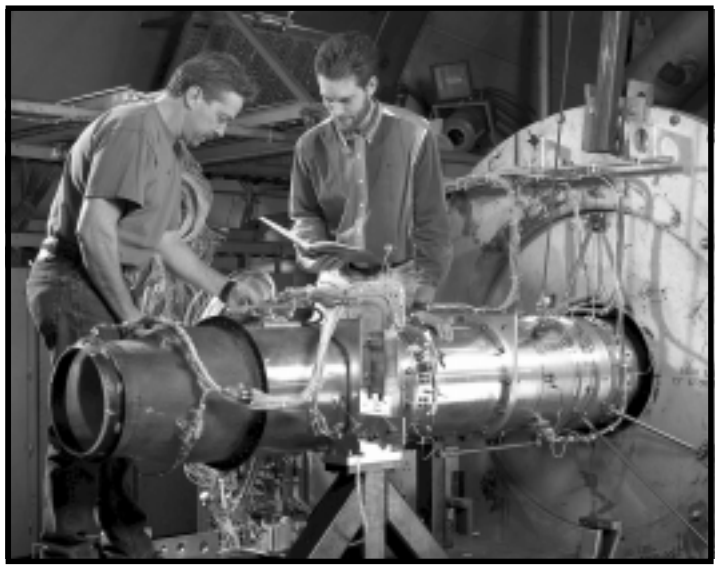
Both engines have passed tests on test stands. "The Williams FJX-2 turbofan engine was tested in Glenn Research Center's PSL (Propulsion System Laboratory) altitude test facility in April. A turboprop version of the engine is also running on a test stand at Williams International. The Teledyne Continental Motors (TCM) Diesel engine is running on dynamometer and propeller test stands at TCM. ModWorks Inc., a Florida based company with an excellent reputation for aircraft modification and modernizations, is in the process of installing the diesel engine in the front engine compartment of a Cessna 337 aircraft. This is the aircraft that will be used for flight testing of the diesel engine. Plans for the FJX-2 to be flight demonstrated at AirVenture 2000 have been changed in order to install the engine

(Continued on page 7)

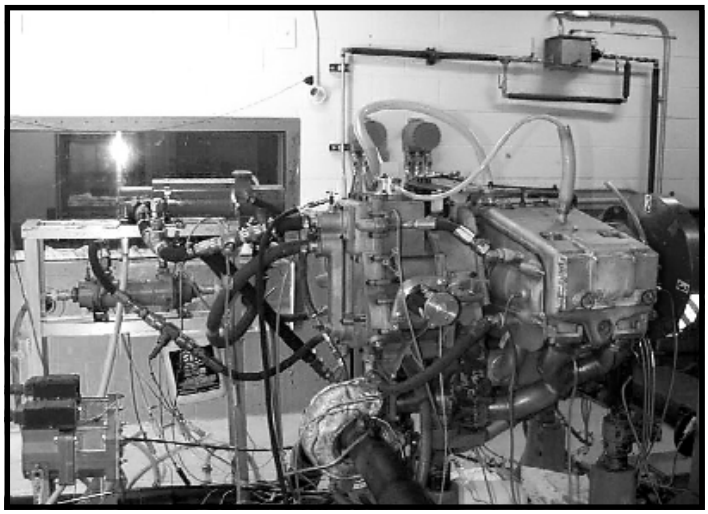


TCM Diesel Engine

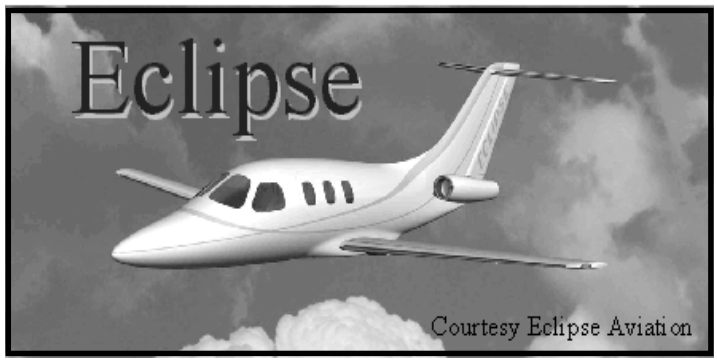
FJX-2 Turbine Engine



FJX-2 turbine engine in PSL test cell at NASA Glenn Research Center



TCM Diesel Engine in test cell at TCM



Eclipse aircraft to be powered by two FJX-2 turbine engines

Message from the Director of the AGATE Alliance Association, Inc.

Jack Sheehan

The AGATE Alliance is nearly seven years old. Within this relatively short period of time, the accomplishments of the alliance are often talked about in the context of commercial products. Although the commercialization efforts are ultimately the measure of success, there are many additional measures of success that we can use when we evaluate the stated objectives and purpose of the program and the alliance.

The revitalization of the general aviation industry was the primary objective; however, the secondary objective was simply stated as the reinvention of government. With respect to the primary objective AGATE cannot claim credit for what appears to be a very successful turnaround of the industry. The AGATE program should be viewed as a catalyst. The commitment of the industry, its trade associations and the entrepreneurs are ultimately responsible for the outward signs of a revitalized industry. The secondary objective of reinventing government must also be viewed in context. The objective certainly did not include all government but really referred to the relationships between the government members of the alliance and the industry. The manner in which the huge organizations of NASA and the FAA now interact with industry through the alliance has in fact reinvented this small portion of government.

In retrospect, the secondary objective may prove to be the most significant accomplishment of the alliance. The ability to work with the federal government and establish clear pathways for certification of new technologies, evaluate the impact of the technologies on certification and to finally establish measures of performance and reliability as a team during the development process will ultimately enable industry to bring technologies forward that will not only spur commercialization but increase safety.

As we look to the future and the Small Aircraft Transportation System (SATS) program, we can do so with the realization that we have a much sounder industry base. More importantly we now have a strong alliance based on technology. This type of an alliance and its objectives are significantly different than either a trade association or a standards setting organization. This alliance in particular has the unique advantage of having accomplished the goal of reinventing our relationship with the government partners. This relationship goes beyond the efforts of certification. The partnership we have established has added definition to the term "partnering." It is important, that as we move forward into the SATS program, we take with us, as an industry, not only the alliance we have formed but also the processes and procedures we have established with our government partners. We can continue to improve but we don't need to reinvent.□

DIF for AGATE

(Continued from page 1)

facilities can also provide such features as: Flight Information Services Broadcast (FIS-B), i.e. weather information service; Automated and Manual Controller Pilot Data Link Communications (CPDLC); Highway-In-the-Sky (HITS) Datalink Interface for Flight Plan Changes; Automated Taxi, Traffic in the Pattern and Landing Instructions; and Digital ATIS (Air Traffic Information System). The goal is to make even the smallest, non-towered airport in America as safe and convenient as the largest towered facilities."

The addition of a research trailer to the experimental inventory gives AGATE planners more flexibility. DiCarlo noted, "There are no differences between the systems/capabilities associated with the fixed ground facility at Langley and those that have been installed in the DIF trailer. The fact that the trailer is mobile enables us to move it to various remote locations, which is an important element to the research aspects associated with such a facility. Communication links between the trailer and the fixed ground stations will include voice and ADS-B message."

The General Aviation Program Office (GAPO) has envisioned that utilizing such ground test facilities will create an electronic research environment that will be a valuable asset to ongoing and future general aviation programs. "The DIF was designed to support research on and demonstration of technologies created within the AGATE Program and, in turn, can be used as part of follow-on NASA programs. As an example, one element of the DIF fixed station is being used to support the Convective Weather Sources (CoWS) experiment that is being conducted as part of the AWIN project at Langley. There are plans to use the DIF trailer as part of the general aviation exhibits at Oshkosh, Wisconsin, during AirVenture 2000 and 2001, and at other general aviation related venues as schedules permit. It is also anticipated that part of the research to be conducted with the DIF facilities is the development of an experimental Air Traffic Management (ATM) workstation. This will be carried out as a collaborative effort between the NASA GAPO, FAA Hughes Technical Center in Atlantic City, New Jersey, Research Triangle Institute, and Harris Corporation. Included will be establishing an ATM concept, the system and performance requirements, and testing needs. Once the ATM functions have been defined, the physical architecture of the DIF and the interfaces to implement such functions will be identified and completed. Such a tool will then assist the FAA with the development of the operational procedures necessary to allow the advanced communications, navigation, and surveillance concepts to be incorporated into the future National Airspace System (NAS). Ultimately, using the DIF capabilities will result in low-cost, autonomous CNS systems that could be incorporated at local airports as a part of the overall future airspace system," DiCarlo added.□

GAP Program Efforts Shift into High Gear

(Continued from page 5)

type in an Eclipse aircraft. Williams would have had a difficult time supporting both the GAP flight demonstration and the development schedule required for the Eclipse, so the GAP program management deleted the requirement for the flight demonstration since commercialization of the technology is the most important outcome of the GAP program," said GAP Program Manager Leo Burkardt.

The GAP program has had strong support and synergy from its constituents. The FAA is participating on a consultative basis concerning certification issues on the engines, while two contractor teams have partnered with NASA for engine development. The industry lead for the Intermittent Combustion Engine (diesel engine) Element is Teledyne Continental Motors. Their partners on the team are Aerosance, Cirrus, Lancair, Hartzell, and ModWorks. The industry lead for the Turbine Engine (turbofan engine) Element is Williams International. Their partners on the team are Cessna, Cirrus, Forged Metals Inc., California Dropped Forge, Unison, Lancair, Piper, Raytheon, Visionaire, Bell Helicopter and sub-contactors Scaled Composites and Producto (a machine tool company).

The implications of Williams International providing a turbofan engine to Eclipse Aviation are great and far-reaching. "We believe that the lowcost turbine engine is going to change the complexion of the general aviation light aircraft market segment and open up a whole new market. With aircraft such as the Eclipse enabled by the FJX-2, smaller businesses which could not afford their own aircraft before will now be able to. Air taxi between small airports at the cost of an airline ticket or less will be possible, so you can travel when and where you want reliably and in comfort at an affordable price. As the engine and aircraft prices (AGATE technologies for airframe and avionics) come down further (especially single engine aircraft) with production increases and further improvements, a jet aircraft at a very affordable price for the individual buyer becomes a real possibility. I believe jet aircraft will dominate the GA market in the mid-to-upper performance class aircraft market in the not too distant future," said Burkardt.

GAP is having a major impact on the mission of revitalizing general aviation. As stated by Burkardt, "I believe the synergistic impact of the GAP program and AGATE is greater than the sum of the two parts. The GA market will not only be revitalized, but it will be redefined, with aircraft like the Eclipse being the first baby step in that direction."

Plans have been made to initiate a follow-on program to GAP once the program closes out at the end of FY00, which would occur under the Small Aircraft Transportation System (SATS) Program. However, according to Burkardt, "at the current proposed SATS funding levels it cannot be implemented."

For all intents and purposes, GAP has been a major success. "Because of the need to develop new engines, GAP was oriented to applying and stretching the state-of-the-art to two modern engine designs. This was accomplished with outstanding results in what are two truly revolutionary new engines. A follow-on project will be oriented toward a quantum leap in the state-of-the-art of small propulsion systems that will enable affordable personal/family air vehicles providing true doorstep to destination operation in a passenger and community-friendly manner," he said. □

NASA SBIR Technologies

(Continued from page 4)

a low cost, intelligent digital engine health monitoring system for GA aircraft through a NASA SBIR Phase II contract. This system significantly decreases the pilot's engine management workload and enhances safety and reliability. Over 1000 of these systems have been sold to GA customers.

Through a NASA SBIR Phase II agreement, Lightning Technologies Inc. (LTI) of Pittsfield, Massachusetts, developed the EquiPlane Cockpit Design technology which offers protection for new digital avionics systems from dangerous lightning strikes at a lower cost. Using this technology, LTI provided design and testing services to two new GA aircraft manufacturers and one GA retrofit company. Revenues from these services amounted to $500,000.

The Design and Research (DAR) Corporation of Lawrence, Kansas, developed its Advanced Aircraft Analysis and Aero-CADD software through a NASA SBIR Phase II contract. The software enables one to custom design GA aircraft and small business jets. This technology has produced over $1,000,000 in sales revenues. In addition, DAR has targeted the GA industry and universities for its marketing efforts. □

Schedule of Events

July 26 – August 1, 2000

Oshkosh, Wisconsin

AirVenture 2000—

- *AGATE Programmatic displays in Hangar Bldg.*
- *Integrated Design and Manufacturing and Flight Training Curriculum*

Technical Council Meetings

Eight Companies Join AGATE

Eight companies have become AGATE members. These companies bring with them diverse talent , offerings, and expertise that promise to help the consortium attain its objective of revitalizing the general aviation industry.

British Aerospace (BAE) Systems, a venture consisting of a merger between British Aerospace (BAe) and Marconi Electronic Systems (MES), is one of the largest companies to join AGATE. BAE Systems provides leading edge technology systems in the areas of electronics and sensors to customers throughout the world *(corporate point-of-contact: Russell Lilly 310-915-8378; company website: http://www.baesystems.com)*.

With offices and facilities in Grand Rapids, Mich. and Columbus, Ohio BFGoodrich Avionics specializes in the development of advanced avionics systems for civil and military aircraft. Other divisions of the company produce evacuation slides, deicing equipment, wheels and brakes, sensors, engine electrical systems, landing gear, and test systems and provide component services and repair *(corporate point-of-contact: Doug Gibbs 614-825-2211; company website: http://www.bfgavionics.com)*.

Echelon Systems has developed a strong background in wireless networking and Internet-related technologies and is seeking to apply this expertise to the GA field. Echelon is a wireless telecommunications network provider and develops items for satellite and pcs systems. In addition, the company produces and markets wireless local area network (LAN) items *(corporate point-of-contact: Kenneth Oshman 415-855-7400; company website: http://www.echelon.com)*.

Eclipse Aviation is seeking to play a major role in revitalizing the GA industry through the introduction of its Eclipse 500 turbofan-powered light jet aircraft into the market. The company hopes that the jet will bring to the public the experience of jet-powered flight at an affordable price *(corporate point-of-contact: Vern Rayburn 480-368-7978; company website: http://www.eclipseaviation.com)*.

Garmin Industries is a leading manufacturer of Global Positioning Satellite (GPS) systems, including personal navigation units that can be carried by people. Garmin is seeking to further apply its specialty to the GA industry through AGATE *(corporate point-of-contact: Gary Burell 913-397-8200; company website: http://www.garmin.com)*.

Noegenesis is presently engaged in the development of an advanced three dimensional weather situational awareness product designed for GA use. A prototype system featuring the joining of multiple live weather phenomena data with 3D moving map technology has captured the interest of AGATE *(corporate point-of-contact: Michael Aratow 650-968-9517; company website: http://www.noegenesis.com)*

The Safire Aircraft Company is the manufacturer of the Safire Personal Jet series of aircraft, powered by turbofan jet engines. The company is presently pursuing production of the first aircraft in this series, the S-26 *(corporate point-of-contact: Michael Margaritoff 561-655-6669; company website: http://www.safireaircraft.com)*. □

Design It, Build It, Fly It Competition

(Continued from page 4)

Senior aerospace engineering design students at the University of Oklahoma are designing and building a four-place high performance general aviation aircraft, the BAC S28R Cougar, that incorporates a number of innovative design features and complies with current FAA requirements for aircraft certification. Over a period of two years, 22 aerospace and mechanical engineering students have been involved in the project. The purpose of the project is to demonstrate the suitability of these features for incorporation into general aviation aircraft, either in new designs or through retrofit to the existing fleet.

The energy absorbing seat design is part of the full aircraft development. The goal for the team's seat design is to create a lightweight, low cost, energy-absorbing, crashworthy seat that would meet the lumbar loading requirements of federal aviation regulations. The seat design will help dissipate excess energy and prevent lower back and pelvic injuries.

The team used a variety of static and dynamic tests to narrow the type of material that should be used. The goal is to design the seat such that the occupant loads would be dissipated in the seat pan rather than the seat frame itself. The seat pan is made of expanded carbon steel, which has been slit and expanded or drawn into an open mesh pattern in a single operation without loss of metal. This process creates a material that is stronger per pound and absorbs impact energy through plastic deformation. The resulting material looks much like a diamond-patterned chain link fence. Early tests using a tapered seat pan have indicated its capability to minimize loads on a passenger's spinal column.

Karl Bergey, faculty advisor, said, "The purpose of the program is to provide hands-on design and fabrication experience for the student aerospace engineers. In a computer-dominated educational system, the requirements for real world engineering judgment are often neglected. The Cougar project supplies that linkage."

Oklahoma students will use the award to undertake additional testing to refine the design of the seat pan and to validate the results of their previous static and dynamic tests. Since the seat pan design is fairly well evolved, the design of the seat back will be the focus of analysis and testing for optimum configuration, design and strength.

The National General Aviation Design Competition iscoordinated for NASA by the Virginia Space Grant Consortium. Copies of the guidelines for the 2000–2001 Academic Year Competition can be requested by calling 757/865-0726 or emailing msandy@odu.edu. □

Management and Technical Progress Highlights

Integrated Design & Manufacturing

Wichita State University presented an overview of the Bi-axial Braid/RTM Qualification test program and results and delivered the raw data. These data have been reviewed and arranged into conventional lamina allowable format and published in-house to support certification activities on the Premier I wing flaps. A copy of the allowables has been delivered to the FAA. The AGATE Advanced Materials program will be given credit for a nationally recognized standard setting effort.

The overhead console conceptual work for Mod Works' interior project has been completed, the control dimensions established, hardware vendor search completed, and hardware selected. The effort is 10 percent complete. Planned completion for modeling is in March 2001.

About half of the PY1999 year-end report for the Crashworthy Airplane program has been completed. The report provides guidance for the design of crashworthy AGATE aircraft. It addresses the design of energy absorbing features, such as the engine mount and subfloor, as well as the design of an antiplowing firewall. An MSC/DYTRAN model with thicker honeycomb in the forebody sidewalls and a small firewall ramp has been run. There was little difference in accelerations and gross motion compared to previous models. The model is being further modified to include a larger ramp, the nose wheel well, a tunnel structure to stiffen the floor and carry loads from the firewall to the wing saddle area, reinforcements in the sidewalls, and a modified engine mount to accomodate the firewall ramp. The addition of an energy absorbing engine mount and subfloor are expected to improve the crashworthy performance of the aircraft. The static testing phase of the corrugated steel tube energy absorber (EA) was completed. In general, the energy absorbers show good load-deflection characteristics and good repeatability. In addition to providing good energy absorbing performance, this design can be manufactured at significantly lower cost than alternative EA designs.

Integration Platforms

Harris Corp. received DIF trailers and started console and radio rack integration. Harris Corp. received all material for trailer #1. The Work Package System Engineer (RTI) coordinated shipment of the Rockwell Collins Differential GPS ground station to NASA Langley Research Center (LaRC) in anticipation of GPS antenna installation being complete during the first few weeks of February. The Work Package continued the coordination of the equipment content of the first portable DIF trailer for the meeting in Lakeland, Florida in April 2000 with the contractors who had equipment in the DIF trailer.

In May 2000, Harris delivered the first DIF trailer to NASA Langley and underwent setup and acceptance testing with the fixed ground station in the Langley Flight Operations Support Center. At the same time, Rockwell Collins also participated in minor modifications to the installation of various components and antennae at the Langley Hangar Building.

In March 2000, the Work Package presented the FY'01 budget proposal for the Work Package to the AGATE Management Team (AMT), in preparation of a balanced budget for the AGATE program to subsequently be presented to the Executive Council at Lakeland.

Program Analysis

Data from the market survey continues to come in. A recent sampling of the data shows that 2,400 people expressed that they were GA aicraft owners and pilots and 2,027 people indicated that they were pilots but not owners of GA aircraft. When asked the question: Would you pay $100, (or$175, or $250 based upon random number assignment to survey respondent) to be able to reduce your automobile travel time by an hour by traveling in a small aircraft? 68 percent of the people surveyed agreed to paying $100, while 50 percent agreed to $175 and 40 percent to $250. When asked the question: Would you consider retrofitting your current airplane to take advantage of some of the new technologies and features that have been developed? 87 percent of those surveyed replied Yes.

The survey site may be accessed at http://apats.org and charts viewed at http://sats.nasa.gov/Presentations/Survey99/index.htm.

AGATE ALLIANCE MEMBERSHIP

Work Packages:
Flight Systems (FS)
Propulsion Sensors & Controls (PS&C)
Integrated Design & Manuufacturing (ID&M)
Ice Protection Systems (IPS)
AGATE Integration Platforms (AIP)
Flight Training Curricula (FTC)
Small Aircraft Transportation System (SATS)
Systems Assurance (SA)
Program Management (PM)

Type of Membership: P = Principal; A = Associate

Work Package Membership

Official Organization Name	FS WP-1	PS&C WP-2	ID&M WP-3	IPS WP-4	AIP WP-5	FTC WP-6	SATS WP-7	SA WP-11	PM WP-12
Advanced Creations Incorporated						P			
ARINC Incorporated	P								
ARNAV Systems Incorporated	P								
AVIDYNE Incorporated	P								
AvroTec Incorporated	P							P	
Cessna Aircraft Company	P		P					P	P
Cirrus Design Corporation			P						P
Embry-Riddle Aeronautical Univ.						P	P	P	P
Global Aircraft Corp.			P						
Harris Corporation	P				P				
Honeywell International	P								
Jeppesen Sanderson Incorporated	P					P			
Lancair International Incorporated			P						P
Mod Works Incorporated			P						P
Ohio State University						P			
Raytheon Aircraft Company	P		P					P	P
Rockwell Collins Commercial Avionics	P				P			P	
Seagull Technology Incorporated	P								
Simula Government Products Incorporated			P						
Stoddard-Hamilton Aircraft Incorporated			P						P
Wichita State University-NIAR			A				A	A	

SUPPORTING MEMBERS

A&P Technology, Inc.
Aerocar Llc.
AGATE Alliance Association Incorporated (AAAI)
AOPA-Air Safety Foundation
BAE Systems
BFGoodrich Aerospace
Executive Jet Incorporated
Experimental Aircraft Association (EAA)
Fibrecote Industries Incorporated
Garmin International
General Aviation Manufacturers Association (GAMA)
Innovative Dynamics Incorporated
Mississippi State University-Raspet Research Lab
National Center for Atmospheric Research
Neogenesis
New Piper Aircraft Incorporated
NYMA
Optimal Solutions Incorporated
Research Triangle Institute
Safire Aircraft Company
Science Applications International Incorporated (SAIC)
Starnet
Teledyne Continental Motors
Toray Composites America Incorporated
Unison Industries
United Technologies Hamilton Sunstrand
University of Alabama
University of Illinois at Urbana-Champaign
University of Kansas
University of Tennessee Space Institute
University Research Foundation
Virginia Tech
Williams International

GOVERNMENT PARTNERS

Federal Aviation Administration
NASA Langley Research Center
NASA Glenn Research Center
USAF Research Laboratories (Wright Directorate)

From the desk of the Program Manager

(Continued from page 2)

making low-visibility takeoffs and landings safe, practical, and possible. We will explore questions like, "What are the roles of a visual segment in approaches, approach lighting, traditional runway protection zones, or decision altitudes for instrument approaches when operating in a highly intuitive graphical cockpit environment (e.g., synthetic vision plus Highways in the Sky)?"

High Density Operations seek to prove that SATS airspace technologies enable safe high density operations in non-towered, non-radar airspace in near-all-weather conditions, as well as for seamless, non-interfering interoperability at facilities in Class B airspace. In some respects this research develops an infrastructureless, or "eFrastructure" concept for operations. We will explore questions like, "What are the safe and practical upper limits of air traffic density for SATS-compliant aircraft operating in non-radar airspace?" The "eFrastructure" concept is based on airborne-centric computational and digital communications capabilities as the basis for air traffic separation and sequencing.

Finally, Automotive Synergies research proposes to explore automotive systems integration for "Six-Sigma" quality and lean manufacturing technologies to radically reduce vehicle complexity, while revolutionizing safety, energy efficiency, and environmental acceptability of SATS aircraft. Here, we will explore questions like "What are the achievable lower limits for the cost of SATS vehicles using automotive design for cost and manufacturability technologies?"

New Partners. NASA envisions that the SATS program will operate through an alliance. The SATS alliance, however, will engage new partners. We envision that the states will organize

Student Pilot Becomes First to Graduate from AGATE Modified Unified Curriculum (MUC)

Student pilot Eric Eckman of Swedesboro, N.J. recently became the first student pilot to graduate from the AGATE Modified Unified Curriculum (MUC) and to receive a Private Certificate with an Instrument Rating following the first Integrated Private/ Instrument Check Ride. Eckman completed the course in 7 months, which included a one-month break for Christmas. His training was completed within the expected time frame.

"The MUC is a second iteration of the Unified Curriculum with changes made based on the results of the Unified Curriculum completed by students in 1999," said Dr. Steven Hampton, AGATE Flight Training Curriculum Work Package Leader. "New this time around has been the development and use of an Integrated Practical Test for the Private and Instrument. Three students have successfully taken and passed the test so far with several more expected to take the test in the coming weeks."

The MUC has been put into use in a relatively short period of time. "Development was begun last summer and completed in time for the fall semester. FAA approval of the Training Course Outline (TCO) was received one week prior to the semester and training beginning," said Dr. Hampton.

"The initiation of the MUC also featured an attempt to use the internet to support the ground training, and extensive use of curriculum-based training (CBT) from Jeppesen was made available to the instructors and students to use. The ability to have access to training materials through the internet was seen as the first step in providing "just in time" training in a low cost environment," he said.

To use the MUC, one needs to obtain a 141-57 Special Curriculum Course Notice and purchase the Curriculum from Jeppesen. Approval must be obtained through your local Flight Services District Office (FSDO).

For more information on the MUC, please contact:
Dr. Steven Hampton
Embry Riddle Aeronautical University
600 South Clyde Morris Boulevard
Daytona Beach, FL 32114-3900
Tel: (904) 226-6797
e-mail: hamptons@db.erau.edu

Courtesy of Embry-Riddle Aeronautical University

Eric Eckman became the first student pilot to graduate from the AGATE Modified Unified Curriculum, completing his training in 7 months.

intrastate partnerships between state transportation/aviation organizations, economic development leadership and the universities. These intrastate SATS partnerships, at either the state or regional level, would form the basis for interactions with NASA for their SATS research. We anticipate that automotive industry partners will engage as well. We also expect that the Federal Aviation Administration will engage in SATS research, through the alliance. Finally, we imagine that most if not all, AGATE Alliance partners will become involved either in the national or local SATS research activities in their states.

The experiences of AGATE have shown us how such alliances can be designed and operated, including how to engage the partnership administration functions through a non-profit organization. We envision that NASA will develop a set of criteria in collaboration with potential SATS partners, for the formation of a non-profit entity. This entity would become the mechanism through which we would implement the SATS research program. Current planning assumes favorable funding decisions from the Congress for an October 1, 2000 program launch.

The countdown continues. The AGATE program ends in September 2001, less than 15 months from the date of this publication. The AGATE membership has remained steady and the budget for the final year remains intact. The year 2000 partner commitments to date include 58 Principal, Associate, Supporting, and Government Members. These are the partners and programs committed to achieving world class research and technology deployment capacity for the U.S. general aviation lightplane industry, in support of creation of the Small Aircraft Transportation System. □

The AGATE Flier

Volume VI, Issue 1 July 2000

The AGATE Flier is published by the AGATE Alliance Association, Inc., a private, non-profit, membership organization founded to stimulate the development and dissemination of general aviation technology. ***The AGATE Flier*** reports on progress in a family of technology initiative and public/private aviation related activities to revitalize the U.S. GA industry, called AGATE-Advanced General Aviation Transport Experiments. The NASA Langley Research Center is the lead center for this program.

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For more information about AGATE please see the following website: http://agate.larc.nasa.gov

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Mail Stop 115
Hampton, VA 23681-0001
(757) 864-6124

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The AGATE Flier

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Information on developing technologies for business and personal transportation aircraft

Volume V, Issue 2

AGATE Certification Will Lead to a Safer General Aviation (GA) Fleet

The push to certify the products and processes of AGATE is leading to major safety enhancements in GA aircraft and GA aircraft flight operations. These enhancements are being experienced in the work of all of the technical work package areas working to make the AGATE project a success. The FAA-led AIR AGATE team, specifically organized to help expedite the certification process regarding GA-related issues, is playing a crucial role in facilitating the certification progress achieved within these technical work packages.

"Many unique organizational roles are performed within the FAA. On a functional level, and strictly considering only those roles most directly related to AGATE and the accomplishment of flight, there are basically two main areas of concern: aircraft and airmen certification. AIR AGATE performs, and therefore represents to AGATE, the aircraft certification role; AFS represents the airmen certification and aircraft operation roles. The NASA Small Aircraft Transportation System (SATS) program will more directly engage other functional parts of the FAA, for example, those dealing with airways/airspace and air traffic control facilities and infrastructure," said Robin Sova, FAA/AIR AGATE Point of Contact (POC).

"FAA rulemaking is an established, deliberate, and time consuming process, as is any standards setting process by any organization (e.g., RTCA, SAE, etc.). Since the FAA is not supposed to be in the business of designing or dictating aircraft design, AIR's rulemaking role frequently follows industry's design role, adopting as airworthiness design standards (e.g., FAR Part 23) those that have already found acceptance in industry. These standards were already viewed as safe, proven, minimum design requirements; rulemaking merely legitimized and standardized the practice. "

AIR AGATE is working to help certify AGATE's high-priority technology item, the Highway-in-the-Sky (HITS) System (left display). The system promises to dramatically improve aircraft flight safety.

Robin Sova
POC, FAA/AIR AGATE

"The achievements in GA certification should enable manufacturers to put more state-of-the-art technology into GA aircraft. This should enable consumers to have access to a higher level of safety in the operational regime than is currently available."

"Therefore, rulemaking via FAR changes in advance of proving new technologies, would require issuing a more abstract level of standard than is currently accepted as the norm. Given the timeframes and level of detail required to develop FAR changes, there are other acceptable means to assist and speed certification of new technologies: policy development and Special Conditions. The FARs are generally flexible enough to allow development of policy to incorporate new technologies; the FAA has used this approach in many AGATE-related efforts (e.g., AC 1309/1311 updates). A Special Condition is a one-time rule issued for a specific project; however, when the FAA sees a new wave of technology approaching, it can begin advance preparation of Special Conditions prior to receiving a project application; we are also doing this for AGATE-related issues," he said.

Several certification issues have been resolved within the AGATE technical work packages. In perhaps one of the most important work packages, the Flight Systems Work Package, the FAA/AIR AGATE team worked laboriously with work package team members to update Advisory Circulars (AC) 23.1309 and 23.1311, which were released in March 1999 with modifications regarding the acceptance of new levels of reliability and software assurance levels for the certification of GA systems. "The intent was to bring these requirements in line with GA aircraft certitude levels rather than Civil Transport aircraft levels in order to allow a more economically palatable solution for putting higher technology avionics in the GA cockpit," said Sova.

AIR AGATE has also spurred the creation of the General Aircraft Manufacturers Association (GAMA) Part 23 Air-

(Continued on page 3)

From the desk of the Program Manager

Dr. Bruce J. Holmes, NASA Langley Research Center

Innovation in aviation is one of the most challenging endeavors undertaken by any industrial or governmental organization. The reason is risk. The innovation process is fraught with risks: technical, financial, and market, but most significantly in certification and regulation. A core motivation for collaboration in the AGATE Alliance has been to mitigate these risks through the partnership's *common vision*, *cohesive voice,* and *shared strategic relevance*. In this issue of the AGATE Flier, you will read about the successes of the alliance in the advancement of aviation innovations through collaboration, with a focus on the vital roles of the FAA.

Common Vision. The General Aviation industry's diverse and diffuse nature makes effective interface with federal government organizations extraordinarily challenging. The term "General Aviation" has been used to classify literally hundreds of companies involved in engines, airframes, avionics, training, and sub-component vendors, but not to describe a single industry working with the federal government. NASA and the FAA, like all federal agencies, are faced with the challenge of being responsive to this array of partners and customers in an era of shrinking resources. The formation of the AGATE Alliance has provided the federal government and diverse elements of the General Aviation industry their first opportunity to form a common vision towards technology development, integration and certification. The resulting alliance is a self-contained means for industry to focus on national priorities in true partnership with the federal government.

One of the principal factors behind AGATE's success has been the leadership exhibited by the FAA in certification and regulatory reforms affecting the alliance's vision for revitalization. The AGATE Alliance provides a means for the industry to effectively interface with the FAA on the important issues affecting certification and regulation of the emerging technologies, even before product applications are fully defined. This interface is one of the key means of risk mitigation. The AGATE experiment in research collaboration taught us all the vital role of engaging both the certification and regulatory branches of the FAA, as well as instituting communication between the branches themselves, starting in the earliest stages of development of the partnership. Based on a clear view of a common vision for a new generation of aviation innovations, the FAA has been able to step forward in AGATE to provide a leadership role in defining the certification path for various emerging technologies.

Cohesive Voice. The alliance also provides a means for the industry to speak with one voice (or at least numerous voices in harmony) with their government partners. This means that the FAA can rely on a relatively unified industry position on priorities for certification paths on specific new technologies. A cohesive voice also provides NASA with access to unified decision-making regarding pre-competitive research strategies and investments. It is vital that NASA has a clear understanding of the certification and regulation risks affecting new technology investments. AGATE provides such understanding.
In past traditional, contracted R&T programs, the federal agencies have utilized various forms of advisory committees and reviews for these purposes. (The traditional role for advisory committees is not relevant for collaborators in a strategic alliance.) The significant advantage of the alliance-based governance process used in alliances like AGATE is that a cohesive industry voice (through the Technical and Executive Councils) is based on shared core business strategies of the partners. A cohesive industry voice means that the quality and pace of advisory oversight functions are improved.

Strategic Relevance. Finally, the formation of the AGATE Alliance provides the means for establishing mutual strategic relevance between the government and industry partners. This means that the partners, both government and industry, each bring a strategic strength to the other. The relevance results from the shared commitment between partners to the objectives and strength of the alliance.

By many measures, the government and industry partners in the AGATE Alliance have met or exceeded their expectations for technology development. The AGATE Alliance has produced a litany of advancements in innovations affecting future aviation safety, affordability, ease-of-use, and transportation accessibility. The FAA has exhibited visionary leadership in crafting certification reforms that support these innovations, as evidenced in the following activities:

- AIR AGATE
- AC 23.1309/Systems, Equipment & Installation
- AC 23.1311/Electronic Displays
- Composite materials qualification process
- Integrated Instrument-Private Pilot Training Curriculum Practical Test Standard
- Exit & Avoid Icing Condition Operations Strategies
- Full Authority Digital Electronic Controls (FADEC)
- Single Lever Power Control (SLPC)
- Basis in FAR Part 23 for certification of turbojet-powered aircraft
- Basis for certification of pilots of GAP-powered, AGATE-equipped turbojet-powered aircraft other than traditional Type Ratings

The benefits to industry are reduced risk for major innovations for future aircraft and pilot training. The benefits to the FAA include accelerated introduction of technologies affecting safety, National Airspace System (NAS) modernization, and costs. Admittedly, there is much work left to be done, but the paths led by the FAA have illustrated what is possible between partners who share a sense of mutual strategic relevance.

It is hard to imagine a period of more rapid technological growth and innovation than we are seeing today. It is not hard to imagine that we will look back on the period from the mid 1990s through the first decade of the new millennium as one of the most significant periods of innovation in the history of aviation. This progress will predictably change the way that transportation affects quality of life in the 21st century, including the role of the Smart Air Transport System (AKA, Small Aircraft Transportation System). We have set the stage for this growth based on the *common vision*, *cohesive voice*, and *shared strategic relevance* through the AGATE Alliance, in particular with the FAA role in mitigating many risks.

The countdown continues. The AGATE program ends in September 2001, less than 22 months from the date of this publication. The AGATE membership has remained steady and the budget continues to be stable. 1999 partner commitments are those shown on page 10. These are the partners and programs committed to achieving world class research and technology deployment capacity for the U.S. general aviation lightplane industry, in support of creation of the Smart Air Transport System.□

Certification Will Lead to a Safer GA Fleet

(Continued from page 1)

craft Human Factors Guidelines document. AIR AGATE's additional involvement with the Flight Systems Work Package has included consultation regarding FAA certification requirements and procedures, hosting three certification workshops, and performing AGATE presentations for Aircraft Certification Office Designated Engineering Representative workshops and conferences.

AIR AGATE has been a major supporter of the development of AGATE's high-priority technology item that promises to drastically improve GA aircraft operational safety, the Highway-in-the-Sky (HITS) system. AIR AGATE participated in the contractor selection process for HITS and is an active participant on the HITS Design Review Board (DRB).

AIR AGATE has maintained a strong presence in the area of Propulsion Sensors and Controls, supporting AGATE and General Aviation Propulsion (GAP) program objectives. The AIR AGATE team has issued policy or letters concerning: digital display of powerplant information, anticipation of special conditions for multi-turbine engine aircraft under 6000 pounds, and issued changes to ACs 23.1309 and 23.1311 which identify the application of digital displays to powerplant information. AIR AGATE has also initiated rulemaking for Full Authority Digital Engine Controls (FADEC), Single Lever Power Controllers (SLPC), and Fuel Quantity/Measurement improvements.

In the area of Integrated Design and Manufacturing, the Composite Material Systems Qualification Project has been a focal point of interest to AIR AGATE. The primary objective of this project is to reduce the testing required by each user of a composite material system by instead qualifying at a higher supplier level, therefore reducing certification costs for all follow-on users of the material process. A final report and workshop are planned in fiscal year 2000.

AIR AGATE is also making its presence felt in the area of Icing Protection Systems. The certification team has been actively involved in the pursuit of cost effective "known icing" certification methods. The team is presently working with the Ice Protection Systems Work Package seeking development of improved simulation codes and ground-based test facilities that will be required in order to reduce certification test costs. As stated by Sova, "If AGATE continues to pursue the "avoid and exit" operational strategy, and depending on the sensor/display technologies proposed, equipment policy may need to be written."

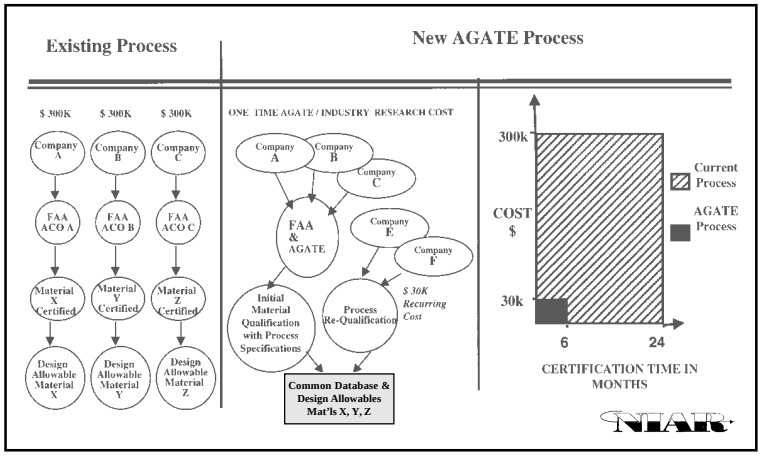
Significant progress is being made in the area of Flight Training for prospective GA pilots. Pioneering work in this field is being led by FAA AFS. Through representation in each of the technical work packages participating in the Flight Training Curriculum, supported by their participation in the Certification Issues Team, AFS and AIR AGATE have worked with AGATE members to define alternative ways of certifying and training pilots in less time and at a lower cost in unconventional AGATE aircraft. "The FAA has been instrumental in approving curriculums to reach our goals. They are currently working with us on appropriate changes to the practical test standards (PTS). The FAA has also been working with us to identify which rule changes may be required to operate AGATE aircraft in both the current and the SATS environment, and a plan on how to implement these changes," said Dr. Steven Hampton, AGATE Flight Training Curriculum Work Package Leader.

"These certification achievements should enable manufacturers to put more state-of-the-art technology into GA aircraft. This should enable consumers to have access to a higher level of safety in the operational regime than is currently available. I also believe that all of these achievements should either lead to a reduction in certification costs or provide enough additional operational benefit to be worth any additional certification costs, therefore encouraging manufacturers to build, and consumers to buy, more GA aircraft," said Sova.

Much can be attributed to the FAA's success in helping to expedite the certification process. "The FAA must follow established and time-consuming procedures, but when government and industry cooperate [e.g., Certification Process Improvement (CPI) program], progress speeds up. By letting the FAA in on what they are doing early, industry can help prevent future problems that are found at a more expensive to fix, and harder to recover from phase of the project," he said.

"Industry also has an opportunity and a role in the updating of regulatory requirements for new technologies via supportive participation in the Aviation Rulemaking Advisory Committee (ARAC) process. If industry supports FAA-initiated rulemaking projects through ARAC, then the regulatory burden associated with repetitive application of special considerations (i.e., Special Conditions process) can be eliminated in favor of permanent rule changes," said Sova.

"The FAA is mantaining an interest in AGATE because it is the right proactive thing to do and because the FAA feels obliged and committed to enhancing safety in the GA fleet. Participation allows us an early opportunity to assess the future direction of GA, and permits earlier preliminary planning for rule changes or alternative strategies in order to accommodate future certification projects more easily," he said."□



Certification Cost for Advanced Materials Under the New AGATE Materials Certification Process

AirVenture ’99

A crowd of 750,000 spectators attended this year’s Experimental Aircraft Association Convention, known as AirVenture ’99, at Oshkosh, Wisconsin. The spectators were treated to static displays and exhibits that showcased AGATE products and AGATE-inspired technologies.

General Aviation’s newest aircraft, the Cirrus SR20 and Lancair Columbia 300, made their Oshkosh debut. These two aircraft make heavy use of AGATE-inspired technologies, including AGATE-inspired avionics, materials testing and standards, and NASA stall resistant aerodynamic airfoil wing designs. Aurora Flight Systems also displayed its Cessna 337 Chiron which is used as a testbed, under the auspices of a Small Business Innovation Research award, to evaluate the single lever power control system.

In making his annual AirVenture visit, NASA Administrator Daniel S. Goldin made it known that he was impressed with the progression of General Aviation and had great expectations of the industry in the future.

NASA’s Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) Programs made strong showings at AirVenture ’99 through various exhibits on display. These included an SBIR exhibit by Vision Micro Design (VMD) that featured a simulated GA cockpit instrument panel that utilized an advanced cockpit projection system (PCD). The PCD system promises to be desirable to GA consumers because of its low cost.

Global Aircraft displayed their low noise 3-bladed propeller and a muffler offering 4–6 dB of noise reduction over conventional mufflers funded under a STTR award. Also among the propulsion technology exhibits on display was an exhibit by D-Star Engineering that showed its enhanced engine combustion and breathing technology. The SBIR exhibit included full-scale diesel and gasoline small airplane engine displays.

In an SBIR exhibit, Mohawk Technology displayed its work involving the production of oil-free air bearings designed for use on small GA turbine engines and turbo-chargers.

Seagull displayed its work involving the development of an attitude reference system with GPS as the primary sensor in a STTR exhibit.

As part of an AGATE Cockpit Technologies exhibit, advancements in cockpit systems were displayed on several posters with a major emphasis on graphical display cockpit systems for navigation and weather analysis. NASA and industry AWIN accomplishments were also highlighted on five posters. The creation of graphical display weather in cockpit systems by two contract winners, ARNAV Systems and NavRadio , in addition to NASA CWIN developments and NCAR hazardous weather prediction advancements were emphasized.

Advancements in manufacturing and materials were highlighted in an AGATE Manufacturing and Materials Technologies exhibit. This exhibit featured numerous posters; a low cost, sub-systems integrated wing constructed by Stoddard-Hamilton; a low cost fuselage constructed by Lancair; and a 3-panel display covering FAA certified composite materials design data and its cost savings impact on new airplane companies as performed by Wichita State University.

A 5-panel Flight Training Curriculum exhibit and an advanced simulator provided spectators with an idea of the gains being made by Embry-Riddle Aeronautical University in reducing the time and cost for GA pilots to obtain adequate training.

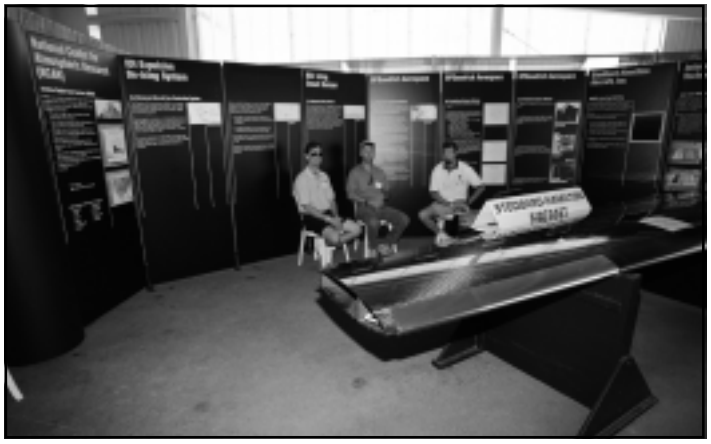
A NASA Craftsmen exhibit highlighted the efforts of NASA crafts people in model making and developing fabrication methods.

Two additional exhibits highlighted NASA’s General Aviation Propulsion (GAP) Program and AGATE’s Ice Protection System work. The GAP exhibit included summaries of ongoing efforts to develop an Intermittent Combustion engine for piston-driven aircraft and the high-performance, environment friendly FJX-2 turbine engine for jet-powered aircraft. In their exhibit, Cox & Company and Innovative Dynamics, Inc. (IDI) summarized the development of their EMEDS (Electro-Mechanical Expulsion Deicing System) product. Such a system promises to provide near evaporative performance using 1/5 of the power required by electro-thermal deicers and 1/50 of the power required by evaporative anti-icers. The system has also been configured for retrofit purposes to replace older and less efficient deicing systems on GA fleet aircraft.□

A multitude of GA exhibits graced the confines of the GA building at AirVenture ’99. Note the Global Aircraft Corporation exhibit (right) displaying their Quasi-Constant Speed (QCS) propeller designed for enhanced aircraft performance and reduced noise during operations, and a composite GA aircraft fuselage (left).

General Aviation's newest aircraft, the Lancair Columbia 300 (left) and the Cirrus Design SR20 (right) made their Oshkosh debut at AirVenture '99.

NASA and industry Aviation Weather Information (AWIN) accomplishments were highlighted in a five-panel poster exhibit.



Stoddard Hamilton and Innovative Dynamics, Inc. GA wing.

Williams International FJX-2 turbine engine and NASA General Aviation Propulsion (GAP) program exhibits.

Message from the Director of the AGATE Alliance Association, Inc.

Jack Sheehan

The role of the AGATE Alliance Association Inc., as a non-profit corporation is to facilitate public education and to support the research necessary for development of Guidelines, standards and certification processes.

We have many accomplishments to be proud of. The ability for each of us to see these accomplishments is hindered by the nature of our organization and also by the propriety of our work. Our efforts to develop certification paths for the emerging technology applications are demonstrations of the fact that we can achieve results as a group that would be nearly impossible as individual companies.

The synergistic effect of the FAA working with the AGATE companies supported by the technical verification of data by NASA have produced remarkable results. The changes will provide a more rapid insertion of technology into both aircraft and flight training markets and create an even safer, more affordable General Aviation. We have chosen to feature some of those activities in this issue of the AGATE Flier.

The ability to organize the public demonstrations of selected AGATE technologies is an outreach and education effort that supports both the government and industry objectives. We were especially fortunate this year at our Oshkosh demonstration, to highlight recent technology accomplishments such as the Stoddard-Hamilton wing, AvroTec displays, ARNAV and Allied Signal (NavRadio) weather displays, a Lancair fuselage and much more. The culmination of past technology and certification work was well represented in the Lancair Columbia 300 and the Cirrus SR20; while the catalyst for the future was represented by the General Aviation Propulsion (GAP) program engines from Teledyne-Continental and Williams International. A number of emerging technologies supported through the NASA SBIR program were also demonstrated. These included low cost, solid state Attitude Heading Reference Systems (AHRS) (Seagull and Vision Micro), low cost training simulator (Mod Works) and the cockpit demonstrator supported by Embry-Riddle and Advanced creations.

Although our theme emphasized the demonstrated goal accomplishments, the overriding interest of attendees was on safety improvements. The repeated question was when can I have it in my aircraft? I would like to thank the companies and their staffs for contributing to the show.

On the lighter side, the best ticket in town was to the GA technology reception. A "who's who" of industry leaders included Dan Goldin, Sam Armstrong, Russ Meyer, Tom Poberezny, Ed Bolen, Lance Neibauer, Alan Klapmeier, Bob Gavinsky, Frank Williams, Tim Coons, Mary Nolan, Mike Smith, Bruce Holmes (who had to answer all the questions) and many other government and industry folks. It was an excellent venue for discussion about the future for GA. A highlight for all of us AGATE folks was the well deserved recognition of Shahid (Sid) Siddiqi by the EAA for all of his hard work. His award was presented by Tom Poberezny and Dan Goldin.

The AGATE Alliance Association, Inc., today performs many research support functions and fulfills a unique technology requirement within our industry. As a Scientific, Research and Education non-profit, dedicated to GA, we are in a position to facilitate the public outreach and standards setting work of the alliance and conduct research on behalf of the government and industry members. We are busy today planning for the future when we, as an alliance, will have the opportunity to participate in the establishment of the Small Aircraft Transportation System and again partner with NASA, the FAA, and the State governments.□

FAA Selects Two AGATE Member Companies to Provide Flight Information Services

In an unprecedented general aviation first, the FAA has awarded the first Flight Information Services (FIS) contract to ARNAV Systems Inc. of Puyallup, Washington, and NavRadio Corp. of Golden, Colorado. The companies and the FAA will supply high quality weather graphics and textual data to the cockpits of general aviation aircraft through the use of Datalink technology.

"This is a wonderful example of government-industry partnering," FAA Administrator Jane Garvey said. "It's a win-win situation for us all: government, industry, and users. The aviation community told the FAA what it needs and through this partnership together we're providing the products and services the users want."

These datalink services will complement voice communications between the aircraft and the air traffic controller. Currently, information pilots receive in the cockpit is provided primarily through voice radio communications by air traffic controllers and flight service stations. The new digital transmissions will allow pilots to more efficiently anticipate, plan, and request changes to their flight plans.

Since hazardous weather is a leading factor in aviation accidents, access to up-to-date weather information will help pilots make more informed decisions. In general aviation, more than 100 fatalities per year are a result of hazardous weather conditions. A key strategy to reducing weather-related accidents is to have timely datalink weather information available to the pilot in the cockpit.

Initial operating capability is planned within six months with Alaska as the first site. The full national deployment schedule will occur within the following year. Users will need to equip with a VHF data radio and a color multifunction display to receive the information. The displays are available today and certified radio systems will be available early next year.

This agreement is unique because it will be accomplished entirely through private investment. Users will receive basic text flight information at no cost through the industry-provided ground infrastructure. Industry will profit by providing value-added products such as color graphic weather radar images and graphical maps of the Meteorological Aviation Report surface observations. A fee will be charged for the value-added products based on user demand.□

National Academy of Sciences Hosts Workshop to Study Impact of Small Aircraft Transportation System (SATS)

The National Academy of Sciences hosted a workshop at the National Research Council Headquarters in Washington, D.C., on August 17-19, 1999 to study the impact of SATS on the nation. The workshop was held at the request of NASA, which proposed that a study be conducted to consider the impact SATS might have on transportation in the United States and to decide if sufficient cause exists for the National Academy to begin a study of possible SATS impacts and benefits. Workshop participants included representatives of: the National Institute for Aviation Research; NASA Code R; Hagler Bailly; the University of Nebraska at Omaha; the NASA General Aviation Propulsion Program; the Transportation Research Board; Solomon Smith Barney; Research Triangle Institute; NASA Langley Research Center; Global Aviation Associates, Ltd.; Regional Airline Association; National Air Transportation Association; Wasserstein Perella Securities, Inc.; George Mason University; Texas A&M University; Aircraft Owners & Pilots Association; National Business Aviation Association; Small Aircraft Manufacturers Association; Library of Congress, Congressional Research Service; Gale Consulting; the Transportation Research Board; Arthur D. Little, Inc.; the SATS Blue Team, NASA Langley Research Center; Parsons Brinckerhoff Quade & Douglas, Inc.; FAA/NASA Executive Committee, NASA H.Q.; Logistics Management Institute; Airports Council International-NA; Paul Masson & Company (PMC); Flight Safety Foundation; the Volpe National Transportation Systems Ctr.; the National Association of Counties; the Virginia Dept. of Aviation; the FAA; SAIC; Delaware Valley Regional Planning Commission; Embry-Riddle Aeronautical University; Global Environment & Technology Foundation; FAA ASC-200; NASA H.Q.; Global Telematics; National Association of State Aviation Officials; National Business Aviation Association, Inc.; National Air Traffic Controllers Association; The Mitre Corporation; Nebraska Dept. of Aeronautics; Helicopter Association International; The AGATE Alliance Association, Inc. (AAAI); Virginia's Center for Innovative Technology; General Aircraft Manufacturers Association; Air Transport Association of America; American Association of Airport Executives (AAAE); the Experimental Aircraft Association; and the FAA AFS-400.

The Workshop focused on the study of public policy issues concerning SATS. "One of the main questions addressed during the sessions was 'Is there probable cause for NASA to invest research dollars in SATS?'," said Peter McHugh, FAA SATS representative at NASA Langley Research Center. "The output of the National Research Council work is important in providing a basis for FAA investment analysis to support SATS research and implementation. Investment analysis would be the next step in progressing the Mission Needs Statement already developed by the FAA," he said.

The results of the Workshop proved to be favorable with only one dissenting vote among the major participants. "The dissenting view was that you don't need a study, that the benefits of SATS are obvious and that the Academy should charter the study," said McHugh. The study promises to provide a wealth of information concerning potential SATS economics, demographics, and policy. "The study will help to determine how the population might benefit. What is the public good and what are the public policy issues? These questions will be answered in the study," he said.

A series of additional SATS Market Analysis Workshops or "Labs" have been scheduled for the near future aimed at defining the latent market—who would buy aircraft and equipment. "States have proposed creating state planning teams composed of the Department of Transportation, State financial planners, and State academic institutions which conduct transportation research. These analyses will be important contributions to the National Academy study effort by identifying population and business centers which likely would benefit most from the point to point transportation at four times the speed of highways provided by SATS. SATS landing facilities will be carefully selected to support these populations and to exploit existing, underutilized airspace system infrastructure," said McHugh.

States that will be participating in SATS. Virginia (darkest shaded state) will serve as the "lead" or model state, with Florida (medium shaded state) serving as the next "lead" state. Other participating states depicted include: Nebraska, North Dakota, Oklahoma, Kansas, Illinois, Indiana, Wisconsin, and Washington.

SATS Labs have been conducted in Virginia and in Florida. Two additional labs are scheduled for October in Raleigh, N.C., and in Columbus, Ohio. "These workshops ultimately might change the complexion of GA by providing market estimates that could spur large production runs for light aircraft for SATS," he said. □

Schedule of Events

January 12, 2000:
Omni Shoreham Hotel
Washington, DC
Transportation Research Board
Smart Aircraft Transportation System

February 1–2, 2000:
Kansas City, MO
Flight Systems Work Package Meeting

February 3–4, 2000:
Kansas City, MO
Databus Work Package Meeting

April 9-15, 2000:
Lakeland, FL
EAA Sun'n Fun
www.sun-n-fun.org

April 16–20, 2000:
Doubletree Resort Hotel
Kissimmee, FL
AGATE Spring Work Package Meetings

Embry-Riddle Team Wins 1998-99 General Aviation Design Competition

The sky was the limit at the fifth annual National General Aviation Design Competition as reflected in the winning aircraft designs. Winners of the competition were announced by NASA and the FAA at AirVenture '99.

The 1998-1999 first place award was presented to a 33-student team from **Embry-Riddle Aeronautical University**. Embry-Riddle's winning design was for a new affordable general aviation jet aircraft designed to attract customers interested in moving up from turboprops to jets without requiring a significant increase in pilot skill. The New Piper Aircraft, Inc. assisted the team in developing design specifications, which are consistent with national revitalization goals. The goals call for a lightweight, general aviation jet with four seats. The project also focused on aerodynamics, integrated cockpit systems, production feasibility, cost analysis and safety. The selected propulsion system was the Williams FJX-2 jet engine. The first place award provides a total of $3,000 to design team members and a $5,000 award to the university's Aerospace Engineering Department.

Second place honors went to **Pennsylvania State University** for "The Baracuda," a conventional layout, modern composite airplane featuring advanced aerodynamics, systems and avionics. Designed by a 13-member team as part of a senior aircraft design course, "The Baracuda," an acronym for Boldly Advanced and Refined Aircraft Concept Under Development for AGATE, is a four-place, single-engine, jet-powered general aviation airplane. The airplane does an excellent job of meeting revitalization goals. The second place award provides a $2,000 prize to the student team.

Third place was awarded to a three-university team involving 21 undergraduate and graduate students from the **University of Virginia, Old Dominion University, and Pratt Institute**. For third place, the student team will share a $1,000 prize. The team was honored for a highly innovative design known as the "Yeah Man." The aircraft displays a unique exterior design featuring two tail booms with vertical tails. The unusual shape features symmetrical wings and canards and asymmetrical tails and fuselage. The interior is a comfortable ergonomic interior with convertible seats to appeal to families or business travelers. The design incorporates newest avionics and instrumentation technologies to assure ease of operation. A model of the unusual design was tested in the Full-Scale Wind Tunnel at NASA Langley Research Center in Hampton, Virginia, with tests indicating good aerodynamic characteristics.

The **Ohio State University** won a $3,000 award for the Best Use of Technology Developed by the Air Force Research Laboratory. The Competition's Air Force Technology award was presented to team representatives at the opening ceremonies of the United States Air and Trade Show in Vandalia, Ohio on July 24. The award and team were also recognized at the EAA's AirVenture '99 ceremony. The team used the United States Air Force Data Compendium handbook in its research.

A **University of Oklahoma** team captured the Aircraft Owners and Pilots Association's (AOPA) award for Best Retrofit Potential in this year's competition. The three-student team developed an innovative approach to energy-absorbing seat design. The group's design sought to show that the use of expanded metal in an innovative seat design can help in the revitalization of general aviation by meeting or exceeding the current FAA requirements for energy absorption while providing savings in both weight and cost. The new seat design consists of a rigid frame supporting a seat pan manufactured from expanded metal, either aluminum or steel. Expanded metal is a rigid, non-raveling piece of metal that has been slit and drawn into an open mesh pattern in a single operation. The team won a $500 prize from the AOPA.

The competition is managed for NASA and the FAA by the Virginia Space Grant Consortium. Guidelines are now available for the sixth annual competition to be held during the 1999-2000 academic year. New criteria encourage both individual and team submissions, and designs ranging from components and subsystems to complete aircraft designs. Guidelines can be requested at 757/865-0726 or mls@penngrad.pgtt.odu.edu.□

photo courtesy of Donna Bushman

Embry-Riddle won first place in the 1998-1999 National General Aviation Design Competition. Pictured are: (Kneeling) Justin Williams and Mike Mercer; (Standing) Bruce Holmes, Manager, NASA's General Aviation Program Office; Cecilia L. Hunziker, Regional Administrator, Great Lakes Region, FAA; Richard Anderson, Chuck Eastlake, Robe Byrne, Patrick Sween, Embry-Riddle; Dan Goldin, NASA Administrator; and Rick Weiss, EAA Washington Representative.

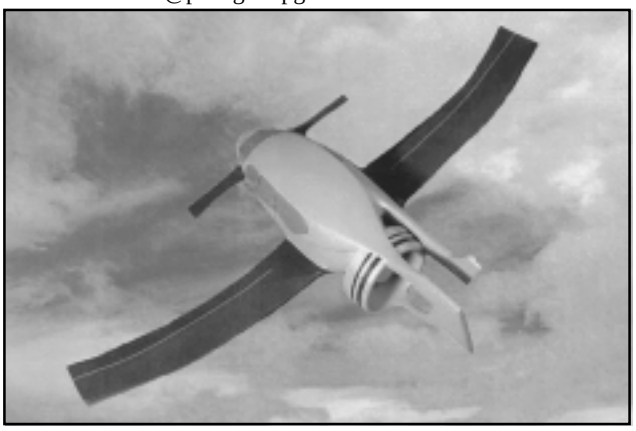


photo courtesy of University of Virginia/Pratt Institute/Old Dominion University

The University of Virginia/Pratt Institute/Old Dominion University team took third place in the 1998-1999 National General Aviation Design Competition for their innovative "Yeah Man" aircraft design. The design makes use of symmetrical wings and canards and asymmetrical tails and fuselage. The cockpit is equipped with state-of-the-art avionics and instrumentation technologies that assure ease of operation, while the interior provides ergonomically designed passenger accommodations.

Management and Technical Progress Highlights

Flight Systems

The Highway-in-the-Sky (HITS) team participated in the second meeting of the AGATE HITS Design Review Board on August 2, 1999 in Oshkosh, Wisconsin. Design work is progressing for the installation of a Phase I HITS system in a current production series Raytheon Aircraft Bonanza.

Allied Signal Aerospace has joined the Flight Information Services Data Link (FISDL) team as the provider of weather data. The FISDL project is a joint effort of the FAA's Advanced Technology Integrated Product Team (AND-500), the AGATE Project, and the NASA Aviation Weather Information (AWIN) Project. The purpose of the FISDL project is to ensure that the FAA's implementation of flight information services (weather initially) in the cockpit of general aviation aircraft leads to enhanced flight safety. Allied Signal will provide display equipment, display presentation software, weather data acquisition equipment, weather data processing equipment, weather data processing software, and will supply actual and simulated weather data for the simulation study. Allied Signal is one of three companies selected by the FAA to provide weather in the cockpit capability to GA aircraft beginning in early 2000. The FISDL simulation study will be conducted in the AGATE Concept Demonstrator at the Research Triangle Institute in Hampton, Virginia, beginning in January 2000.

Rockwell-Collins made final preparations for September flight testing of a Satellite Digital Audio Radio Services (S-DARS) antenna/receiver to be conducted using a Cessna 172 aircraft flying in Johannesburg, South Africa. The C-172 aircraft will acquire weather images from the geostationary AfriStar satellite using low-cost antennas, a modified commercial off-the-shelf receiver, and a laptop computer as a display. The project will address signal reception during aircraft turn and bank maneuvers and signal noise during transmission of weather products. The S-DARS satellites are the most powerful communications satellites ever produced, giving them the unique capability of having users receive signals using simple low-cost patch antennas rather than high-cost beam steered antenna arrays.

Test flights of AGATE-1B were conducted in August, which successfully demonstrated that the Rockwell Collins differential-GPS (DGPS) receiver and antenna configuration is compatible with the DGPS ground station at Beech Field in Wichita, Kansas.

Flight Training Curriculum

The HITS display has been defined for training purposes and agreed to by the Flight Systems Work Package. The testing scenario and test design have been completed. Modifications to the Simulation and Training Testbed (STT) and Integrated Cockpit Information System (ICIS) are complete for 1999. The STT was transported to and demonstrated at Oshkosh. Two hundred surveys relating to the use of the display were completed by pilots and non-pilots attending AirVenture '99. Work on the Computer Based Training module is ongoing.

The Modified Unified Curriculum (MUC), now called the Modified Integrated Curriculum (MIC), has received FAA approval. A Web-based data collection process has been developed and tested. Forty students have been recruited as volunteers for AGATE MIC training in the Fall of 1999 and Spring 2000 at Daytona. An agreement has been reached with the Wright Patterson Air Force Base Flying Club at Wright Patterson to allow the MIC to also be tested at a location other than Embry Riddle Aeronautical University. Up to 10 students will use the MIC curriculum at Wright Patterson.

Program Analysis

A graphical pilot interface for situation awareness is still being ranked as the most important AGATE aircraft feature by pilots and aircraft owners while affordability is still being ranked as the most significant benefit of using AGATE/SATS aircraft by latent market survey participants. The survey site may be accessed at http://apats.org and charts viewed at http://sats.nasa.gov/Presentations/Survey99/index.htm.

Data show that 42,907 users visited the program analysis Internet site. These visitors have spent an average of 06:46 minutes exploring the site and have accessed 226,734 page views for an average of approximately 5 page views per visitor.

The visitors have completed 4,269 surveys and 1,405 of the survey respondents have requested more information on either learning how to fly or on purchasing an airplane.

The number of identifiable International Users who visit the site is 9.62 percent of the total traffic. The number of United States visitors is 57.38 percent with 32.99 percent of the visitors not identified.

AGATE ALLIANCE MEMBERSHIP

Work Packages:
Flight Systems (FS)
Propulsion Sensors & Controls (PS&C)
Integrated Design & Manuufacturing (ID&M)
Ice Protection Systems (IPS)
AGATE Integration Platforms (AIP)
Flight Training Curricula (FTC)
Systems Assurance (SA)
Program Management (PM)

Work Package Membership: P = Principal; A = Associate

Official Organization Name	FS WP-1	PS&C WP-2	ID&M WP-3	IPS WP-4	AIP WP-5	FTC WP-6	SATS WP-7	SA WP-11	PM WP-12
Advanced Creations Incorporated						P			P
Allied Signal Aerospace Company	P								
ARINC Incorporated	P								
Avidyne, Incorporated	P								
AvroTec Incorporated	P							P	
Cessna Aircraft Company	P		P					P	P
Cirrus Design Corporation			P					P	
Compaq	P								
Embry-Riddle Aeronautical University			A			P	P	A	P
Global Aircraft Corp.			P						
Harris Corporation	P				P				
Jeppesen Sanderson Incorporated	P					P			
Lancair International (PAC USA)			P					P	
Mod Works Incorporated			P						P
Ohio State University						P			
Raytheon Aircraft Company	P		P					P	P
Rockwell Collins Commercial Avionics	P				P			P	
Seagull Technology Incorporated	P								
Simula Technologies Incorporated			P						
Stoddard-Hamilton Aircraft Incorporated			P					P	
WSU-National Inst. for Aviation Research			A				A	A	A

SUPPORTING MEMBERS

A&P Technology, Incorporated
Aerocar Project Llc.
AGATE Alliance Association, Incorporated (AAAI)
AOPA-Air Safety Foundation
Aurora Flight Sciences Corporation
BF Goodrich Aerospace
Cox and Company Incorporated
Executive Jet, Incorporated
Experimental Aircraft Association (EAA)
Fibrecote Industries Incorporated
Garmin International
General Aviation Manufacturers Association (GAMA)
Honeywell Tech Center
Innovative Dynamics Inc.
Mississippi State University-Raspet Labs Research Center
Mitre Corporation
National Center for Atmospheric Research
Neogenesis
New Piper Aircraft Incorporated
NYMA
Optimal Solutions Incorporated
Research Triangle Institute (RTI)
Safire Aircraft Company
Science Applications International Incorporated (SAIC)
Small Aircraft Manufacturers Association (SAMA)
Toray Composites America Incorporated
Unison Industries
United Technologies Hamilton Sunstrand
University of Alabama
University of Illinois at Urbana-Champaign
University of Kansas
University of Oklahoma
University of Tennessee Space Institute
University Research Foundation
Virginia Tech
Williams International
Wyndemere Incorporated

GOVERNMENT PARTNERS

Federal Aviation Administration
National Aeronautics and Space Administration (NASA)
USAF Research Laboratories (Wright Directorate)

EAA Recognizes the Accomplishments of NASA for Revitalization of General Aviation (GA)

In recognition of his support of GA and in launching AGATE to help revitalize GA through technological developments, the Experimental Aircraft Association presented NASA Administrator Daniel Goldin with the Medal of Freedom at AirVenture '99 in Oshkosh, Wisconsin. The award was presented at a Theater-in-the-Woods ceremony attended by over 3,000 people. Goldin drew inspiration for his support of the once beleaguered GA industry from a visit to the EAA Fly-In and Convention at Oshkosh in 1992.

As described by Shahid Siddiqi of the AGATE Alliance Association, Inc. (AAAI), "Administrator Goldin got his first glimpse of the Oshkosh flight line when Donna Bushman (EAA photographer) and I (on behalf of the EAA) toured him, Allison McNealy (his then secretary) and other NASA senior staff, around the Air Show grounds. He gasped 'How many airplanes are here?' and was stunned to hear 'in excess of 12,500." Mr. Goldin was further excited by his visits to the exhibits of Sport Aviation manufacturers, Cirrus Design, Lancair, and Stoddard Hamilton. He noted that these companies were in the forefront when applying NASA-developed aircraft technologies. He changed his agenda and just like many of us decided to walk around the flight line looking at airplanes and talking to builders and owners."

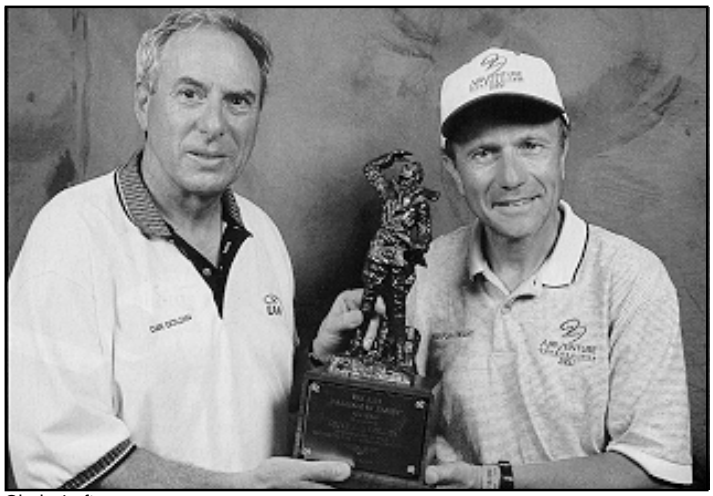
Mr. Goldin was so impressed by his visit to Oshkosh that he had his first meeting with representatives of the GA industry that very afternoon. The meeting was hosted by the EAA and the lead presentation was given by Mr. Paul Fiduccia, President of the Small Aircraft Manufacturers Association (SAMA). Also attending on NASA's side were NASA Langley Director Mr. Paul Holloway and then Deputy Director of Aeronautics Dr. Bruce Holmes. Oshkosh's favorable impressions led to another historic meeting between Administrator Goldin, NASA's senior managers and representatives of the GA industry, held in Washington, D.C., in November 1992, to finalize the main points of emphasis of a plan for revitalizing the GA industry. "Mr. Goldin had the insight to note that 'small airplanes can be an efficient business and personal travel vehicle in the national transportation system.' He went on to articulate this new relationship in his 1992 Wright Brothers speech and charged NASA with the creation of a small airplane transportation system for the 21st Century through a cost-sharing partnership with the General and Sport Aviation industry. This is how the Industry-NASA-FAA-Universities Advanced General Aviation Transport Experiments (AGATE) program was born. By 2001 AGATE will have invested $55 Million and the SBIR Program will have invested $45 Million of NASA funds. The General and Sport Aviation industry is investing matching funds and the total is almost $200 Million for GA technology development," said Siddiqi.

The historic meeting between Mr. Goldin and members of the GA industry in Washington, D.C., also led to the birth of the GA element of the NASA Small Business Innovation Research (SBIR) program. "Only small businesses are eligible to apply for the competitive awards made under this program whose goal is to create new products and new jobs in the nation's economy. Since 1993, NASA has invested over $30 Million for GA technology in this program, with awards made to over 90 aviation companies across the nation," said Siddiqi.

"In my view, Mr. Goldin is a visionary who sees in Oshkosh an aviation spirit that inspires people to propel themselves and the nation forward. His own Oshkosh spirit has been renewed with four visits since 1992. His enthusiasm is captured in the words he inscribed to Tom Poberezny (EAA President) when he presented the EAA with a volume of The Winds of Change, 'Tom lets you and me always keep looking upwards'," he said.

In recognition of his role in "helping the EAA to build and maintain its partnership with NASA for the benefit of General and Sport Aviation," Siddiqi was also presented with an EAA award at AirVenture '99. □

From left to right: Tom Poberezny, President of EAA; Shahid Siddiqi, AAAI; Seth Anderson, NASA Ames Research Center; Administrator Daniel Goldin, NASA.



Cindy Luft *photo courtesy of Sport Aviation*

From left to right: Administrator Daniel Goldin, NASA and Tom Poberezny, President of EAA.

The AGATE Flier

Volume V, Issue 2 September 1999

The AGATE Flier is published by the AGATE Alliance Association, Inc., a private, non-profit, membership organization founded to stimulate the development and dissemination of general aviation technology. ***The AGATE Flier*** reports on progress in a family of technology initiative and public/private aviation related activities to revitalize the U.S. GA industry, called AGATE—Advanced General Aviation Transport Experiments. The NASA Langley Research Center is the lead center for this program.

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March 1999

The AGATE Flier

Information on developing technologies for business and personal transportation aircraft

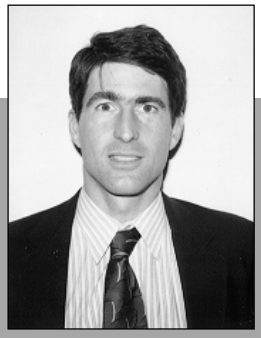
Volume V, Issue 1

National General Aviation Roadmap Approved

At the October 9, 1998 Conference on Turning Goals into Reality, held at Lewis Research Center, the NASA and FAA administrators unveiled a plan that lays the groundwork for the future of general aviation (GA) in the United States. The plan, known as the National GA Roadmap, was approved by the NASA Aero-Space Enterprise Executive Board, which includes all Aeronautic Center Directors and the Associate Administrator.

The National GA Roadmap is a comprehensive 25-year plan for the establishment of a Small Aircraft Transportation System (SATS). Dr. Bruce J. Holmes, NASA General Aviation Program Office Manager, defined a SATS as "an intermodal, personal, rapid transit, air travel system." The Roadmap emphasizes the vigorous creation and initiation of SATS aircraft and airport/facility technologies during the early 21st Century. The plan's major objective is to "enable doorstep-to-destination travel at four times the speed of highways to 25 percent of the Nation's suburban, rural, and remote communities in 10 years and more than 90 percent in 25 years." This means providing access to aerial transportation in hard to reach locales across the country and developing small aircraft that will surpass automobiles in intercity transportation capability and performance.

The Roadmap vision stresses the use of up to 5,400 public airports that are to be designated as SATS airports. These facilities will be outfitted with sophisticated flight communication and weather tracking equipment designed to support flights of SATS aircraft. SATS aircraft "employ new avionics, airframe, pilot training, and engine technologies derived from current investments on the Roadmap." As stated in the Roadmap, "These new aircraft technologies create new features and capabilities that significantly improve affordability, safety, and ease-of-use for single-engine, single-pilot, transportation lightplanes."



John Gallman
Chairman, AGATE Executive Council

"The series of investments described in the National GA Roadmap clearly recognizes GA as a valuable part of our transportation system and defines a significant role for a small aircraft transportation system."

Roadmap investments will be made in both SATS aircraft and SATS infrastructure technologies through public-private partnerships. Investments in SATS aircraft technologies are expected to be completed by 2001 as the AGATE and General Aviation Propulsion (GAP) programs wind down, with investments in SATS infrastructure technologies continuing

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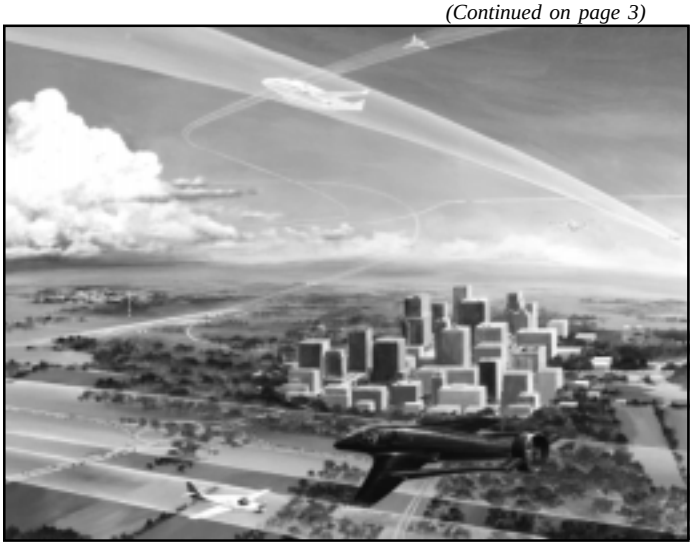
The National GA Roadmap outlines the strategy for the creation of a series of Small Aircraft Transportation System (SATS) airports throughout the United States.



The National GA Roadmap calls for the development of advanced GA technologies that will help to make the "Highway in the Sky" concept a reality.

From the desk of the Program Manager

Dr. Bruce J. Holmes, NASA Langley Research Center

The countdown is on. The AGATE program ends in September 2001, less than 29 months from the date of this publication. What comes next? Who is involved? What happens to the AGATE Alliance?

NASA Administrator Dan Goldin has established the "roadmapping" process as the strategic planning mechanism within the agency. The National General Aviation Roadmap is one of 10 Aero-Space Enterprise roadmaps. The GA Roadmap is focused on the goal *"to enable doorstep-to-destination travel at four times the speed of highways, to 25% of the nation's suburban, rural, and remote communities in 10 years and over 90% in 25 years."*

This long-term goal provides the strategic framework for government investments in a Small Aircraft Transportation System (SATS) to serve the burgeoning travel demand of American citizens in the early years of the 21st century. The Roadmap sets a national goal for coordinated investments by both the public and private sector in the "public good." The "public good" metrics are established by the Administration and Congress and implemented as public policy in the form of federal budgets. For NASA, the DOT, and FAA, the "public good" metrics include mobility, accessibility, safety, airspace capacity, security, noise, and emissions for the nation's air transportation system.

The Roadmap has prepared us for one of the most significant steps that we must take. That step is to negotiate the transition from General Aviation as we know it today, toward tomorrow's SATS. Several converging forces are fundamentally re-shaping transportation demand characteristics as we move into the first decade of the 21st century, including the following trends and forces:

- Transportation demand will outpace supply early in the 21st century. This trend results from the U.S. rural migration of population and jobs, telecommuting, and Baby Boom effect, all shaping 21st century transportation demand. The current mitigation plans for highway gridlock and hub-spoke saturation will not easily satisfy future transportation consumer demand.
- Time is the scarce commodity in the Information Age. Therefore speed is the premium commodity, specifically doorstep-to-destination speed. The revolution in digital bandwidth is the motive force behind the emergence of human/intellectual capacity, displacing physical capacity, in the creation of wealth and jobs. Thus, time and speed will be the motive forces of the Information Age.
- Enabling technologies set the stage for a SATS. These advancements include the AGATE and GAP vehicle technologies (propulsion, avionics, airframe, and training) as well as evolutionary infrastructure technologies ("Smart" airports, Free Flight in Classes C, D, E, and G underutilized airspace).

What comes next?

To date, Roadmap investments have been focused on vehicle technologies associated with revitalizing the U.S. General Aviation industry. With completion of the aircraft technology investments in the next 29 months, the question is, "What comes next?" The next logical step on the Roadmap involves planning for investments in the infrastructure as well as vehicle technologies beyond GAP and AGATE. Together, these investments create the basis for a SATS. The near-term products of these investments include: (1) The emergence of a new generation of safe, affordable, and easy-to-use transportation lightplanes; and (2) The potential for increased National Airspace System (NAS) capacity, through expanded utility of general aviation aircraft, smaller airports and underutilized Classes C, D, E, and G airspace in the NAS infrastructure.

The objective of SATS is to benefit suburban, rural, and remote consumers <u>and</u> improve access to the Hub-Spoke system. These benefits will accrue to "Enriched-"/"Mini-Spoke" capabilities for smaller and more remote airports and communities. In addition, SATS Free Flight will unencumber congested airspace. The nature of these objectives makes the State and Local airport owners, the FAA, and the traveling public the stakeholders in the investments.

A SATS is defined as an intermodal, personal, rapid transit, air travel system. The SATS concept of operations utilizes small aircraft for personal and business transportation, point-to-point direct travel between smaller regional, reliever, general aviation and other landing facilities, including heliports. The SATS would operate within the NAS infrastructure, specifically between about 5,400 public-use landing facilities.

The public good impacts of a SATS occur at four levels—national, regional/state, community/airport, and personal/business. The anticipated public benefits accrue from revolutionized mobility for citizens traveling throughout the Nation and accessibility for vastly more of the nation's communities. In addition, anticipated benefits accrue in safety, cost, airspace efficiency (or throughput), and environmental effects of the Nation's intermodal transportation system. States and regions would benefit from reduced economic disparities due to accessibility improvements. SATS operating capabilities will also benefit and serve the needs of small cargo providers, public service aviation, law enforcement, and emergency medical services. Current investments in SATS vehicle technologies are producing significant improvements in affordability, safety, and convenience or ease-of-use for transportation lightplanes.

The major elements of the SATS vision are:

- Infrastructure: The SATS architecture contemplates landing facilities that would be upgraded to provide near-all-weather

(Continued on page 11)

GA Roadmap Approved

(Continued from page 1)

well into the 21st Century under the follow-on SATS program. NASA and the FAA are also making plans to introduce technologies that will support the concept of free flight in a SATS.

The adoption of a SATS for transportation purposes promises to provide the public with several advantages. Dr. Holmes' paper "NASA Aeronautics Enterprise National General Aviation Roadmap for Pillar II 'Revolutionary Leaps' Goal #7" presented at the National Research Council Transportation Research Board Annual Meeting stated "The emergence of a Small Aircraft Transportation System that utilizes the Nation's currently underutilized airspace and airports would contribute substantially to the Throughput Goal of 'tripling the aviation system throughput, in all weather conditions, within 10 years, while maintaining safety,' while enabling the General Aviation goal. The resulting effect could have significant favorable impacts to the cost, efficiency, and safety for the National Airspace System (NAS), as well as to the mobility and accessibility for America's travelers. In addition, SATS can create potential for larger load factors, and therefore profitability, for existing hub-spoke scheduled service providers through the increased accessibility."

According to Dr. Holmes, as stated in his National Academy of Sciences/National Research Council Transportation Research Board news article on a Small Aircraft Transportation System Concept,

"The four levels of SATS benefits include:

- National.– (1) National impact of SATS on the vitality of the U.S. economic competitiveness; (2) The impact of a SATS on mobility, accessibility, cost, environmental compatibility, and efficiency of the overall National intermodal transportation system; (3) The effects of a SATS on mitigation of pressure for growth of the existing air and ground infrastructure; (4) Effects of a SATS on land use and land value; (5) SATS impact on the cost and efficacy of Federal disaster relief, emergency, and public aviation services; and (6) The SATS impact on the nation's standard of living and quality of life.
- Regional/State.–The Regional/State-level public sector impacts and requirements include state policies, laws, regulations and funding related to development and deployment of a SATS. As a minimum, the impact analysis shall address the following elements: (1) Effects of a SATS on regional and local intermodal transportation system planning; (2) Effects of a SATS on state and local disaster relief, emergency, and public aviation services; and (3) The effects of a SATS on economic disparities within states.
- Community/Airport.–The Community/Airport-level public sector impacts and requirements include local policies, laws, regulations and funding related to development and deployment of a SATS. As a minimum, the impact analysis shall address the following elements: (1) The effects of a SATS for on- and off-airport local economic development opportunities; (2) The effects of a SATS on environmental compatibility of expanded air transportation for smaller communities; and (3) The economic impact of a SATS from local airport utilization changes.
- Personal/Business.– The personal- and business-level public sector impacts and requirements include the individual and corporate social, cultural, and economic issues related to development and deployment of a SATS. As a minimum, the impact analysis shall address the following elements: (1) The effects of a SATS on individual business expansion and efficiencies; and (2) The effects of a SATS on core and extended family quality of life and standard of living."

Plans are being made to establish a federal-state-local partnership to handle policy requirements for a SATS infrastructure. These requirements include: (1) coordinating the National GA Roadmap main objective with federal transportation authorities and the FAA; (2) developing the criteria for identification of prospective SATS airports; (3) establishing standards for national SATS airport ownership; (4) evaluating funding issues for SATS airports; (5) developing a national standard for SATS State Aviation System Planning; (6) expanding the definition of the Airport Compliance Program (ACP) to include a SATS; (7) exploring standards for obligations of SATS airport sponsors; (8) exploring the establishment of SATS Airport Minimum Standards; (9) developing appropriate policy and standards for Commercial Aeronautical Activities, responsive to the national strategic infrastructure nature of SATS facilities; (10) establishing national noise and curfew standards for a SATS; (11) developing standards and procedures for measuring NAS access metrics; and (12) developing a strategy for public education, awareness, and training for SATS users.

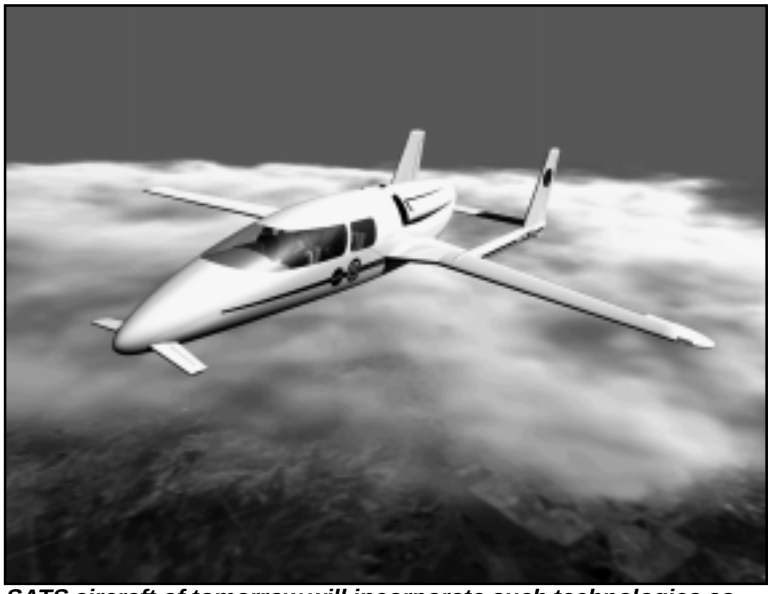
The National Research Council is in the process of preparing a SATS study designed to identify persuasive factors that will cause people to use personal air transportation in the next century and to provide guidance to NASA and other federal and state government partners concerning SATS planning. NASA is also forming a SATS Blue Team, led by Dr. Holmes, to develop a program plan for review this fall. Government and industry will be invited to participate in the program planning conferences and workshops during the coming months.

SATS aircraft and infrastructure technologies will be discussed indepth in the following two articles.□

Small Aircraft Transportation System Aircraft Technologies Lead Way to Future Flight

The National GA Roadmap encourages the vigorous creation and initiation of Small Aircraft Transportation System (SATS) aircraft technologies during the early 21st Century. The objective is to complete deployment of the first generation SATS vehicle technologies (fixed wing and rotorcraft) to recapture the "current market" at 10,000 new aircraft deliveries per year by 2007. The specific technical objectives encompass:

- Integrated flight systems for aircraft including simplified controls and display systems for "electronic Visual Flight Rules" operating capabilities. This includes introduction of the Highway in the Sky (HITS) graphical flightpath operating system. A HITS system consists of a Primary Flight Display (PFD) with a flight pathway depiction, and a Multi-Function Display (MFD) that will provide intuitive situational awareness and supporting information sufficient to enable a pilot to perform safely with reduced work load. The PFD is designed to present easily interpreted technical information in a graphical format, along with the MFD presentation of position, navigation, terrain, weather, and air traffic information. The HITS system is the "high priority" item within the AGATE program to revitalize general aviation. Development of a certifiable HITS cockpit display system has been accelerated by the adoption of a competitive tasking management approach. The HITS system and its certification is scheduled for completion by the fiscal year 2001. Other integrated flight systems and operational features to be introduced are decoupled controls, envelope protection, ride quality, enhanced/synthetic vision,and VDL Mode 3 data radios.
- Propulsion systems including ever more affordable and quieter propellers, more efficient piston engines, single-lever power controls to reduce pilot workload, and small turbine engines such as the FJX-2 lightweight high bypass ratio turbofan engine developed under the NASA General Aviation Propulsion (GAP) program.
- Integrated composite crashworthy airframe systems including automotive manufacturing synergies.
- Unified Instrument-Private pilot training including further reductions in the time and cost for pilot training and proficiency through use of an onboard cyber-tutor and InterNet training.
- Ice protection and operations for true near-all-weather safe utility, including lightning protection.



SATS aircraft of tomorrow will incorporate such technologies as turbine engines developed from the NASA General Aviation Propulsion (GAP) Program.

Example of a HITS system as envisioned by the NASA General Aviation Program Office (GAPO).

SATS aircraft, both piston and turbine engine-powered, are expected to be capable of flight at speeds of at least 200 to 300 knots, making them faster than current GA aircraft. The SATS aircraft will cruise at altitudes of 6,000 to 25,000 feet and at average ranges of 800 to 1,200 miles. These low-cost aircraft are anticipated to rival the automobile for day trips in excess of 300 miles.

Second generation SATS aircraft technology objectives focusing on the "latent market" and slated for completion by the year 2017 will encompass: (1) affordable, certifiable software; (2) synthetic/enhanced vision with simplified controls and training; (3) automotive synergies in manufacturing; and (4) quiet, non-hydrocarbon propulsion. □

SATS Infrastructure Technologies to Provide Enhanced Flight Operations Capability

In addition to stressing the creation and application of SATS aircraft technologies, the National GA Roadmap calls for the introduction of SATS infrastructure technologies that promise to enhance flight operations capability during the early 21st Century. The objective is to complete deployment of the first generation SATS infrastructure technologies to support recapturing the "current market" of 10,000 new aircraft deliveries annually by the year 2007. The specific technical objective encompasses the creation of National Airspace System (NAS) infrastructure technologies for SATS airports and heliports to achieve accessibility, safety, cost, and efficiency objectives. The technical elements will include:

- "Smart" airports equipped with Mini-LAAS (Local Area Augmentation System) GPS navigation, Datalink Flight Information Services (FIS), Traffic Information Services (TIS), and airport databus/CIS standards. Helping to develop these services will be a ground station, located at the NASA Langley Research Center in Hampton, Virginia, that will comprise a Datalink Infrastructure Facility (DIF). AGATE is establishing this first ground station to develop systems technologies and procedures for General Aviation (GA) compatible with those of commercial air carrier and cargo aircraft in the future Air Traffic Management (ATM) System. This ground station is being implemented at NASA Langley to provide an experimental flight test setting for use by the Government and industry. The ground station at Langley, along with additional ground stations, will serve as a network of prototype ground stations, or initial test sites, needed to support the AGATE program.
- EnRoute and terminal free flight procedures at non-towered non-radar airports.

photo courtesy of Harris Corporation

A Harris Corporation Datalink Infrastructure Facility (DIF) Operator's Console.

The DIF ground stations will incorporate various advanced datalink communications, navigation, and surveillance (CNS) systems not typically available in the current ATM System. These CNS systems will include: (1) FIS—Broadcast via VHF Datalink VDL Mode 2 Broadcast, (2) Controller Pilot Data Link Communications (CPDLC) and digital voice via VDL Mode 2 and Mode 3 two-way datalink, (3) Automatic Dependent Surveillance-Broadcast (ADS-B) via 1090 Mhz squitter, and (4) a "Low cost" Differential Global Positioning System (DGPS) using VDL Mode 3 datalink. Systems engineering for the ground stations is being undertaken by the Research Triangle Institute, with the system components and station console being provided by Harris Corporation, NavRadio Corporation, and Rockwell-Collins Commercial Avionics. "The DIF will provide the mechanism to evaluate avionics related products and operational concepts being developed in the AGATE program, and the means to acquire baseline and long-term data necessary to define the design guidelines, systems standards and certification methods (GS&Cs) for the new products and procedures being developed," said Dan DiCarlo, AGATE Integration Platforms Work Package Leader.

Planning for the establishment of a network of ground stations has been directed towards meeting the growing need for a suitable data acquisition range. Sites along the East Coast region have been selected by AGATE in order to incorporate two major NASA facilities, planned FAA projects, and participation by various localities recommended by the Commonwealth of Virginia. "After establishing the first ground station at Langley, future expansion is planned to provide continuous signal coverage between Langley and the NASA Wallops Flight Test Facility with eventual extension of the test range to the FAA's Hughes Technical Center in Atlantic City, New Jersey, and other sites, as locations and funding sources are identified. Anticipated participation by the FAA and the use of remote facility tielines will allow linkage of AGATE flights, originating at Langley, with controllers in Air Traffic Control (ATC) labs in Atlantic City for study of real time pilot/controller communications," DiCarlo said. □

Message from the Director of the AGATE Alliance Association, Inc.

Jack Sheehan

The AGATE Alliance Association is a very unique organization. The diversity of the members and their interests create an environment where we can truly accomplish things together that no one member could possibly accomplish alone. This unique aspect of the alliance seems to be the catalyst for our continued growth. The interest in membership in the alliance is higher now than at any time in the past. We have accomplished a great deal and have produced some significant breakthroughs. The challenge we now face in each of the work packages is determining the value of our individual and collective investments and weighing that against the value of new member participation. The closed architecture school of thought was the prominent one when we started this experiment. Many encouraged a more open environment and the results have been rewarding. We need to continue to look toward the idea of open environments but also to protect each member's interest. There is some degree of inherent shelf life in our technology and having a proprietary piece of technology is of no value unless it is incorporated in a product that reaches the market. I believe it will be important in the coming year to find those areas where we can leverage the technology with new members, and to determine, in the case of a required investment on their part, where to invest the funds received.

A significant finding during our survey entitled *A Collaboration in Progress* was the fact that one of the highest rated responses was the overwhelming agreement that "The value of the collaborative alliance went beyond the government participation and funding". We are taking some bold initiatives along those lines. These have included the public release of data, the initial agreement to exchange data with the rotorcraft industry and the competitive tasking within the alliance requiring much greater industry contribution. These initiatives combined with the admission of suppliers to a work package indicate a true maturing of the collaborative process.

We are now exploring new initiatives in which the alliance would actively participate role in the determination of technology requirements for the Small Aircraft Transportation System. We are also considering the formation of member-funded work packages and are working on the details for a FY00 start (October 99). The member-funded work packages could be the logical extension of work packages that have completed their AGATE objectives and funding but whose members wish to continue to collaborate, or the establishment of new work packages with different subject matter.

The business of the alliance continues to grow and the AGATE Alliance Association is finding new ways to serve the membership. We recently set up the opportunity for some of our members to talk with the U.S. Air Force Flying Clubs strategic steering committee about the future of aircraft with AGATE technology and how the clubs might either retrofit their aircraft or consider new aircraft and also utilize the new training products.

World's First SATS Airport Designated

The world's first SATS airport was officially designated at the Virginia Aviation Board meeting on Oct. 28, 1998. Manassas Regional Airport was chosen for its location and modern facilities. It is also Virginia's busiest general aviation airport with 130,000 operations per year and 350 based aircraft—the most in the state. Requirements for airports under SATS include accessibility, the availability of reliable aeronautical services, and intermodal connectivity.

"Virginia's airports come pretty close to meeting the requirements of SATS goals," Virginia Department of Aviation Director Ken Wiegand said. "The challenges as I see them are the increased demand for land and infrastructure to accommodate SATS and precision GPS instrument approaches to all runway ends, as well as the provision of reliable modern services and issues relating to intermodal connectivity at individual airports." Bruce Lawson, Airport Manager at Manassas, called the designation exciting "With our proximity to the nation's capital, FAA and NASA and funding sources for research and development, members of Congress and their staff understand the impacts upon the national transportation system."

"The Manassas Regional Airport already has the kind of surface environment (runways, taxiways, lighting, etc.) and aeronautical service providers that one would think of when identifying a modern, full-service airport. It also has a ground-based precision instrument approach, automated weather reporting equipment, automated weather dissemination and flight planning equipment (Weathermation), a full range of excellent aeronautical services, and uncommon ground transportation choices to include rental car availability on the field, crew cars, taxi service, a direct link to Interstate 66, unique and convenient rail service to the District of Columbia via the Virginia Railway Express from a rail station situated on the airport," said Wiegand.

"Manassas represents a convenient site for testing and demonstration. Most importantly, Manassas is among 68 licensed, public-use airports in Virginia that are eligible to receive funding and technical assistance from one of the most progressive state aviation agencies in the country. Future Virginia SATS airports will provide a range of infrastructure and services from the very basic to those mirroring those at Manassas," he said.

"As time goes on, we look forward to working with NASA's General Aviation and Commuter Program to introduce other Virginia airports to the SATS system. Future plans to implement emerging aviation technologies in Virginia include upgrades to the existing AWOS and ASOS, weather dissemination equipment, communications equipment, and the ARNAV WeatherNet system. We are also considering the installation of a Differential GPS approach somewhere in Virginia and, of course, we are always looking for new and exciting aviation technologies to introduce to our system users," added Wiegand. □

We are trying to do something new this year at the Spring "Sun 'n' Fun" meetings by having the meeting hosted by Embry-Riddle Aeronautical University and also by interspersing the plenary session with some interesting presentations from the foreign market and new technology issues. □

"Live Shot" Offers Media a Glimpse of Latest GA Aircraft

The first two airplanes to make extensive use of AGATE technology were featured in a successful series of NASA television "Live Shot" interviews via satellite February 12, 1999 at the NASA Langley Research Center. A NASA single-day record of 28 television stations around the country interviewed Bruce Holmes as he sat in a Cirrus SR20, with a Lancair Columbia 300 filling the rest of the frame. As AGATE director and manager of NASA's General Aviation Program Office, Dr. Holmes talked with news and morning show reporters on the theme of "Putting Wings on America." Another 20 stations used NASA-provided video to cover the story. The event was attended by 60 invited guests which included dignitaries from throughout the state of Virginia.

AGATE technologies utilized in the aircraft designs include spin resistant wings, recovery parachutes, and advanced composite materials. The Columbia 300 and SR20 are to serve as Small Aircraft Transportation System (SATS) type airplanes.

The dignitaries who attended the "Live Shot" at Langley included the Virginia Secretary of Commerce and Trade, Barry E. DuVal who expressed an interest in SATS for Virginia as well as the state's utilization of manufacturing technology for the SATS program. These statements were echoed by James Eason, the former mayor of the city of Hampton and president of the Hampton Roads Partnership.

"Virginia has become a leader in economic development in the last five years. One important component of Virginia's business success is the ability of organizations to be efficiently and effectively connected to the outside world. Virginia's transportation system provides that connectivity. An important part of business success is moving people and products through general aviation. Virginia's commitment to technology in improving its airports will result in even more competitiveness for the business community. Moreover, NASA Langley Research Center, located in Virginia, positions the Commonwealth to take advantage of technology and new applications for general aviation research, development, maintenance, and manufacturing within the aerospace industry," said DuVal. "It is critical we maintain a strong NASA presence in Virginia."

Virginia Department of Aviation Director Ken Wiegand also took the occasion to speak about SATS technology in Virginia. "Virginia was the first state to realize the importance of emerging technologies and their impact on AGATE as well as our airport infrastructure. When we were introduced to ARNAV's WeatherNet datalink system, we immediately realized the value of having the system working for us in Virginia. We saw the value of weather graphics and weather text information in the cockpit as well as having the capability to communicate outside of radio voice capabilities. We especially saw the value of being able to track our equipped aircraft as they traveled around the Commonwealth or out of state where the system was active. The safety enhancement of having weather graphics in the cockpit and the flight following alone sold us on the value of the system to our operation which includes transporting the Commonwealth's First Family and VIPs around the country, but primarily in Virginia," he said.

photo courtesy of Jeff Caplan (NASA Langley Research Center)

The Lancair Columbia 300, left, and Cirrus Design SR20 represent the latest GA aircraft designs and are to serve as SATS type airplanes.

"Virginia was also the first state to designate a SATS airport at Manassas, Virginia. Manassas Regional Airport is one of the most active General Aviation facilities on the East Coast and in Virginia. Manassas is a high-end, model SATS facility that will be considered for the application of emerging technologies as they become available," said Wiegand.

Other guests included: Arthur Collins, Hampton Roads Planning District Commission; James R. Smith, Peninsula Airport Commission; James W. Holley, III, Mayor of the City of Portsmouth; Michael Montgomery, Executive Director of the Peninsula Alliance for Economic Development; Dorothy Buchanin, FAA Technical Center; and Shirley J. Ybarra, Secretary of Transportation, Commonwealth of Virginia.□

Schedule of Events

April 5-9, 1999:
Lakeland, FL
EAA "Sun 'n' Fun" Fly-In

April 6-8, 1999:
Daytona Beach, FL
Technical Council Meetings

April 9, 1999:
Daytona Beach, FL
AGATE Executive Council Meeting and All Member Plenary

April 20-21, 1999:
Phoenix, AZ
NATA

April 20-22, 1999:
Phoenix, AZ
FAA Forecasting Conference

June 21-24, 1999:
NASA Langley Research Center
Hampton, VA
Small Aircraft Transportation System Planning Conference

July 28-August 5, 1999:
Oshkosh, WI
EAA AirVenture '99
- *Oshkosh Technical Council Meetings*
- *NASA-FAA General Aviation Technology Press Event*
- *National General Aviation Design Competition Awards*

1998 Phase I and II SBIR/STTR Awards Announced

Phase I and II award winners for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) programs have been announced by NASA. The SBIR and STTR programs are playing a major role in the efforts to revitalize general aviation (GA). Awards provided to small businesses and research institutions are leading to significant technology development efforts. Many of these are being conducted by AGATE members. The awards are competitive and the winners are selected on the basis of their value to GA revitalization through potential commercialization of their innovative technology. Past GA SBIR/STTR winners have had a strong commercialization track record. Since 1993, NASA has awarded GA companies over $32M in these programs.

In 1998 the GA Phase I and II SBIR and STTR Phase II award winners and their project titles are as follows:

SBIR Phase I Awards (1998)

***Seagull Technology, Inc.**
Universal Aviation Data Service (UADS)

Vision Micro Design Inc.
Low Cost Design & Manufacturing of GA Cockpit Displays using Projection LCDs

*** Mod Works**
Advanced Low Cost Airframe Construction Techniques

Zerad Inc.
A Vent Control for Optimizing Airbag Performance

Aqualytic Technologies
Catalytic Ignition System

***Global Aircraft Corporation**
A Novel Rotary Diesel Engine for General Aviation Aircraft

SIETEC Corporation
Compression Ignition Engine for Light Aircraft

SBIR Phase II Awards (1997)

***AvroTec, Inc.**
Innovative Affordable Head-Mounted General Aviation Pilot Information System

Team Vision
Integrated Design and Manufacturing Software Tool for Windows

Mide Technology Corporation
Piezoelectric Ignition and Sensing Device

STTR Phase II Awards (1997)

Alpha Star Research Corp. and Clarkson University
Progressive Fracture Simulation for Design of Braided Ceramic Combustors for Turbine Engines

***Global Aircraft Corporation and *Research Triangle Institute**
Design and Implementation of an Integrated Landing System for Small General Aviation Airplanes

The 1998 Phase II awards up to $600,000 each will be made upon completion of the ongoing Phase I work, expected by December 1999. Solicitations for 1999 SBIR Phase I proposals open April 24, 1999 and close on July 14, 1999. Selections for 1999 SBIR Phase I awards up to $70,000 each will be made in October 1999.

More information can be found on the internet at http://sbir.gsfc.nasa.gov.□

***AGATE Member**

AAAI photo

Mod Works Human Factors Engineered Instrument Panel developed with Florida Institute of Technology under the NASA STTR program.

AAAI photo

Seemann's Composites Cirrus SR20 Fuselage manufactured with the SCRIMP™ Low Cost Manufacturing Process under the NASA SBIR program.

Management and Technical Progress Highlights

Flight Systems

The AGATE Flight Systems Work Package hosted a technical meeting with the Flight Training Curriculum Work Package on February 25-26, 1999 in Hampton, Virginia. Over 25 consortium members from government, industry, and academia were in attendance. Additionally, representatives from the Aviation Safety Program, Synthetic Vision Element, and human factors experts from the NASA Crew/Vehicle Integration branch attended the meeting. The Flight Systems Work Package is developing affordable flight systems that allow near all weather flying capability for light GA airplanes, including a "Highway-in-the-Sky" operating capability. The Flight Training Curriculum Work Package is developing and validating advanced training methods that take advantage of these emerging technologies. The AGATE flight systems test vehicle, a modified Beechcraft Bonanza, was made available (in cooperation with Raytheon Aircraft, an AGATE partner) for viewing. This test vehicle (identified as AGATE 1-B) is available to NASA researchers interested in a low-cost flight test solution for experiments in single-pilot flight deck, decoupled flight controls, display safety, human factors, and related experiments.

Integrated Design and Manufacturing

The Integrated Design and Manufacturing (ID&M) Work Package reported that AGATE and the Rotorcraft Industry Technology Alliance (RITA) met at NIAR (the National Institute for Aviation Research) on February 3, 1999 to review the business issues associated with data sharing. John Tomblin reviewed the AGATE Materials Research Program. A short discussion followed in which the financial details of the two programs were compared. The AGATE research represents $0.7 M/yr that is matched 1:1 by industry. The total RITA program is funded ($9M/yr) and is also matched 1:1 by industry. These funds support 60 projects, 20 of which are in composites. Jack Sheehan and John Ward provided presentations describing the business operations of AGATE and RITA respectively. Paul Masson then led a discussion to determine how to proceed. The group also agreed that their initial effort in the materials area would be followed by other collaborative efforts in other technical areas.

Integration Platforms

Work orders and engineering review requests for the installation of a Datalink Infrastructure Facility (DIF), located in the NASA Langley Research Center Mission Control Center (MCC), are being processed. Due to re-negotiation of the current in-house support contract, no additional work is being accepted by the current contractor with work requests sent out of house for bids. Initial engineering review estimated major structural enhancement needed at the catwalk site where some of the DIF hardware is to be located. This has delayed support for the installation, as alternate solutions to minimize impact of such a requirement are being addressed. FY '99 funding to complete the installation and support the development of approach profiles and other operational procedures needed for the DIF has been resolved, with completion of the basic system at NASA Langley targeted for April 30, 1999.

Flight Training Curriculum

Four students have completed training in the Unified Curriculum and are awaiting the FAA check Private/Instrument check ride.

The ICIS STT training module has been integrated and tested. The system has been deployed to Embry-Riddle. The CBT module has been completed and tested. A draft analysis of the results has been completed and is under review.

The Primary Flight Display (PFD) for the PFD learning module has been defined for training purposes and agreed to by the Flight Systems Work Package. The testing scenario and test design have been completed.

Program Analysis

The Program Analysis Work Package reported that 27,576 users have been on the program analysis Internet site. These visitors have spent an average of 8:18 minutes exploring the site and have accessed 153,707 page views for an average of approximately 5.6 page views per visitor.

The visitors have completed 3,675 surveys and 1,198 of the survey respondents have requested more information on either learning how to fly or on purchasing an airplane.

The Work Package reported that the number of identifiable International Users who visit the site remained relatively constant at 9.21 percent of the total traffic. The number of United States visitors is 59.03 percent with 31.75 percent of the visitors not identified.

AGATE ALLIANCE MEMBERSHIP

Work Packages: Flight Systems (FS)
Propulsion Sensors & Controls (PS&C)
Integrated Design & Manuufacturing (ID&M)
Ice Protection Systems (IPS)
AGATE Integration Platforms (AIP)
Flight Training Curricula (FTC)
Systems Assurance (SA)
Program Management (PM)

Work Package Membership: P = Principal; A = Associate

Official Organization Name	FS WP-1	PS&C WP-2	ID&M WP-3	IPS WP-4	AIP WP-5	FTC WP-6	SA WP-11	PM WP-12
Advanced Creations Incorporated						P		P
Airborne Research Associates	A							
Allied Signal Aerospace Company	P		P				P	
ARINC Incorporated	P							
ARNAV Systems Incorporated	P							
Aurora Flight Sciences		A						
AvroTec Incorporated	P						P	P
BFGoodrich Aerospace				P				
Cessna Aircraft Company	P	P	P	P		P		P
Cirrus Design Corporation			P				P	
Cox and Company Incorporated				P				
Digital Equipment Corp.	P							
Embry-Riddle Aeronautical Univ.			A			P	A	
Global Aircraft Corp.			P				P	
Harris Corporation	P							
Hartzell Propeller Company			P					
Honeywell Technology Center		P						P
Innovative Dynamics Incorporated				P				
Jeppesen Sanderson Incorporated	P					P		
Lancair International Incorporated			P					
Mod Works Incorporated			P					
NavRadio Corporation	P							
Ohio State University						P		
Raytheon Aircraft Company	P		P		P	P		P
Raytheon E-Systems		P					P	
Rockwell Collins Incorporated	P						P	
Seagull Technology Incorporated	A							
Simula Technologies Incorporated			P					
Stoddard-Hamilton Aircraft Incorporated			P					
Teledyne Continental Motors		P						
Textron Lycoming		P						
Unison Industries		P						
United Technologies Hamilton Standard			P	P				
Wichita State University-NIAR			A	A			A	A

SUPPORTING MEMBERS

A&P Technology, Inc.
Aerocar Llc.
AGATE Alliance Association Incorporated (AAAI)
AOPA-Air Safety Foundation
Avidyne Incorporated
Executive Jet Incorporated
Experimental Aircraft Association (EAA)
General Aviation Manufacturers Association (GAMA)
Georgia Tech Research Institute
Kansas State University
Micro Craft Incorporated
Mississippi State University-Raspet Research Lab
Mitre Corporation
National Air Transportation Association (NATA)
National Center for Atmospheric Research
New Piper Aircraft Incorporated
Optimal Solutions Incorporated
Research Triangle Institute
University of Illinois at Urbana-Champaign
University of Kansas
University of Tennessee Space Institute
University Research Foundation
Williams International
Wyndemere Incorporated

GOVERNMENT PARTNERS

Federal Aviation Administration
NASA Langley Research Center
NASA Lewis Research Center
USAF Research Laboratories (Wright Directorate)

From the desk of the Program Manager

(Continued from page 2)

utility and minimize user uncertainty regarding destination services. "Smart" airports with higher utility and safety in more weather conditions would be included, along with free flight procedures for expanded NAS capacity, and airport utility.

- Vehicles: The aircraft will be predominantly GAP-powered AGATE planes, incorporating state-of-the-art advancements in avionics, airframes, engines and pilot training and capable of operating in free flight modes within the evolving NAS. These aircraft will possess revolutionized vehicle safety, affordability, maintainability, environmental compatibility, and ease-of-use.
- Users: Simplified and affordable pilot training through advanced technologies, enabling pilots to maintain all necessary competencies and proficiencies for AGATE Highway in the Sky system flight operations, within the practical constraints imposed by typical professional and personal time schedules.

Who is involved? The follow-on to AGATE and GAP is planned to be the SATS Program. NASA, the FAA, industry, and universities will all play vital roles in the continued technology development. There will be a few new players involved as well. The States will play a key role in infrastructure technologies development and deployment. In addition, the National Research Council's Transportation Research Board will become engaged in evaluating the SATS concept and public sector requirements. Finally, the role of the FAA will become more clearly defined as the Mission Need Statement (MNS) that is under development for SATS matures.

The FAA Administrator commissioned an MNS development project for the SATS. The MNS documents the shortfalls in agency mission capabilities for the SATS. The MNS process initiates all major investment planning by the FAA. The MNS is planned for completion as early as the spring of 1999.

The NRC is planning a SATS study to evaluate trends and forces that shape 21st century demand for higher-speed personal air transportation and provide guidance to NASA, as well as other federal and state government partners, for SATS investment and partnership planning. The NRC SATS Committee will plan to complete their consensus report by about the end of 2000.

What happens to the AGATE Alliance? AGATE and GAP have taught the General Aviation public and private sectors how strategic alliances and partnerships are designed and operated. The development and deployment of SATS infrastructure technologies will require an innovative federal-state-local government partnership mechanism. The lessons learned during the past six years will be valuable.

At the completion of the AGATE program in 2001, the industry and government partners must make a pivotal choice in how to continue. Both the government and the industry have a stake in continuing partnership. NASA will look to industry leadership for vehicle technology investment strategies and partnerships. The federal government will likely continue to take a strong leadership role as managing partner for infrastructure technology investments. Under industry leadership, the AGATE Alliance has the potential to play a more lasting role in SATS.

The goal of a federal-state-local partnership would be to establish the national requirements and planning templates for an interstate system of smaller airports for the SATS. The strategic premise for the partnership would be to "treat the nation's public use airports as a national economic strategic infrastructure (like highways & public utilities)." The products of this partnership would include the means for development and deployment of SATS operating capabilities.

In conclusion, the Roadmap strategy holds that the ingredients for a significant advancement in transportation are present. Specifically, the most significant innovation in doorstep-to-destination speed since the emergence of the hub-spoke airways system is possible, if the challenges can be met for making small aircraft and airports more available to the traveling public. The transportation innovation would take the form of a SATS for personal and business travel. The National General Aviation Roadmap establishes the vision and goal metrics for a SATS, to contribute to satisfying these burgeoning transportation demands of the 21st Century.

The AGATE membership has remained steady and the budget continues to be stable. The 1998 partner commitments to date include 36 Principal, 4 Associate, 20 Supporting, and 3 Government Members. These are the partners and programs committed to achieving world class R&T capacity for the U.S. general aviation lightplane industry, in support of creation of the Small Aircraft Transportation System. □

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The AGATE Flier

Volume V, Issue 1 March 1999

The AGATE Flier is published by the AGATE Alliance Association, Inc., a private, non-profit, membership organization founded to stimulate the development and dissemination of general aviation technology. ***The AGATE Flier*** reports on progress in a family of technology initiative and public/private aviation related activities to revitalize the U.S. GA industry, called AGATE—Advanced General Aviation Transport Experiments. The NASA Langley Research Center is the lead center for this program.

For address corrections and additions, please write to:

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For media information concerning NASA's General Aviation Programs please contact:
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Office of Public Affairs
Mail Stop 115
Hampton, VA 23681-0001
(757) 864-6124

GAPO Plans Expanded GA Display at Oshkosh AirVenture '99

NASA is planning an expanded display for AirVenture '99 showcasing the latest advancements in General Aviation Technolgy. The centerpiece of the display will be the newly certified Cirrus SR20, and Lancair Columbia 300 aircraft. A new animated video called "The Small Aircraft Transportation System (SATS) Flight Immersion Experience" will be presented in a theatre within the display area and will demonstrate flight as experienced from inside the cockpit of an AGATE airplane. The Theatre has three screens, showing front and peripheral views from within the aircraft. This year's display will also feature a flight simulator from Embry-Riddle Aeronautical (ERAU).

"We are planning to change the basic format of the display from one based on programs (which is a logical layout for a NASA or Industry person) to one based on product, to provide the most logical flow to the general public," said Hank Jarrett, Deputy Manager of NASA's General Aviation Program Office. "Even the name of the building is being changed to reflect this. The display building is now being referred to as the NASA GA Building."

The principal areas for presentation at this year's display are: (1) the new aircraft displays, (2) Propulsion Systems, (3) Cockpit Displays, (4) Flight Training, and (5) Material and Processes, and (6) SATS Infrastructure.

Specific displays in each area have not been finalized and members are encouraged to make proposals for displays within their respective areas. The Theatre will be available for conventional video displays (other than the "SATS Flight Immersion Experience") and additional video proposals will be entertained.

The AGATE Flier

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Hampton, VA 23666
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Address correction requested

September 1998

The AGATE Flier

Information on developing technologies for business and personal transportation aircraft

Volume IV, Issue 2

New Training Courses Accelerate Pilot Qualifications

A revolutionary series of flight training courses, known as the AGATE Flight Training Curricula, are helping prospective pilots to learn how to fly advanced general aviation (GA) aircraft in less time and at lower cost than traditional flight training courses. The Flight Training Curricula were developed by AGATE Curriculum Development Team member Jeppesen Sanderson and administered by Embry-Riddle Aeronautical University (ERAU), Daytona Beach, Florida. The curricula, part of the Flight Training Curriculum Work Package, are supported by NASA through the AGATE program and the FAA Flight Standards District Office, Orlando, Florida. In addition to offering students the opportunity to obtain their Private/Instrument certificate in one step with about a 25 percent reduction in cost and flight time, the curricula introduce students to AGATE-developed technologies designed to reduce workload and improve safety.

According to Dr. Steven Hampton, Principal Investigator for Embry-Riddle, significant progress is being made within the Flight Training Curricula Program. "The Flight Training Curriculum Work Package has three goals this year: (1) to establish a baseline against which further enhancements in training curricula can be measured, (2) to develop a Training Module for the Integrated Cockpit Information System (ICIS), and (3) to develop a Training Module for the Propulsion System Management Functions (PSM). At the present time, progress has been made towards the first two goals. Two curricula have been written: a Basic Curriculum modeled after the new FAR Part 141 regulatory requirements, and a Unified Curriculum that teaches instrument and private certificate skills in an integrated program."

The Basic Curriculum consists of Private training followed by Instrument training in a continuous program—students are taught all of the skills required for Private Pilot certification followed by skills required for Instrument training. The training follows established guidelines and meets all of the FAR Part 141 requirements. One difference is that a proficiency-based approach is used, instead of the traditional minimum time requirement.

Ray Wabler
AGATE Executive Council Member

"If we can successfully attract and efficiently train more pilots, the market for new aircraft will be expanded. The expansion of the market for new aircraft will result in greater economies of scale and lower prices for the aircraft."

The Unified Curriculum integrates Private and Instrument skill training from the beginning. Traditional training methods call for separate courses for separate ratings. The Unified Curriculum is intended to provide additional reinforcement of skills such as ADF Instrument Approaches. "Introduction of these types of activities early in training gives

(Continued on page 6)

photo courtesy of Embry-Riddle Aeronautical University

AGATE Flight Training Instructor Jesse Rhodes (left) and AGATE Flight Training Student Eric Pedroza pose alongside an AGATE Flight Training Curricula Program C-172.

photo courtesy of Embry-Riddle Aeronautical University

A Personal Computer Aviation Training Device (PCATD) used for ground training in the Unified Curriculum.

From the desk of the Program Manager

Dr. Bruce J. Holmes, NASA Langley Research Center

A Preview of AGATE Legacies

"The tide raises all ships." This metaphor aptly describes general aviation revitalization. As we approach the end of the AGATE program in three short years, we will see (in some cases, are already seeing) the emergence of new and different kinds of industrial competitiveness on this "raised tide." The new competitiveness will be characterized by faster paced innovations, higher levels of performance, and lower cost, all with advancements in quality. AGATE's most important legacy will be the revitalized research and technology (R&T) capacity in the U.S. general aviation lightplane industry. This emerging R&T capacity is becoming world class in all disciplines, avionics, airframes, engines, and pilot training technologies. If the new R&T capacity is the "tide," then ***open systems*** will be the sails propelling the ships (companies) that sail with the tide.

Some AGATE legacies will be highly visible, others virtually invisible. Paradoxically, it is the less visible legacies, including the industry movement toward open systems, that will carry the more visible legacies to full fruition. What are open systems? What is the role of open systems in general aviation revitalization? What is the Government interest in open standards?

What are open systems? The U.S. DoD definition for open systems is: ". . .a business and engineering strategy to choose specifications and standards that are (1) adopted by industry standards bodies, or (2) *de facto* standards (set by the marketplace) for selected systems interfaces (both functional and physical), products, practices, and tools." Aircraft comprised of subsystems adhering to open systems, architectures, and protocol standards will achieve high levels of component integration and interoperability; in turn, several benefits accrue.

The benefits of open systems include access to COTS economies of scale, more rapid technology insertion, higher system performance, increased interoperability, and ultimately, improved competition. For example, general aviation will ride the coat tails of the PC revolution in both technology and cost. The ultimate beneficiary is the consumer. The challenges to open systems are significant. They include reduced vendor control, development of certification paths under the Federal Airworthiness Regulations (FAR), and ongoing standards management. AGATE is tackling these challenges through an industry consensus approach to standards. This approach is producing FAA advancements in certification reforms. These reforms include the new materials qualification process for composites and the revised FAA Advisory Circulars (23.1309 and 23.1322) for the revolutionary changes in cockpit systems. This approach also results in competitive product innovation in the marketplace. Open systems are all about better, faster, and cheaper.

Some open systems standards can be defined up front; clearly, others must await the vote of the consumer. AGATE focuses on those high level open systems capabilities that can be defined up front, using the industry consensus approach. There are clearly risks in attempting to choose standards. AGATE targets those standards that have the greatest likelihood of robustness for standing the test of time. We also seek standards that create pathways for expansion of performance in both hardware and software.

What is the role of open systems in general aviation revitalization? The industry movement toward open systems and protocol standards plays a key role in revitalization. The most visible AGATE legacy will be our "Highway in the Sky" operational capability. A "highway in the sky" is a graphically intuitive PFD depiction of a desired flightpath (either your VFR flight plan or IFR clearance) derived from the functions provided by the AGATE Architecture. This flightpath depiction resolves weather, traffic, terrain, and airspace issues for the pilot without the use of ATC voice communications. The ability to affordably deliver the "Highway in the Sky" concept to market depends vitally on open systems standards.

We plan to complete other equally vital legacies including simpler and safer engine management, more utility in weather (including icing conditions), more affordable and crashworthy composite airframes, and streamlined flight training. These legacies will appear as the most visible industry products and services.

The less visible paper products are taking the forms of RTCA and AGATE MOPS for CNS and cockpit information and display systems; design guidelines for crashworthiness and lightning protection; and industry standards for architecture and subsystems and components affecting engines, airframe, and avionics. These are the invisible legacies that enable the visible legacies to emerge.

The adoption of open systems philosophies and standards by the U.S. general aviation industry will open the door to the revolution in digital bandwidth. In the past, manufacturers have relied on proprietary standards as the basis for competitiveness. Full access to the power of the information age demands that shared standards become the norm. The ultimate beneficiaries are the future Small Aircraft Transportation System (SATS) consumers. They will benefit from revolutions in affordability, safety, and ease of use for a new generation of SATS aircraft and airport infrastructure.

What is the Government interest in open standards? Simply stated, open systems greatly facilitate technology transfer and deployment, which are the primary functions of Federal funding for general aviation R&T. The Government role is to stimulate development of high risk technologies that have significant "public good" value. The public good metrics, directed by the Administration and Congress, include safety, mobility, National Airspace System capacity, noise, and emissions. Future NASA investments have far greater impact on these "public good" metrics if the U.S. general aviation industry adopts open standards and architectures. This fact becomes increasingly important to mitigate the effects of declining Federal R&T budgets during the coming years.

Open systems business and engineering strategies are relatively new to the general aviation industry. In the past, companies built their competitive edge on the basis of proprietary standards. In the future, the achievement of the technological and operational features and capabilities needed for a SATS will depend vitally on open systems standards. Over time, the use of proprietary standards will have diminishing value to the speed, quantity, and quality of innovations. To continue the "raised tide" metaphor, we must all raise our anchors, whatever those anchors may be, before the tide runs out.

In summary, AGATE will leave several legacies. The legacy of open systems will pave the way for advancements in affordability, safety, and ease of use for future aircraft. These are advancements that have seemed like "pie-in-the-sky" in the past. The door to open systems leads to the path to more rapid innovations and increased influence of market forces (versus certification or regulatory inhibitors) for new products. Yet, the move by industry toward open systems requires a shared belief that doing so energizes the potential for growth, both in total market as well as in individual market shares. AGATE is built on the foundations of this shared belief.

The AGATE membership has remained steady and the budget continues to be stable. The 1998 partner commitments to date include 36 Principal, 4 Associate, 20 Supporting, and 3 Government Members. These are the partners and programs committed to achieving world class R&T capacity for the U.S. general aviation lightplane industry. □

Aviation Weather Information (AWIN) Program Commences

AGATE Members ARNAV and NavRadio Selected to Develop GA Weather Systems

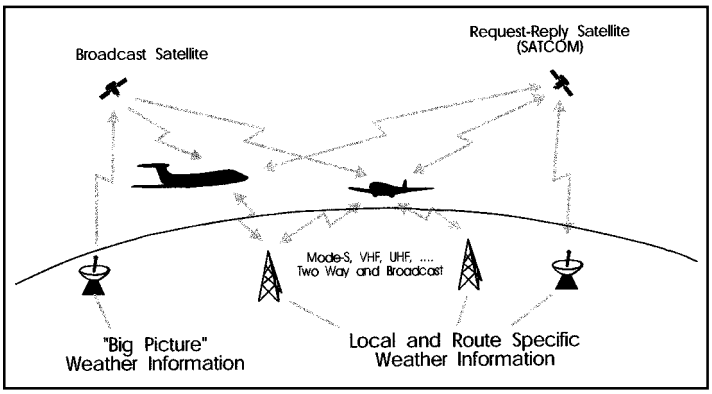
Efforts to provide general aviation (GA) pilots with up-to-date weather information in the cockpit are shifting into high gear under the auspices of the Aviation Weather Information (AWIN) project. AWIN is part of a research and technology program known as Aviation Operations Systems (AOS), which is being led by NASA Ames Research Center. The parent AWIN project, directed by officials at the NASA Langley Research Center, features three sub-elements: AWIN, turbulence, and communications.

"The main focus of AWIN is to take existing weather information that is available and provide a means to get it in an accurate and timely manner to the flight deck, to air traffic control, and to airline operation centers—for GA, maybe a private aircraft operation organization or fixed base operator (FBO) such that you would be able to do collaborative decision-making. That is, the air traffic controller and the flight deck, and some other party involved would be able to jointly and very quickly, using the same information, make a decision beneficial to the overall traffic flow, efficiency, and safety," said Paul Stough, AWIN Level Three Manager.

There are three major areas of emphasis in AWIN. The first area concerns Enhanced Weather Products. "This is where you take existing weather products and reformat them or combine several products into a new product that presents the information that is really needed. Another part of providing enhanced weather products is weather hazard detection. This involves determining what kind of on-board sensors are required so that they can become more effective parts of hazard detection systems. One activity we are looking at is taking existing radars that are on airplanes and enhancing them so that they can better detect turbulence. The idea of Electronic Pilot Reports (EPIREP) would fall under this category as an enhancement to the ability to detect weather hazards," said Stough.

The second major area of emphasis in AWIN is Data Communication/Link. According to Stough, this involves "looking at the system architecture such that you can connect together the airplanes and the ground, and pass the information back and forth on the ground and in the air in a timely manner and do it accurately and affordably."

The third major area of emphasis in AWIN is Operator Support. As stated by Stough, "This encompasses how you present the information. Display is certainly a large part of this, but there may be other appropriate interfaces such as a tactile or oral annunciator for certain things that would be part of the presentation system. The other part of operator support is decision-making. This involves determining what we can do to take the weather information and help the crew, or the controller, or airline operation center make the right decision. Ultimately, you want to make a decision that supports a safe action," said Stough.



graphic courtesy of Dr. Charles Scanlon, NASA Langley Research Center

AWIN Technology Systems

AWIN efforts began last December, when NASA circulated a research announcement that solicited proposals for aviation weather information systems or elements of such systems. "We targeted selections for two of the proposals for transport world-wide systems and two for GA. One of the GA teams selected is headed by ARNAV and the other is headed by NavRadio, both of which have been active members in the AGATE Flight Systems Work Package. A proposal submitted by NavRadio to develop a system for EPIREPs was also selected. This activity is being performed through the Flight Systems Work Package in AGATE, and started back in July," said Stough.

ARNAV and its team members are concentrating their AWIN efforts on the development of an advanced weather hazard information system designed to reduce GA fatal weather-related accidents. This system will integrate the use of advanced graphical weather displays among GA pilots and entail the connection of the existing ARNAV datalink infrastructure and WxLink services, a vast network of 57 ground stations located throughout the United States, to the National Center for Atmospheric Research (NCAR). The team will provide more than 400 hours of in-flight evaluation on four advanced weather products presently being developed by NCAR. "The AWIN program allows us to develop more advanced weather products by using the expertise of NCAR, and sending the new weather products via the ARNAV ground communications network. The other team members (Cessna, NCAR, SAMA, and EAA) provide an unparalleled evaluation team to facilitate the rapid deployment and certification of weather products that will provide a much higher level of safety," said Frank Williams, President of ARNAV Systems Inc.

NavRadio leads two AWIN projects. The company and its team have been selected to deploy and operate a fully functional "weather in the cockpit" system via VHF broadcast datalink, and to conduct topical research into practical EPIREP systems. The broadcast datalink system encompasses ground

(Continued on page 11)

U.S. Air Force Research Laboratory Hosts AGATE Alliance Executive Council Meeting

The AGATE Executive Council held a meeting at Wright-Patterson Air Force Base June 23-24. The meeting was preceeded by an in-depth tour of the National Center for Composite System Technology facility located just outside the Air Force Base. The tour provided an excellent demonstration of public-private technology commercialization. The facility provides state-of-the-art prototyping for large composite structures. An ongoing project for the automotive industry was demonstrated that produces a structural composite pick-up truck bed.

The Executive Council had a full agenda that addressed items ranging from approval of the individual work package research plans and budgets to establishing guidelines for new member acceptance. Individual work package leaders presented their Technical Councils plans and budgets, and action items were referred to the General Aviation Program Office (GAPO) for resolution. The host for the meeting, Dr. Lanny Jines, chief of Air Force Research Laboratory (AFRL) Corporate Communications, provided an excellent venue in an environment surrounded by aviation history. "We were delighted and honored to host the latest Executive Council meeting here at the AFRL's Ohio headquarters. . .The synergy of these face-to-face meetings is outstanding," said Dr. Jines. A break for dinner provided an opportunity for a great meal in the hotel that was host to the historic Dayton Peace Accords conference. After the somewhat controversial budget session, peace accords seemed to be in order. The evening session dealt with various issue papers and lasted late into the night. The meeting concluded the following day with very active participation of the council observing members. The General Aviation Manufacturers Association (GAMA) took the opportunity to take an active role in support of the Flight Training Curriculum Work Package.

The day following the Executive Council meeting provided an opportunity for Dr. Bruce Holmes to present the National Roadmap Strategy for the Small Aircraft Transportation System (SATS) to over 200 industry representatives in the auditorium of the U.S. Air Force museum. The gathering of the AGATE members and other industry representatives was a pioneering endeavor in its own right on our quest for the "Highways in the Sky." □

Integrated Design and Manufacturing Work Package Votes Unanimously to Admit Material Manufacturers

Seven Companies to Become AGATE Members

A group of AGATE organizations working on new materials testing have made significant breakthroughs that have been recognized by the FAA and attracted seven companies to seek membership in the Alliance, beginning with the 1999 project year. The new members, all materials suppliers, are seeking participation in the Alliance to conform their materials testing to the new AGATE standards. The companies will join in a category designed specifically for suppliers. The Integrated Design and Manufacturing (ID&M) Technical Council reviewed and agreed to the new members during its business meeting the week of August 17, in Hampton, Virginia, held at the offices of the private sector members technology development association, the AGATE Alliance Association, Inc. (AAAI).

The seven companies seeking participation in the Alliance under the ID&M Work Package include FiberCote, Inc.; 3M; Newport Adhesives & Composites; Toray America Composites; Shell; Foster-Miller; and A&P Technology. These companies manufacture and supply advanced composite materials used for structural aircraft components.

The invitation for the companies to join the work package was made by the Principal members of the work package. "This decision was made based upon the growing importance of providing the GA airframe companies with FAA approved material design properties and to alleviate the need for each individual company to generate or qualify the material independently," said Dr. John Tomblin, Task Leader for the AGATE Materials Work Group. "The materials suppliers will be providing important data to AGATE that, hopefully, the airframers can use to minimize their materials qualification costs on future programs," added Tom Freeman, ID&M Work Package Leader.

The seven new materials members will be joining the Alliance next month as Supporting members. This requires them to meet just two terms: the ability to demonstrate a capacity to contribute technically to the AGATE goals, and payment of member dues.

The ID&M Technical Council also approved Scaled Technology Works as a Principal member. New Principal members are required to meet three conditions: demonstration of a capacity to contribute technically via assignment of a technical task; provision of resources to match Government funding for the task, payment of a fee for past deliverables, and dues; and demonstration of capacity to commercialize the results of their assigned task work. Organizations seeking additional information about AGATE membership are directed to the AGATE Alliance Association, Inc. Also, the Alliance maintains a business operating handbook, which contains a section specifying the steps for application to AGATE membership. □

AirVenture ’98

A record 855,000 people attended this year’s Experimental Aircraft Association Convention, known as AirVenture ’98, at Oshkosh, Wisconsin. The expansion of the general aviation (GA) industry served as a major theme at this year’s exhibition and was evidenced through numerous aircraft manufacturer and aircraft static displays.

The main AGATE display at the Convention was the AGATE-1B testbed aircraft. This aircraft, a Raytheon Bonanza, is used by AGATE Alliance members to flight test AGATE-developed technologies.

NASA Administrator Daniel S. Goldin visited AirVenture ’98 and had productive interactions with a variety of GA industry representatives, AGATE members, and state aviation officials. He emphasized that his 21st Century vision for NASA was to see a successful Mars landing and a national small airplane transportation system.

Several NASA Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) Program exhibits were featured. These included an SBIR exhibit by AvroTec highlighting its development of an innovative integrated cockpit display system for small aircraft. The low cost AvroTec display will utilize a computerized monitoring system that significantly reduces pilot workload and provides access to ATC datalink, traffic control information, and graphical real-time weather information.

In an STTR exhibit, Mod Works displayed its proposed low cost retrofit process for integration of avionics and cockpit sub-systems into GA aircraft. The process involves the use of computer aided design, CNC machining, robotics, connectors, wire, composite materials, and low cost labor practices. Mod Works’ STTR partner, Mississippi State University, developed the direct female molding making manufacturing method for the project.

In another STTR exhibit, Wiesen Engine displayed a prototype of a lightweight inexpensive aircraft diesel engine. The engine is also being marketed in the marine world. Plans are being made to test the prototype in test facilities of the U.S. Merchant Marine Academy, an STTR partner to Wiesen.

Lightning Technologies highlighted their GA lightning protection achievements in their SBIR exhibit. The exhibit discussed lightning safety design guidelines for protecting digital avionics against HIRF and atmospheric lightning effects.

Cox & Company, Inc. and Innovative Dynamics, Inc. described their Electro-mechanical Expulsion Deicing System (EMEDS) in an SBIR exhibit. EMEDS uses expulsion deicing in combination with conventional electro-thermal anti-icing to protect GA aircraft from ice buildup. Other SBIR exhibits highlighted Global’s Quasi-Constant Speed Composite Propeller development efforts and Aurora Flight Sciences’ Single-Lever Power Control for GA aircraft.

Heading the list of futuristic GA aircraft on display were VisionAire’s VA-12B Spirit jet-powered aircraft and the CarterCopters Gyroplane. The CarterCopters Gyroplane design combines autogyro and airplane operations. CarterCopters performance targets are operating altitudes up to 45,000 feet and cruise speeds of over 300 mph, while retaining very short field take-off and landing capability. Development of the Gyroplane is being funded by NASA Ames Research Center under the SBIR program.

The Cirrus SR20 and Lancair Columbia 300 aircraft were popular AirVenture ’98 attractions. Both airplanes are AGATE-type airplanes and are meant to appeal to existing and emerging customers looking for high performance and comfortable personal small airplanes. Both airplanes use technologies ranging from composite aircraft materials to single-lever power controls and advanced cockpit displays.

AirVenture ’98 also marked the debut of “Aladdin,” a jet-powered, radio-controlled model of an advanced GA aircraft design developed by engineering students at four Kansas universities. The team won funding to develop the model through the National General Aviation Design Competition which is sponsored by NASA and the FAA. The design was developed under a new award category—Design-It, Build-It, Fly-It—which is co-sponsored by the Experimental Aircraft Association (EAA). The category allows students to take a well-evolved design to a proof of concept phase. □

photo courtesy of Lancair International

The AvroTec Innovative Integrated Cockpit Display System as applied to the Lancair Columbia 300.

photo courtesy of CarterCopters

The CarterCopters Gyroplane.

Message from the Director of the AGATE Alliance Association, Inc.

Jack Sheehan

The AGATE Alliance Association Inc. (AAAI) continues to mature as an organization with the mission to support the development of technology necessary for the revitalization of the general aviation industry. AAAI is also performing research in the field of public-private consortium management. An alliance as large as AGATE provides many unique management challenges on both the government side and the private side.

The formation of AAAI as a non-profit 501 (c)(3) was an industry recognition that the Research and Technology (R&T) issues needed a focal point and that research support for program management activities could better be accomplished by a dedicated industry organization. The challenges at AAAI range from proprietary intellectual property issues to the logistics of a work package meeting. Communications is one of those enabling functions that always needs attention. From publishing the internal and external newsletters, to operation of both the open and secure Internet servers, AAAI is very busy communicating. The electronic registration for our Plenary meeting and Technical Council sessions in Kissimmee, Florida after the Lakeland Airshow made life easier on everybody and helped reduce costs. The event was the most successful session to date. Since then, we have held technical councils at AAAI and provided some excellent support by facilitating very difficult issues.

The role of AAAI has changed as responsibilities have gradually shifted from the public sector to the private sector. Industry, represented by the Executive Council, has recognized the need to be more active in the technical management of the Alliance. As such, AAAI will perform some functions normally associated with a chief engineer in a company. These functions, such as critical path analysis and design reviews, will be performed for the Alliance by AAAI. We will contract for services utilizing the broad talent base of the members. This is a great example of the collaborative strength in numbers. We have also presented a plan for a more streamlined acquisition process by reducing the number of NCA's and utilizing AAAI as a prime contractor for each work package, providing advance payments and reducing the administrative workload.

In our endeavors to pursue research in public private alliances, Paul Masson of PMC Consulting is still very active working for AAAI. As you will recall, Paul provided some excellent background work on the performance of companies engaged in alliances (AGATE Flier, March 98). I have asked Paul to work on commercialization data for a qualitative report specific to AGATE, in order to generate some inference concerning the value of the Alliance. Ultimately, the success of AGATE will be judged on technical achievements, but I often hear senior personnel in member companies stating that the collaborative effort has done more than it is being given credit for. We are going to try and measure that element of AGATE and produce a report that supports the use of such alliances. □

New Training Courses

(continued from page 1)

students time to repeat and reinforce needed skills more often than in the past," said Dr. Hampton. Another key element is the delay of solo activities until late in training. "This reduces the pressures of performing solo type skills, aids in confidence building, and allows additional skills to be taught prior to solo. The result is a better prepared solo pilot with additional skills. Solo is scheduled at about 26 hours of flight time, against the traditional 10-14 hours. The national average is somewhere around 18 hours," he said.

Embry-Riddle has invested heavily in the Flight Training Curricula Program. The University has dedicated ten new C-172s to training the Flight Training Curricula students. Ground training for the Unified Curriculum is being enhanced through the use of Personal Computer Aviation Training Devices (PCATD). "Embry-Riddle's involvement with the AGATE project has benefited the university in several ways. The program has helped us establish new relationships and strengthen existing bonds with aviation industry leaders and has given us an opportunity to work with NASA Langley's General Aviation Program. Our students will benefit from the cutting-edge technology and training that we are incorporating into the curriculum and our association with AGATE reinforces our reputation as the world's leader in aviation/aerospace education," said Dr. Steven M. Sliwa, President of Embry-Riddle Aeronautical University.

"The AGATE Flight Training Curricula Program is the largest single research project that we have had at Embry-Riddle. Our success in this program is a clear demonstration that Embry-Riddle has become a mature research organization. Embry-Riddle is the only non-government organization that has the responsibility for leading one of the AGATE work packages. Our successful management of the Training Work Package is showing the world that even though we are a small university and a relative newcomer to the research community, we have reached a maturity that is generally only associated with large research institutions with many decades of research experience. I am convinced that the type of university, industry, and government partnership that we have established to carry out the Training Curricula Program is a model for successful research partnerships in the next decade," said Dr. Andres Zellweger, Dean of Graduate Programs and Research at Embry-Riddle Aeronautical University.

Eighty-one students volunteered, at their own expense, to participate in the program for a one step Private/Instrument certificate. The students are currently completing the final phases of flight training. "We were hoping that all the students would have completed their training courses by the end of July; however, uncharacteristic weather conditions and the fires in the Daytona Beach area have caused delays in training of one-and-a-half to two months. We still anticipate that the majority of the students will be completed by the end of August. One student, Algeria Morse, has successfully completed the Unified Curriculum, and we anticipate more shortly. As in all training, there are those that are more motivated and have better learning skills than

others. As a result, the students will not be completing the program all at the same time," said Dr. Hampton.

"Students seem to excel faster through the advanced instrument phases of training (like approaches and holding) rather than the private phases. The private training causes the most difficulty, because it is where the students learn to actually fly the aircraft (takeoff, climb, straight and level; do turns, descents, landings, etc.). Once this initial training is accomplished, the flight course flows a lot smoother," said Jesse Rhodes (ERAU), AGATE Flight Training Curricula Program Flight Instructor.

Algeria Morse's completion of the Unified Curriculum represents the first step toward achieving a dream. She plans to major in Aerospace or Aeronautical Engineering at the United States Naval Academy and would like to become a Naval Aviator. "My ultimate goal is to become an astronaut for NASA," she said.

The national average for receiving a basic private pilot license is approximately 72 hours of in-flight training over nine months. This is followed by instrument training of 104 hours over an additional nine months. Morse completed the equivalent training with a 29 percent savings in ground and flight training, a 20 percent savings in cost ($4,000) and an 83 percent savings in total elapsed time. "Flying is the thrill of my life. The AGATE training was intense indeed, yet I strongly believe that my love for aviation is what guided me to success. I must also give credit to my flight instructor, Jesse Rhodes, who is a very motivated individual. His love for aviation played a tremendous part in my success. While the training was intense, I was still able to maintain a full-time status and a 4.0 GPA at ERAU. I say this because I would like to encourage those who want to participate in the AGATE Flight Training Curricula Program but may think that they will not have enough time to dedicate to the program. I feel anyone can accomplish this task if they truly have a love for aviation," said Morse.

Morse anticipates that her flight training experience in the AGATE Flight Training Curricula Program will help greatly in her future piloting endeavors. "Because of the intensity of my initial flight training, I feel that I am prepared to take on the challenge of future pilot certifications. Although my training took only 3.5 months, I believe that the incorporation of Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) reinforced many important concepts that may not have been reinforced in the normal pilot training. Unlike the traditional training, in the dual program, learning both VFR and IFR is a part of daily routine. As a result of this format, I studied concepts in the private pilot manual and then had them repeated in the same session when studying the instrument manual. In my opinion, this was positive reinforcement. Learning IFR at an early stage helps to build confidence that the average new student pilot does not have because of fear or ignorance of what the instruments really are. Confidence is always important when controlling an aircraft," she said.

The FAA is also playing a key role in the Flight Training Curricula Program. "The FAA's role is to advise the Flight Training Curriculum Work Group on regulatory requirements and FAA policy, assist in the facilitation of the Flight Training Curricula, be the FAA representative on the team, and coordinate with AGATE management," said Tom Glista (FAA), Acting Flight Training Curriculum Work Package Leader. The FAA is facilitating progress within the curricula program by "ensuring that the level of safety is not reduced; advising the work group members of FAA policy and procedures; and working with FAA management to change policies, procedures, and rules, as necessary, to attempt to implement AGATE," he said.

The Flight Training Curricula Program holds numerous benefits for those who want to learn how to fly in an advanced GA aircraft. "Reduced cost and an easier, more interactive learning experience, especially during ground school, are among the main benefits," said Dr. Hampton. "The goal is to have a fully interactive experience for those students seeking Private/ Instrument certification."

In the near future, Flight Training Curricula Program planners plan to integrate AGATE specific systems into the curricula. These systems include single lever power control, AGATE flight displays, and ice protection devices. The introduction of these new technologies is expected to have a dramatic effect on the ability of students to fly an advanced GA aircraft. "The number one issue constantly related to training and safety is situational awareness. Use of moving map displays and presentation of weather information will contribute greatly to the safety of flight and the ability of pilots to maintain situational awareness. Decision-making aids will also greatly enhance the pilot's ability to make correct decisions in critical situations," said Dr. Hampton.

"This past year, we have been looking at new training technology, especially PC air crew training devices and have conducted research on training for single lever power control and for the AGATE integrated cockpit information system. This coming year, we will integrate what we have learned about training for the AGATE cockpit technologies into the combined curriculum and begin evaluation of it using the AGATE Simulation Training Testbed at Embry-Riddle. It is our hope that this will lead to some real advances in understanding how to best train pilots to fly AGATE airplanes in a Free Flight environment," said Dr. Zellweger. □

Schedule of Events

October 21–22, 1998:
Palm Springs, CA
Flight Systems Technical Council Meeting

October 23–25, 1998:
Palm Springs, CA
AOPA EXPO '98

February 2–3, 1999:
Washington D.C.
National Research Council –Transportation Research Board SATS Workshop

TBD, 1999:
Atlantic City, NJ
FAA Tech Center
Conference of Technical Councils

Virginia Tech Team Wins 1997-98 General Aviation Design Competition

Futuristic design concepts and tools captured the imaginations of those judging the fourth annual National General Aviation Design Competition. Winners of the competition were announced by NASA and the FAA at AirVenture '98.

The 1997-1998 first place award was presented to a 27-member undergraduate team from **Virginia Tech**. Their winning design, dubbed "VicTor," is a single-engine, four seat, high performance aircraft. The team's broad goal was "a fun-to-fly, safe, affordable aircraft prepared to fly on the 'highway in the sky' of the twenty-first century." The sleek airframe design features an ergonomic cockpit with adjustable side control sticks and dual airbags, a choice between two high performance engines, and advanced technology instrument displays. The design looks to the next century by providing an upgrade option to allow autonomous flight if it becomes a reality. The VicTor incorporates state-of-the-art manufacturing techniques and advanced composite materials. The first place award provides a total of $3,000 to design team members and a $5,000 award to the university's Department of Mechanical, Nuclear, and Aerospace Engineering.

The team also won a separate $3,000 award for the best use of technology developed by the Air Force Research Laboratory. The team incorporated Air Force data on pilot anatomy to create an innovative fully ergonomic cockpit. The students also used the United States Air Force Data Compendium handbook in their research. Aircraft navigation for the VicTor design is largely dependent on the Global Positioning System, jointly developed by Air Force and other Defense Department organizations for military and civilian users.

Second place honors went to **Pennsylvania State University** for "Skipper 2," a high performance, two person single-engine, composite fuselage, tractor-prop light airplane. The low wing design features a high power engine and retractable landing gear. Other hallmarks are a user-friendly, multifunctional display cockpit, good stall characteristics, and structural simplification for ease of manufacturing. To enhance all-weather capability, the design also features a weeping wing de-icing system. Crashworthiness was also a major consideration. The team offered design variations for four-place, trainer, and acrobatic versions of their aircraft. The design was developed by a 15-student team as part of a senior level design course. The second place award provides a prize of $2,000 to the student team.

Third place was awarded to a team of 13 undergraduate students from the **University of Virginia**. For third place, the student team will share a $1,000 prize. The team was honored for developing a computer program that predicts drag, or resistance to air flow, in the design of new small passenger airplanes. One of the things that slows the development of new aircraft is the need for extensive flight testing of a prototype to determine the drag factors. The UVA team recognized that a computer program that could do much of the drag prediction in the design phase would save time and money in the development of new and modified airplanes, speeding effective new designs to the marketplace.

The competition is managed for NASA and the FAA by the Virginia Space Grant Consortium. Guidelines are now available for the fifth annual competition to be held during the 1998-99 academic year. New criteria encourage both individual and team submissions, and designs ranging from components and subsystems to complete aircraft designs. Guidelines can be requested at 757/865-0726 or mls@penngrad.pgtt.odu.edu. □

photo courtesy of Donna Bushman

Virginia Tech won first place in the 1997-1998 National General Aviation Design Competition. Pictured are: *(Front Row, L-R) Students-Phillip Vallance, John Fussell, Joseph Honaker, Chuck Boyer; (Middle Row, L-R) Students- Kristin Burke, Derrick Radtke, John Helmantoler, Adam Olsen; (Back Row, L-R) Students- Jana Schwartz, Kristin Makovec, Steve Penn; Michael Mann-NASA Deputy Associate Administrator for Aeronautics and Space Transportation Technology; Bruce Holmes-NASA Langley General Aviation Program Office Director; Ann Harlan-FAA William J. Hughes Technical Center Director; Jim Marchman-Project Faculty Advisor and Design Professor; Dennis Carter-Competition Judge, Air Force Research Laboratory, Wright Patterson AFB.*

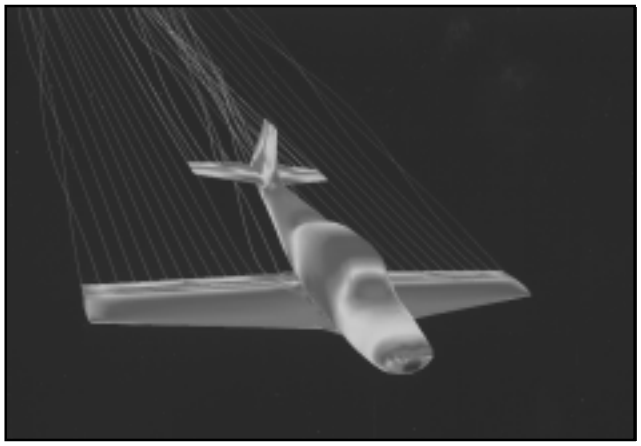


photo courtesy of University of Virginia

The University of Virginia took third place in the 1997-1998 National General Aviation Design Competition for developing a computer program that predicts drag. This computer image depicts differences in air pressure acting on a general aviation airplane.

Management and Technical Progress Highlights

Integrated Design and Manufacturing

The Integrated Design and Manufacturing (ID&M) Work Package reported that FAA conformance qualification is proceeding with Cessna material (Fiberite 7740) with three Carbon fiber forms—unidirectional tape, plain weave, and eight harness satin weave. These materials are autoclave processed at 40 psi and 250 deg. cure. Materials equivalence testing began in late August.

Simula reported that a review of the Design Guide section drafts is continuing. The review of the restraint system section was completed in June and the revision of that section is underway. Review of the seat section was completed in July followed by a review of the remaining sections (anthropometry, airframe structural crash resistance, and interior delethalization). The human tolerance section is presently undergoing review and revision. The main focus of the review and revision process is to reorganize the drafts (which are based on the U.S. Army Aircraft Crash Survival Design Guide) so the information is easier to find and to include more recent crashworthiness research from AGATE and other sources. The "Reference System A" draft of the Design Guide will be complete by the end of the summer.

The Work Package reported that six more indoor drop tower tests (12 cushion tests) were performed at the Simula Technologies Dynamic Test Facility. These tests were conducted on twin rigid seat fixtures (with two dummies) to the FAR 23.562(b)(1) vertical test condition (19 G, 50 ms rise, 31 feet/sec delta V, 30-degree nose down). Terence Lim at Cessna is analyzing the test data. More cushion drop tests have been planned for late summer.

Ice Protection Systems

The University of Illinois completed their wind tunnel testing in June. A final report was completed in August.

Integration Platforms

The Integration Platforms Work Package reported that control system modifications to the F-33C Bonanza (AGATE-1B) aircraft have been completed at Raytheon. The computers have also been upgraded to support the "Highway in the Sky" software.

The Work Package also reported that AGATE is working with the Aviation Weather Information (AWIN) program to identify both ground sites and candidate airplanes that are suitable to expedite flight testing of an affordable Flight Information Services (FIS) system, which would be of benefit to both programs. This comes as a result of AWIN finalizing a Cooperative Research Agreement (CRA) with the NavRadio Corporation regarding the development and implementation of a general aviation oriented VDL-based FIS broadcast, reception, and display system.

Flight Training Curriculum

A Web Site has been completed for the Flight Training Curriculum Work Package. The site can be found as a link off the AGATE home page. As part of the Web Site, a questionnaire is being developed to generate public opinion on Flight Training activities.

Validation of the first Basic Curriculum is in progress, the ground school has been completed, and the students are flying. Students are now completing flight training.

Validation of the Unified Curriculum is in progress. One student has already been completed and others are close.

Program Analysis

The Program Analysis Work Package reported that 4,927 users have been on the program analysis Internet site. These visitors have spent an average of 5:39 minutes exploring the site and have accessed 27,517 page views for an average of approximately 6 page views per visitor.

The visitors have completed 413 surveys and 100 of the survey respondents have requested more information on either learning how to fly or on purchasing an airplane.

The Work Package reported that the number of identifiable International Users who visit the site remained relatively constant at 14 percent of the total traffic. The number of United States visitors is 49 percent with 37 percent of the visitors not identified.

AGATE ALLIANCE MEMBERSHIP

Work Packages: Flight Systems (FS)
Propulsion Sensors & Controls (PS&C)
Integrated Design & Manuufacturing (ID&M)
Ice Protection Systems (IPS)
AGATE Integration Platforms (AIP)
Flight Training Curricula (FTC)
Systems Assurance (SA)
Program Management (PM)

Work Package Membership: P = Principal; A = Associate

Official Organization Name	FS WP-1	PS&C WP-2	ID&M WP-3	IPS WP-4	AIP WP-5	FTC WP-6	SA WP-11	PM WP-12
Advanced Creations Incorporated						P		P
Airborne Research Associates	A							
Allied Signal Aerospace Company	P		P					
ARINC Incorporated	P							
ARNAV Systems Incorporated	P							
Aurora Flight Sciences		P						
AvroTec Incorporated	P						P	P
BFGoodrich Aerospace				P				
Cessna Aircraft Company	P	P	P	P	P	P		P
Cirrus Design Corporation	P	P	P	P			P	
Cox and Company Incorporated				P				
Digital Equipment Corp.	P							
Embry-Riddle Aeronautical Univ.			P			P	P	
Florida Institute of Technology						P		
Global Aircraft Corp.			P			P	P	
Harris Corporation	P							
Hartzell Propeller Company			P					
Honeywell Technology Center		P						
Innovative Dynamics Incorporated				P				
Jeppesen Sanderson Incorporated	P					P		
Kestrel Aircraft Company			P					
Lancair International Incorporated			P					
McCauley Propeller Systems			P					
Mod Works Incorporated			P					
NavRadio Corporation	P							
Ohio State University				P		P		
Raytheon Aircraft Company	P	P	P	P	P	P	P	P
Raytheon E-Systems	P	P					P	
Rockwell Collins Incorporated	P						P	
Ross Engineering	P	P						
Seagull Technology Incorporated	P							
Simula Technologies Incorporated			P					
Stoddard-Hamilton Aircraft Incorporated			P					
Teledyne Continental Motors		P						P
Textron Lycoming		P						
Trimble Navigation Limited	P							
Unison Industries		P						
United Technologies Hamilton Standard			P	P			P	
Wichita State University-NIAR			A	A			A	A

SUPPORTING MEMBERS

Aerocar Llc.
AGATE Alliance Association Incorporated (AAAI)
Aircell Incorporated
Air Force Research Lab
AOPA-Air Safety Foundation
Avidyne Incorporated
Bihrle Applied Research Incorporated
Executive Jet Incorporated
Experimental Aircraft Association (EAA)
General Aviation Manufacturers Association (GAMA)
Georgia Tech Research Institute
Kansas State University
Micro Craft Incorporated
Mississippi State University-Raspet Research Lab
Mitre Corporation
National Air Transportation Association (NATA)
National Business Aircraft Association (NBAA)
National Center for Atmospheric Research
New Piper Aircraft Incorporated
Optimal Solutions Incorporated
Research Triangle Institute
Seemann Composites Incorporated
Small Aircraft Manufacturing Association (SAMA)
II Morrow Incorporated
University of Illinois at Urbana-Champaign
University of Kansas
University of Tennessee Space Institute
Williams International
Wyndemere Incorporated

GOVERNMENT PARTNERS

Federal Aviation Administration
NASA Langley Research Center
NASA Lewis Research Center
USAF Research Laboratories (Wright Directorate)

AWIN

(continued from page 3)

infrastructure, weather data acquisition and delivery, low-latency information delivery via datalink, and display of the weather in the cockpit. NavRadio will produce a system of "Open Architecture" technology that conforms to the new VDL Mode 2 international datalink standard. "That means that the datalink technology that we are using is the same technology that has been selected for DGPS approach correction data, ARINC's next-generation airline datalink, and future FAA digital air traffic communications, and is already being implemented internationally for ground-to-air datalink," said Brian Haynes, Vice President of NavRadio. "NavRadio made the first public demonstration of VDL Mode 2 technology for small aircraft two years ago in conjunction with AGATE; today the AGATE-1B aircraft includes NavRadio's VDL-based weather datalink as a baseline capability. Now, through AWIN, those ground-breaking developments will be taken to the implementation phase over a regional area and multiple aircraft."

On the cockpit side, NavRadio's team will focus on "Open Architecture" once more. The datalink radio receiver will be compatible with multiple displays from lap-top/palm-top computers, through portable flight computers like the AvroTec Flight Monitor, to panel-mounted Multi-function Displays (MFDs) like the model 5RR from team member Avidyne Corporation. "Our goal is to be conservative of valuable panel space, by providing a blind-mounted radio and the option to choose from a variety of display types," said Don Moore, President of NavRadio, who uses the datalink for test purposes in his Beech Baron with a palm-top display. "The palm-top display works well as a starting point. I see the lap-top option as a way for aircraft owners to try their hand at datalink with the least amount of investment, and move up to permanent avionics over time." With NavRadio's program, the choice of display is up to each individual aircraft owner.

To realize the ultimate goal of AWIN, significantly reducing aviation weather related fatalities, NavRadio will provide high quality, real-time, easy to read data, both in graphical and textual formats, to pilots operating aircraft that traditionally have not been equipped with any weather avoidance information systems besides voice communications with FSS. Also, these aircraft most frequently operate at low altitudes where significant weather phenomena are present.

NavRadio's second AWIN project features a team that will deploy, operate, and evaluate automatic electronic pilot reporting (EPIREP) for GA aircraft. The total package includes onboard sensor technologies, air-to-ground datalink, and ground infrastructure capable of routing the data to NCAR for new weather modeling and product generation. Also, the information can be re-distributed via datalink after it has been collected, sorted, and used to produce new weather products. This program is focused on GA including regional airlines, as they generally fly "down in the weather" as well.

As with the data broadcast system project, the EPIREP project facilitates the goals of both AWIN and AGATE. In recognition of that common interest, the AWIN Program Office and the AGATE Alliance have agreed to pursue the EPIREP project jointly, giving both groups access to the results achieved.

In conjunction with AGATE, NavRadio and several other AWIN team members have flight tested many key technologies to be used in the AWIN projects, particularly in the AGATE-1A and AGATE-1B aircraft. The EPIREP technology is a new development that will be tested in part in conjunction with the AGATE-1B program.

Beginning in the fiscal year 2000, the AWIN activity will still be known as AWIN, but it will be transitioned over to NASA's Aviation Safety Program (AvSP). NASA plans on spending $60 million (gross) over a period of seven years on AWIN.

In the future, AWIN participants will be developing and fielding prototype AWIN technology systems. "This will help to better develop the technologies and also provide some seed money for the start-up of such systems," said Stough. "We intend to be working with AGATE and the Aviation Systems Capacity program as much as we can to make sure that we are not duplicating efforts and that we are working toward common goals. We will also be working with the FAA and NCAR," he said. More information on the AWIN program can be found at the following AWIN website: http://zethus.larc.nasa.gov/~jayr/webpages/awin/index.htm. □

Plans Set for Datalink Infrastructure Facility

Activities in AGATE have progressed to a stage where a ground infrastructure is needed to conduct comprehensive in-flight evaluations of developing products and related avionics, and to acquire baseline and long-term data necessary for defining guidelines, standards, and certification methods (GS&Cs) for such new products. It is anticipated that other government and standards setting organizations will have similar requirements for testing datalink products and services, and developing procedures and certification policies associated with incorporating advanced concepts into the airspace system. Accordingly, AGATE has initiated an effort to deploy—over a limited area—the needed ground infrastructure in which to evaluate these systems, which had been referred to as the National Airspace System Datalink Infrastructure Facility (NASDIF), but is now simply identified as the Datalink Infrastructure Facility (DIF).

To date, no facility exists capable of providing the necessary infrastructure to support data acquisition for certification in prototype and human factors studies to bring new products to market. By setting the cornerstone for a DIF—with a first ground station at the NASA Langley Research Center—AGATE has taken the lead to establish the needed environment, and will work in concert with the FAA and other organizations in further developmental activities.

Services supported by AGATE at the NASA Langley ground station will include: Flight Information Services—Broadcast via VDL Mode 2 Broadcast Datalink, CPDLC and digital voice via VDL Mode 2 and Mode 3 two-way datalink, ADS-B via 1090 Mhz squitter, and "low cost" Differential GPS using VDL Mode 3 datalink.

An evaluation facility in the East Coast region was selected by AGATE in order to incorporate two major NASA facilities, planned FAA projects, via the FAA Technical Center, and state interest as expressed by the Commonwealth of Virginia. Future expansion is planned to provide continuous signal coverage between Langley and the NASA Wallops Flight Test Facility with eventual additional ground stations at the FAA Technical Center, and other sites, as locations and funding sources are identified.

The AGATE Flier

Volume IV, Issue 2 September 1998

The AGATE Flier is published by the AGATE Alliance Association, Inc., a private, non-profit, membership organization founded to stimulate the development and dissemination of general aviation technology. ***The AGATE Flier*** reports on progress in a family of technology initiative and public/private aviation related activities to revitalize the U.S. GA industry, called AGATE—Advanced General Aviation Transport Experiments. The NASA Langley Research Center is the lead center for this program.

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Address correction requested

March 1998

The AGATE Flier

Information on developing technologies for business and personal transportation aircraft

Volume IV, Issue 1

AGATE Moves Into Flight Experiment Phase

The AGATE program has entered its flight testing phase with two series of flight experiments. These will validate advanced navigation and communication technologies developed to revolutionize how general aviation (GA) pilots interact with real-time weather and flight data information. The experiments are intended to flight validate the technologies that will ultimately be used on AGATE aircraft and are being conducted by the AGATE Flight Systems Work Package with support being provided by the AGATE Integration Platforms Work Package. The experiments use testbed aircraft that are capable of being modified for use by other Work Packages within AGATE. Results from the flight experiments are expected to have a major impact on the standards that will be set for operating GA aircraft in the future.

The first series of these flight tests, which began in December 1997, initiated the AGATE Systems Standards Team (SST)-1A experiments in an attempt to learn more about the display and use of real-time weather in the cockpit. Operating out of the Cessna Aircraft Plant in Wichita, Kansas, the 1A Team, which is led by Jon Carr of Cessna, consists of Cessna Aircraft, ARNAV, NavRadio, Trimble Navigation, ARINC, and DEC (Digital Equipment Corporation). The 1A Team is using a Cessna T210 as the experiment testbed. The aircraft is equipped with weather displays and a GPS-based navigational system. It is also equipped with an ARNAV 5200 multi-functional display (MFD) type-certified box that has an added weather display. The ARNAV system incorporates navigation and weather displays into one box, thus reducing the pilot's need to look at two separate displays. The goal of the installation was to end up with a certifiable configuration that could represent the AGATE A aircraft. That goal was met with the T210 and the ARNAV equipment. "This equipment allows the pilot to gather current data and form an accurate mental picture of weather conditions in relation to the aircraft's position. An accurate understanding of the weather will yield correct flight planning decisions. Also it will keep the pilot from worrying about the unknown and concentrating efforts on flying the aircraft," said Jon Carr.

Mary Nolan
Chairperson, AGATE Executive Council

"The SST flight experiments are vital to the success of AGATE's cooperative research. By making these experimental flights, we have the chance to test the technology—and just as important, we have the chance to learn how the pilot and aircraft work together as a system."

The SST-1A flight experiments consist of two flight scenarios: "canned" weather and real weather. The canned weather scenario is a controlled test where an actual weather

(Continued on page 7)

photo courtesy of Cessna

Flight tests of a Cessna T210 are leading the way for experiments on real-time weather displays for the SST-1A Team activities.

photo courtesy of Raytheon Aircraft

A Raytheon Bonanza is being used for assessments of advanced data link communications in SST-1B Team studies.

From the desk of the Program Manager

Dr. Bruce J. Holmes, NASA Langley Research Center

AGATE in Flight

In the realm of aeronautics research, flight experiments translate ideas into hardware, vision into reality, and uncertainty into confidence. We might say that flight is where the rubber meets the road on the highways in the sky. This issue of the *AGATE Flier* highlights the Alliance progress in flight experiments.

Several of NASA's investments in general aviation revitalization have taken to the air. The NASA Lewis-led General Aviation Propulsion (GAP) Program received a boost when the VJET II flew at Oshkosh '97. It inspired the public about revitalization and will serve as the flight platform for the upcoming FJX-2 turbine engine testing. Projects supported by the NASA Small Business Innovation Research (SBIR) Program's general aviation topics are flying as well. These SBIR flight activities include advanced cockpit configurations, new GPS-based solid-state Attitude-Heading Reference Systems (AHRS), and an innovative propeller. During 1996, the FAA invited AGATE to participate in Operation Heli-Star for the Atlanta Olympics. AGATE partners led by ARNAV flew equipment to demonstrate the key functions for free flight. The AGATE concepts for advanced flight training curricula are reaching the flight line at Embry Riddle Aeronautical University. AGATE member companies are flying production prototypes of the next generation of general aviation lightplanes, and into the next generation of business jets as well.

The remarkable accomplishments of the AGATE technical teams take many forms, not all on flight experiments. We are publishing documents on ground-breaking design guidelines, industry-changing system standards, and revolutionary certification reforms. During the past year a Terry Engineering-led SBIR team conducted the first successful (i.e., survivable) full-scale crash test of a general aviation airplane. The materials task of the AGATE ID&M Work Package has produced a revolutionary means for composite materials qualification and a related materials database, literally saving the industry millions of dollars and years of development time for new aircraft. This team included WSU, the FAA's Small Airplane Directorate and its Technical Center. For the public, however, our progress is most apparent in our flight experiments.

At this point in our program it is valuable to ponder, "*What do these experiments mean?" and "How does our progress in flight fit into the larger picture?"*

What do these experiments mean? Four years ago, at the beginning of AGATE, the end of the eight-year program was difficult to see. Today, the reality of the end of the program in 2001 has come into clear focus. Our flight experiments have turned ideas into hardware, and testing increased our confidence and clarified the reality of our products at the end of the program. By the end of AGATE in 2001, we will have completed an essential and unique set of flight experiments. The results of our testing pave the way for industry to design, standardize, manufacture, and achieve FAA certification of new aircraft and pilots. AGATE took a systems approach to revitalization and every key feature of the system we call general aviation is being tested. These key features include: advancements in airframes, avionics, propulsion systems, flight training, and airspace operating procedures. Our experiments represent progress toward final AGATE documents. Those documents support new capabilities for producing an order of magnitude or more improvement in reliability, ease-of-use, safety, and utility of future general aviation lightplanes.

How does our progress in flight fit into the larger picture? The NASA Aeronautics Enterprise strategy is guided by the Administrator's Three Pillars for Success (see http://www.hq.nasa.gov). These Pillars frame our national technology goals which are designed to stretch the boundaries of our capabilities. Pillar I supports advancements in "Global Civil Aviation," including safety, affordability, and efficiency of airline travel. Pillar II supports "Revolutionary Technology Leaps," including revitalization of U.S. general aviation and the High Speed Civil Transport. Pillar III targets more affordable "Access to Space." Each goal is framed in terms of final outcome and defines the anticipated benefits of the NASA investments once they are incorporated by industry. For general aviation, the goal metrics are "to invigorate general aviation by achieving 10,000 aircraft deliveries annually in 10 years (2007) and 20,000 in 20 years (2017)." The Three Pillars frame the NASA investments in AGATE, the General Aviation Propulsion (GAP) Program, the Small Business Innovation Research (SBIR) general aviation subtopics, and related advancements from other safety and airspace capacity investments. These current government-industry-university investments total about one quarter of a billion dollars. The results directly support achievement of the first half of the Pillar II goal of 10,000 deliveries per year by 2007.

We are presently focused on the completion of AGATE during the next three years. The AGATE and GAP technologies are defining new paradigms for the state of the art of avionics, airframes, engines, and pilot training technologies. We are beginning the process of planning our investment strategies

(Continued on page 4)

Single Lever Power Control Successes

SLPC Passes Flight Tests

The year 1997 marked the successful flight tests of one of general aviation's (GA) most welcomed advancements—single lever power control (SLPC) for aircraft. The revolutionary technology was put to the test in two forms, a highly efficient, low-emission electronic version and a lower cost, easy-to-repair mechanical version. The flight tests demonstrated that SLPC is a viable control option to the GA pilot and significantly reduces the piloting workload. Three projects are currently being validated in flight.

An electronic SLPC was developed by Aurora Flight Sciences, of Manassas, Virginia, jointly under a NASA Small Business Innovation Research (SBIR) Program award and as an AGATE task. The all-digital SLPC system was installed in Aurora's Cessna O-2 Chiron research aircraft and test flown in July and August 1997. The system makes use of a computer known as full-authority digital engine control (FADEC) which controls the throttle, fuel-air mixture, and the propeller pitch angle with electromechanical actuators. These variables are controlled by three separate levers moved by the pilot in conventional GA aircraft. In addition to reducing the pilot's workload, the electronic SLPC should provide improved fuel consumption through FADEC's control of the fuel burn rate. The high-bandwidth air-fuel mixture feedback control ensures optimum engine health and performance, having potential for increasing engine life-time and TBO (Time Between Overhaul), thus lowering operating costs further while adding safety. Following concept-proving flights in July, the Aurora Chiron research aircraft was displayed at the EAA (Experimental Aircraft Association) Oshkosh Fly-In in August 1997.

A mechanical SLPC was developed by Cessna Aircraft and flown aboard an R182 airplane as an AGATE task. The flight tests for this aircraft commenced in September 1997 and will be completed in March 1998. Rather than strictly using digital computers, the Cessna aircraft made use of mechanical mixing of the controls. "Several tests were performed with the R182 to determine ease of engine start, power response, engine performance, and backup system capability," said Damian Ludwiczak, AGATE Propulsion Sensors and Controls Work Package Leader.

"Cessna is still completing its test report. However, it could be stated that both systems did successfully perform the function of providing the pilot with an SLPC in the cockpit. There were no outstanding issues or concerns from the tests," said Ludwiczak.

With the successful completion of the SLPC flight tests, plans are being made to incorporate the concept in the GA aircraft fleet. Plans have been made to install an electronic SLPC on the Cirrus SR20 once the system is certified by Teledyne Continental. Currently Cirrus Design has installed a simplified power control in its SR20 prototype (see photo on page 4). "The SR20's single lever power control combines the throttle and propeller control into one convenient lever that yields maximum performance from the aircraft. By adjusting the propeller speed automatically, the single lever control reduces pilot workload and increases ease of operation," said Dean Vogel, Vice President of Research and Technology at the Cirrus Design Corporation.

All of the members of the AGATE Propulsion Sensors and Controls Work Package¾ Textron Lycoming, Teledyne Continental, Cessna Aircraft, Cirrus Design, United Technologies

photo courtesy of Aurora Flight Sciences

Aurora Flight Sciences Cessna O-2 Chiron research aircraft equipped with electronic SLPC

photo courtesy of Cessna

Cessna R182 research aircraft equipped with mechanical SLPC

Hamilton Standard, Unison Industries, Honeywell Technology Center, Raytheon Electronics, Aurora Flight Sciences, and Ohio State University¾ plan on investing in the technology. "The ability to operate an aircraft engine with digital fuel and ignition control has proven successful. In addition, the ability to perform the same function with mechanical linkages has also proven to be successful. The future goals will be to develop standardization of all the SLPC 'parts' such that the SLPC system will be affordable. The AGATE SLPC FADEC system should be able to fit on any engine and use any sensor or control servo that meets their AGATE developed standards," said Ludwiczak. □

photo courtesy of Cirrus Design

The Cirrus SR20 in flight

photo courtesy of Cirrus Design

The Cirrus SR20 features a simplified power control that couples the throttle and propeller controls mechanically. When an electronic SLPC is certified by Teledyne Continental, it will be installed on the SR20.

AGATE in Flight

(Continued from page 2)

to achieve the second half of the Pillar II goal toward 20,000 deliveries per year by 2017. We can best characterize the next steps as supporting sustained growth toward the 20-year goal and beyond.

Those of us who work daily in the AGATE Alliance understand how challenging and rewarding this work has been. We also understand that our successes have not come easily and that collaboration among competitors is a learned skill. However, as a government-industry-university partnership, we have also learned how to operate the key processes in an alliance. Some of these processes include alliance self-governance, facilitative leadership, systems engineering, standard-setting, consensus building, collaborative decision-making, aviation safety assurance, market assessment, and management of proprietary issues. All of these collaborative processes will be vital to the sustained growth of the personal aircraft industry in America. As the planning unfolds for the investments toward the second half of our Pillar II goal, we will leverage our lessons learned from AGATE and GAP. We will continue to invest in partnerships that continue toward the creation of a small aircraft transportation system in America.

Envisioning the future is perhaps the biggest challenge during an era of such fast-paced technological advancements such as we have today. Tomorrow, we will take for granted today's miracles. However, as we guide our efforts with an ambitious vision, and a willingness to take risks, our challenge is less one of envisioning and more of creating the future.

The AGATE membership has remained steady and the budget continues to be stable. The 1998 partner commitments to date include 36 Principal, 4 Associate, 24 Supporting, and 3 Government Members. These are the partners and programs committed to bringing revitalization to U.S. general aviation. □

Schedule of Events 1998

April 1-3:
Kansas City, MO
NATA

April 19-25:
Lakeland, FL
EAA "Sun and Fun" Fly-In

April 25-29:
Kissimee, FL
Technical and Executive Council Meetings and All Member Plenary

June 23-25:
Wright Patterson AFB, OH
Executive Council Meeting

July 29-August 4:
Oshkosh, WI
EAA AirVenture '98

July 31-August 6:
Oshkosh, WI
- *Oshkosh Technical Council Meetings*
- *NASA-FAA General Aviation Technology Press Event*
- *National General Aviation Design Competition Awards*

AIR AGATE Continues

AIR AGATE Tackles Tough Certification Issues

Last year, the FAA's AIR AGATE Team put together a Certification Workshop to highlight the FAA's certification requirements for small airplanes. From that workshop, the FAA, NASA, and Industry identified certain certification compliance requirements that needed revision to meet the NASA/AGATE goals. In July 1997, a team of specialists met at the FAA's Small Airplane Directorate with members of the AIR AGATE Team to study small airplane system design requirements. Several studies were used to define the existing state of the small airplane reliability, two from NASA-sponsored contracts and two from internal FAA studies. This effort created a foundation to define different levels of reliability and classification of failure conditions for different classes of airplanes within 14 CFR part 23. This is a major shift in policy for the FAA and helps provide the means to affordably certificate advanced technology avionics systems.

"The excellent collaborative process created as part of the NASA/AGATE, FAA, and Industry partnership has resulted in a streamlined certification process that everyone who has reviewed the draft documents agrees, 'is the means to reduce or eliminate the current economic barrier to certificate affordable advanced technology avionics systems'," said Tim Smyth, AIR AGATE Team Leader (FAA ACE-111). "This accomplishment may be the single biggest contributor to improving the safety of small airplanes," he said.

Internal FAA studies have documented the high reliability of IFR avionics systems and that pilot error accidents prevent this reliability from being fully realized. "We now have the opportunity to significantly improve the situational awareness for the pilot with the development of advanced technology avionics. Integrated primary flight displays, GPS moving maps, computer processor systems to control engine function, airplane attitude, and other airplane functions will provide real-time capability to the pilot that he or she has never had. 'Highway in the Sky' with graphical flight path guidance will become a reality and make flying a small airplane easier and safer than ever before," said Smyth. "In the 1970s, the airline industry started using new technologies in great numbers (e.g., turbojet and turbofan engines, advanced systems, simulators, and other products) and the FAA saw a dramatic drop in accident rates. The NASA/AGATE, FAA, and Industry collaborative effort has the potential to accomplish similar results once the products are implemented," he said.

As a member of the AGATE Propulsion Sensors and Controls Work Package, the FAA has provided guidance regarding current FAA regulations and policy that are applicable to reciprocating engine electronic controls. Because industry and FAA experience and knowledge relative to these systems is currently evolving in parallel with the NASA/AGATE research initiatives, the FAA has been evaluating the current regulations to determine if they adequately accommodate these new, advanced technology engine control systems. As stated by Mark Rumizen, FAA ANE-110, "The FAA provided an overview of the current regulations and policy to the Propulsion Sensors and Controls Work Package Team at the February 18 team meeting. Also, at that meeting, the FAA commented on the applicability of certification data and guidelines produced by the AGATE consortium for other similar projects."

(continued on page 13)

AGATE Sets Agenda at Annual Planning Workshop

Program Specifics Discussed

AGATE held its Annual Planning and Scheduling Work shop on November 17-20, 1997, in Williamsburg, Virginia. Forty-eight attendees represented the General Aviation Program Office (GAPO), the AGATE Management Team (AMT), the System Assurance Technical Council (SAWP), and Industry Technical Leads. The purpose of the workshop was to coalesce, integrate, and strengthen the AGATE Alliance Team and to review the Master Schedule, Integrated Products List, and Requirements Documentation.

The planning workshop began Monday evening with Mr. Greg Richardson, AIM Associates, Inc., as Keynote Speaker. Two Training sessions entitled Leadership & Collaboration, and Facilitation & Process were provided by AIM Associates, Inc. and George Denninghoff of HR Synergy Inc. Each work package presented a technical progress review which included the AGATE Master Schedule Milestones and the Integrated Products List (IPL) status. Configuration Change Requests were proposed and voted on by the Configuration Change Board (which is made up by the SAWP). After a group discussion of the IPL, breakout sessions were facilitated for specific work package interfaces. Both technical data exchange and revisions to the current IPL list were discussed.

The products resulting from the workshop included: (1) Revised GS&C List, (2) Revised Features and Capabilities List, (3) Annual update to the AGATE Master Schedule, (4) Revised Integrated Products List, (5) Revised AGATE Traceability Matrix, and (6) Collaborative Leadership Training, with AGATE specific process feedback on consensus building.

"With the accomplishment of these products, the AGATE Alliance Team can now transition from component to system integration efforts, and from technology options to product driven planning. A bottom-up/top-down management information system was created," said Linda Campbell, AGATE Schedule Analyst. □

General Aviation Safety Research Opportunities

Continued concern over air safety is causing leaders in America's civilian aviation communities to change the way they invest in and view safety-related issues. This concern extends to President Clinton who, in response to recommendations from the Commission on Aviation Safety and Security, challenged the nation to "reduce the fatal accident rate by 80 percent within 10 years." As a result, the National Aeronautics and Space Administration (NASA) has repositioned $500 million of its aeronautics funding to focus on civil air safety matters over the next five years. A major part of this NASA initiative is a new focused effort called the Aviation Safety Program (AvSP). The AvSP will be extensive in scope, including commercial transports, rotorcraft, and general aviation.

AvSP was born from a series of public workshops held in early 1997 that focused on how NASA funding, under the recommendations of 99 government, industry, and academic organizations would address the most significant safety-related technology areas. The workshops, led by the multi-center NASA Aviation Safety Investment Strategy Team (ASIST), were devoted to finding system-wide air safety improvements.

ASIST investment recommendations were grouped into three areas: Accident Prevention, Accident Mitigation, and Aviation System-wide Monitoring and Modeling. Approximately 75% of the funding will be invested in Accident Prevention. Examples of potential early start investments include: dissemination of current weather products, implementation of early AGATE results, systems for aircraft health and usage monitoring, human error metrics-designs and procedures, improved training for weather/FMS/maintenance, aging aircraft and systems, and integrated crashworthiness for GA aircraft. Some "bold visions" investments include "virtual VMC" displays for night/IMC conditions, world-wide strategic separation from hazardous weather, traffic and terrain, error-proof flight decks, measurable training and operator proficiency, and crash-survivable aircraft designs.

The ASIST workshops also addressed several leading causes of general aviation accidents and possible technology solutions. For example, weather-related precursors such as low ceiling, reduced visibility, and turbulence pose major problems for GA operators. Continued VFR flight into IMC conditions is a leading cause of fatal accidents. According to Mike Durham, AvSP Business Development Lead, participants agreed that "in the near-term, we should take the graphical weather products available on the ground and get them into the cockpit. We need to complete the communication 'pipeline' so the pilot and the controller are looking at the same graphical forecast. In the long-term, sensing ahead of the aircraft and three dimensional displays, in the form of synthetic vision systems, could alleviate low visibility accident precursors."

The fast-track ASIST process started in late February 1997, less than two weeks after the President's national challenge, and the team presented the recommendations to NASA senior staff by the end of April 1997. In May 1997, Langley Research Center was selected to lead the new multi-center safety program and Mike Lewis (LaRC) was named as the program manager. By July 1997, budget sources for the new focused program were identified, a Program Office structure was approved, and funding allocations were made.

Mike Lewis, Langley Research Center's AvSP Program Manager, leads the team spearheading NASA's new safety research initiative.

Mike Lewis is challenging the industry to form partnerships and jointly develop safety products ready for implementation. The AGATE consortium is being held up as an example of the partnering that will be required to implement the enabling technologies. "NASA will not pay for all of anything," said Lewis. An array of collaborative and competitive teams are envisioned over the diverse program investments. NASA is looking for companies/individuals that can say; "we have a safety idea that we can systematically show is applicable to an important group of accident types." Lewis is expecting to partner with companies that are ready to commit significant resources of their own to develop their ideas, and who have partners who agree with the approach and are committing resources of their own. NASA is seeking products that face a technical/risk/cost/test/data hurdle that the AvSP can help overcome and partners who have a plan and the motivation to work together to bring this idea/product/result through to system implementation. Lewis envisions the AvSP funding as a catalyst to take bold steps toward improving safety. An 80 percent reduction in the fatal accident rate will not come from incremental advances in technology or procedures. NASA is looking to motivate the necessary partnerships to implement enabling technologies that change the current paradigm of reactive "fixes" to proactive detection of the precursors that lead to future accidents.

(continued on page 13)

Alliance Results: Better Corporate Financial Performance

Recently released studies on the performance of companies most actively engaged in business alliances reveal they experience higher Return on Equity (ROE), better worker productivity, and shorter product development cycles. Consulting firms and university business schools initiated these studies during the early 1990s, to determine the value of these new business relationships. The activities of R&D production and marketing alliances have been exempt from the severest anti-trust provisions only since the mid 1980s, and are a relatively new business phenomenon in the United States.

A 1997 Conference Board survey of the Fortune 500 firms, found that the 25 companies most actively engaged in alliances had a ROE of 17.2 percent (1995). The average 1995 ROE for the Fortune 500 was 12.2 percent, while the 25 companies least engaged in alliances had an 1995 ROE of 10 percent.

A 1997 survey released in the "Trendsetter Barometer" found that small and medium sized firms that engaged in alliances generated higher growth rates, better unit revenue per employee, and broader market penetration. The study was conducted by Coopers & Lybrand, among 458 product and service companies ranging from $1 million to $50 million in size. The survey results reveal that companies that participated in alliances experienced 49% higher revenue growth than non-participants. These high growth firms generated their results without increasing employee levels, generating an average of $119,200 per annum in revenue per employee, 38% higher than non-participants. Alliances also appear to be linked to business expansion beyond geographic boundaries...50% of the surveyed firms involved in alliances market their goods/services internationally, versus only 30% of the non-participants.

Four books have been released between 1990 and 1996 by university professors from major business schools, who have conducted in-depth studies of the use of alliances by large and medium sized corporations. Two of those books are authored by Dr. Jordan Lewis, a former Wharton professor who analyzed alliances of 40 major corporations in America, Europe and Asia. The benefits described by Dr. Lewis' survey include shorter product development cycles, improved market access, added product value with limited direct investment, and lower cost for technology based, product development. Equally as important, the books emphasize the need for alliances in the era of global competition. Dr. Lewis opens his first book, Partnerships for Profit, with a quote from one of his Japanese interviews, regarding their approach to alliances:

" Blood ties aren't that important when it's a matter of survival." □

AGATE Flight Experiments

(continued from page 1)

system was recorded by NavRadio and is played back for the flight experiments. The first leg of the test is a cross-country flight from Wichita to Tulsa. The first leg uses existing information-gathering techniques, i.e., no graphical weather display. The return trip allows the use of the graphical pilot interface.

The test subjects were from the pilot base at Cessna, which has a large pool of GA pilots and supports a flying club with over 450 members. The test pilot is provided a preflight weather briefing which includes information about a very unstable airmass conducive to rapid-building convective activity. The pilot is also shown the current radar which shows no significant activity. As the pilot is preflighting the aircraft, the canned dynamic weather system is building, which tends to make for an interesting flight. Weather information is provided to the pilot via a mock Flight Service Station which has radar, surface observations, and forecast information. A safety pilot in the right seat is playing the role of air traffic control (ATC) and is also making observations of time utilization and recording activity of the test subject. Automatic Dependent Surveillance Broadcast (ADS-B) is used to provide a ground display of aircraft position relative to the convective activity for a measurement of pilot weather avoidance capability.

Preliminary results of the flight evaluation indicate that the pilot activity on the return trip (using the advanced cockpit displays) has been greatly reduced while increasing the pilot's ability to accurately navigate around the hazardous weather with large safety margins and greatly reducing voice communications. The ADS-B reports clearly show the pilot understands his relationship between the aircraft and convective activity when using the graphical pilot interface. The results to date show a strong correlation of a significant reduction in pilot workload, increased situational awareness, and increased safety.

"Feedback from the experiments so far has been positive," said Peter Padilla, Lead for Cockpit Information Systems Task under the Flight Systems Work Package. "All of the test pilots have indicated that they would like to have this kind of capability in the cockpit for their future flying activity. Improved safety and increased utility are primary benefits they are recognizing," said Carr.

Future flight testing plans are to complete this phase of tests by March 31, 1998. The aircraft will then be made available to test and evaluate future advanced weather displays.

The second series of AGATE flight tests began in January 1998 with SST-1B experiments designed to assess the operational capabilities of datalinks. Operating out of the Raytheon Aircraft Plant in Wichita, Kansas, the 1B Team is co-led by Mark Gardiner of AvroTec and Rich Haendel of Rockwell Collins. Team members include Raytheon Aircraft, Rockwell Collins, Harris Corporation, Seagull Technology, AvroTec, NavRadio, Trimble Navigation, Jeppesen, ARINC, and ARA. The 1B Team is using a Raytheon F-33C Bonanza as the experiment testbed. The Bonanza is equipped with two 10-inch displays rather than the conventional single display. The two advanced displays are a primary

flight display (PFD) and a multi-function flight display (MFD) also known as an ICIS (Integrated Control Information System).

Dan DiCarlo, AGATE Integration Platforms Work Package Leader said "The 1B Team is looking at the graphical and digital weather information via the datalink¾ VDL Mode 2 or VDL Mode 3. VDL Mode 2 and VDL Mode 3 have been identified by the FAA as being part of the future National Airspace System (NAS). VDL Mode 2 is designated for Flight Information Services (FIS), like datalinked weather, and VDL Mode 3 is designated for Air Traffic Control (ATC)/Air Traffic Management (ATM). VDL Mode 2 provides two-way communication and reduces the number of systems required to maintain inflight communication. VDL Mode 3 provides the same kind of information path, but also adds voice communication.

"Flight tests of the ADS-B system are also underway. ADS-B information is much like current transponder information, which has been greatly enhanced, and is available both on the ground and in the cockpit. The system is characterized by broadcasting highly accurate GPS position via the same frequency as the secondary surveillance radar."

Twelve flight tests were made in the Bonanza in January 1998. Tom Carr and Noel Duerksen of Raytheon Aircraft were the test pilots for the SST-1B tests. The flight tests have been focused on determining the characteristics of the datalink systems including range, the effects of antenna placement on the airplane, and the effects of radio configurations on RF noise rejection. The systems examined so far include VDL Mode 2 and VDL Mode 3 in the VHF frequency range and ADS-B using a 1090 Mhz mode S squitter. Independent tests were performed on VDL Mode 2, VDL Mode 3, and ADS-B. "Digital radio has had promising results which showed that the system will be implementable and the integrated displays are exceeding expectations," said Mark Gardiner, SST-1B Co-Leader (AvroTec). "The tests have shown that the effective range for VDL Mode 3 extends up to 63 miles and that ADS-B coverage extends up to 47 miles. We are encouraged with these results," he said.

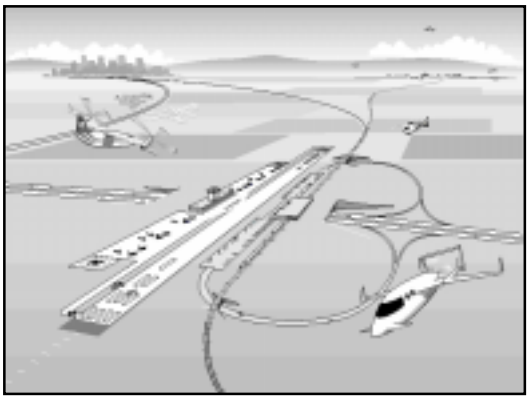
Future plans for SST-1B flight testing are broad in scope. "We are going to continue with the SST work," said DiCarlo. "In Fiscal 1998 or 1999, an Attitude and Heading Reference System (AHRS) is going to be tested on the Bonanza," said Gardiner. "The Bonanza will also have a decoupled flight controls system and a 'Highway-in-the-Sky' display. All of these systems will be linked together later in the program to evaluate the overall effect of all of the AGATE cockpit technologies working together," said Noel Duerksen, SST-1B Project Engineer.

"There are other activities on the horizon that are going to be coupled with the SST work or are going to be done independently like testing of the quiet propeller and aircraft structures and materials coming out of the Integrated Design and Manufacturing Work Package, additional testing of the Single Lever Power Control (SLPC) concepts coming out of the Propulsion Sensors and Controls Work Package (the two testbed aircraft can be retrofitted for SLPC), and examining de-icing capabilities on aircraft. Included in the plans is the development of a proposed test range, with ground sites at several NASA and FAA facilities, that would allow flight segments that are representative of the typical point-to-point AGATE mission (150-700 mile range). The use of such a test range would allow flight experiments with either single or multiple aircraft, while permitting air traffic control procedures associated with these newer communications, navigations and surveillance systems, to be examined and developed," said DiCarlo.

The SST-1A and SST-1B flight experiments are of great significance to both AGATE and the GA consumer. "The flight experiments are the mechanism to gather final flight data or information that will be critical to defining the guidelines, standards, and certification methods (GS&C). The GS&Cs will not be final until all the theoretical or speculative information is verified. The data and operational experiences gathered in these flight tests will play a key role in the FAA certification process for advanced cockpit technologies. The flight tests will help to provide for the consumer an economically more viable airplane concept than what is commonly available on the market," said DiCarlo. □

New NASA General Aviation Planning Activity Underway

The NASA Headquarters Office of Aeronautics and Space Transportation Technology (OASTT) has initiated the development of follow-on investment strategies to the current Aeronautics Enterprise programs. The agency is forming an intercenter-interagency-industry-university team to plan a General Aviation Technology Roadmap during the coming 12 months. Bruce J. Holmes of NASA's General Aviation Program Office leads the planning effort. NASA Lewis has assigned Mr. Leo Burkardt, NASA General Aviation Propulsion (GAP) Office. NASA Ames has provided Michael Landis. NASA Dryden, the FAA, DOT and DOD will also make assignments for this effort. The AGATE Executive Council, including all Observing Members, will receive an information briefing on the planning process at their April 25-26 meeting in Kissimmee, Florida. An information briefing is planned for the GAP Coordinating Committee spring 1998 meeting. The Roadmap will define possible investment strategies starting in 2001. □



A future Small Aircraft Transportation System (SATS) can provide high-speed, intermodal personal and business transportation for the Nation's smaller, rural, and remote communities.

1997 Phase I SBIR/STTR Awards Spur General Aviation Revitalization Efforts

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) programs are playing a major role in the efforts to revitalize general aviation (GA). Awards provided to small businesses and research institutions are leading to significant technology development efforts. Many of these are being conducted by AGATE members. Since 1993, NASA has awarded GA companies over $28M in the program, in 96 Phase I and 37 Phase II SBIR/STTR GA awards.

AGATE companies have fared well in the competition for SBIR/STTR funding for several reasons. "The company that shows diligence in putting together a proposal stands to win. Within AGATE they have the resources to do this. The people involved with AGATE do an outstanding job," said Thayer Sheets, NASA Langley Research Center SBIR/STTR Program Manager.

In 1997 the GA Phase I SBIR and STTR award winners and their project titles are as follows:

SBIR Phase I Awards (announced February 1998)

***AvroTec, Inc.**
Innovative Affordable Head-Mounted General Aviation Pilot Information System

***Advanced Creations, Inc.**
Pilot Voice Recognition for GA Aircraft

***Global Aircraft Corporation**
Integration of Materials and Technologies into an Innovative, Low-Cost, Composite, Spray-Up Toolings System (STS)

W. Brandt Goldsworthy & Associates, Inc.
Automated Manufacturing System for Grid Stiffened Structures for General Aviation Aircraft

***NavRadio Corporation**
Shared-Bandwidth Broadcast FIS System

Micron Corporation
A High Lift Generation and Stall/Spin Recovery System

ViGYAN, Inc.
Low-Cost Piston Engine Health Monitoring and Control System for General Aviation

DeltaHawk, Inc.
Lightweight Aircraft Diesel Utilizing Carbon-Carbon Technology

Mide Technology Corporation
Piezoelectric Ignition and Sensing Device

Team Vision
A Windows Based General Aviation Design and Cost Evaluation Tool

SBIR Phase II Awards (announced January 1998)

Payload Systems Inc.
Low Cost Flight Data Recorder for GA Aircraft

Advanced Creations Inc.
Affordable Computer Based Trainers

STTR Phase I Awards (announced July 1997)

Alpha Star Research Corp. & Clarkson University
Progressive Fracture Simulation for Design of Braided Ceramic Combustors for Turbine Engines

Compact Membrane Systems Inc. & Argonne National Laboratory
Air Modifying Membranes for Use with Unleaded Fuel in General Aviation

Crew Systems & *Wichita State University
Low Cost General Aviation Head-Up Displays

Global Aircraft Corporation & *Research Triangle Institute
Design and Implementation of an Integrated Landing System for Small General Aviation Airplanes

***Global Aircraft Corporation & *Embry-Riddle Aeronautical University**
Design and Production of an Affordable Engine Exhaust Muffler System for General Aviation Engines

NASTEC Inc. & University of Toledo
Application of Unique Wave Bearing Concept to General Aviation Gas Turbine Engines

Wiesen Engine & U.S. Merchant Marine Academy
Lightweight Inexpensive Aircraft Diesel Engine

Wyndemere Incorporated & *National Center for Atmospheric Research
A Weather Conflict Prediction and Avoidance Service for General Aviation

STTR Phase II Awards (announced September 1997)

Mohawk Innovative Tech, Inc. & Parks College of St. Louis University
Advanced Bearings/Seals for General Aviation Engines

***Mod Works, Inc. & Mississippi State University**
A Low Cost Cockpit Design, Integration and Manufacturing System for Installation of Emerging Avionics and Cockpit Sub-Systems

SPEC, Inc. & *National Center for Atmospheric Research
Improved Measurements and Detection of Freezing Drizzle

The 1997 Phase II awards up to $600,000 each will be made upon completion of the ongoing Phase I work, expected by December 1998. Solicitations for 1998 SBIR Phase I proposals open April 24, 1998 and close on July 7, 1998. Selections for 1998 SBIR Phase I awards up to $70,000 each will be made October 25, 1998.

More information can be found on the internet at http://sbir.gsfc.nasa.gov. □

***AGATE Member**

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Management and Technical Progress Highlights

Flight Systems

The AGATE Flight Systems Technical Team met at NASA Langley December 9-11 for presentation of 1997 reports. The next TC meeting will be a progress review in April following ‘‘Sun and Fun.’’

The FAA ASICS Team has completed revisions to AC 23.1309-1B, Equipment, Systems, and Installations in Part 23 Airplanes; and AC 23.1311-1, Installation of Electronic Display Instrument Systems in Part 23 Airplanes. FAA, industry, NASA, and trade organization inputs were incorporated into these revised Advisory Circulars. Erv Dvorak, FAA ACE-111, coordinated these revision activities.

The flight experiments of Systems Standards Teams (SST) 1A and 1B are underway and highlighted on page 1 of this issue of the Flier.

Propulsion Sensors and Controls

A Propulsion Sensors and Controls Technical Council Meeting was held on February 17-19, 1998 at the Teledyne Continental Motors facility in Mobile, Alabama. A tabulation of all task reports completed to date was presented by NASA to insure all work package members have copies for their archival libraries. The 1998 tasks are currently on schedule and budget. Delivery of final reports for 1998 are expected by October 31, 1998. Tasks for 1999-2001will be available for the Lakeland meetings in April 1998. The Propulsion Sensors and Controls Work Package will present what engine information will be available for display to the pilot on the AGATE aircraft at the joint Flight Systems, Propulsion Sensors and Controls, Ice Protection Systems, and Flight Training Curriculum Work Packages technical interchange meeting in March 1998.

Integrated Design and Manufacturing

The Integrated Design and Manufacturing Work Package reported that Lightning Technologies has distributed 9 of 14 sections of the AGATE Direct Effects Handbook for review.

Simula reported that a draft of the AGATE Crashworthiness Design Guide will be complete in time for "Sun and Fun."

Ed Hooper and Bob Gavinsky of Stoddard Hamilton met with the Ice Protection Work Package to coordinate the integration of ice protection devices into the ID&M wing demo article that Stoddard Hamilton is building. A full-scale wing demo article is planned for Oshkosh ’99 with plans for a flight test at Oshkosh 2000.

Global Aircraft Corporation reported that recent modifications to their quasi-constant speed composite (QCS) propeller blade and collar design have increased pull-out strength by 40 percent. Current blade pull-out strength is about 4.5 times the maximum centrifugal load under operating conditions.

Ice Protection Systems

An Ice Protection Systems Technical Council Meeting was held on February 3-4, 1998 at the NASA Lewis Research Center, Cleveland, Ohio. A tabulation of all task reports completed to date was presented by NASA. The 1998 tasks are currently on schedule and budget. Delivery of final reports for 1998 are expected by October 31, 1998, and the 1999-2001 tasks were discussed and will be available for the Lakeland meetings in April 1998.

The Ice Protection Systems Work Package will host the joint Flight Systems, Propulsion Sensors and Controls, Ice Protection Systems, and Flight Training Curriculum Work Packages technical interchange meeting at the NCAR (National Center for Atmospheric Research) facility, Boulder, Colorado, in March 1998. Contributions will be icing protection and detection information available for display on the AGATE aircraft and the development of updated Integrated Product Lists (IPL). The Ice Protection Systems Work Package has also developed a working relationship with the Integrated Design and Manufacturing Work Package to integrate an ice protection system into a Stoddard Hamilton Glasair wing by the end of 1999.

Integration Platforms

The Integration Platforms Work Package reported that it has started the process to determine the future role of the AGATE Concept Demonstrator as part of the ground network needed to elevate this form of program advocacy to the realm of a flight demonstrator. A strategy will be developed, in collaboration with other GA related programs, to satisfy the various program priorities, technical requirements, schedules, etc., and identify areas where funding can be shared.

Follow-on datalink/displays flight tests, with the F-33C Bonanza (SST-1B), have been conducted at Raytheon Aircraft. Problems encountered during previous Automatic Dependant Surveillance Broadcast (ADS-B) tests were verified as well as a solution path for the work package members developing this system. The first set of VHF Datalink (VDL)-mode 3 tests were also conducted, which resulted in successful two-way communications out to a range of 60 miles. Control-related modifications to the aircraft airframe are continuing at Raytheon, per FY98 tasks, as the flight schedule permits.

The Integration Platforms Work Package is continuing the effort to identify costs and installation requirements for various ground station sites that would comprise a future National Airspace System (NAS) Datalink Infrastructure Facility to support AGATE flight tests and demonstrations. Important aspects in determining the various ground station needs include identification of general aviation Free Flight operational concepts and scenarios, which are being developed. Also needed is collaboration with other GA related programs to foster mutual areas of interest that can be satisfied by establishing a joint test range.

Flight Training Curriculum

The Flight Training Curriculum Work Package reported that validation of the first unified curriculum is in progress, the first test in ground school has been completed, and the students are flying. Students are presently completing the first stage of flight training, and following that are being soloed. To date six students have flown solo.

The AGATE Unified Instrument-Private curriculum has been approved by the FAA. Forty-five subjects are currently enrolled in ground school and have begun flight training.

ACI is continuing development of the Integrated Control Information System (ICIS). A teleconference was held February 20 with the Flight Systems and Ice Protection Systems regarding display issues for the Multi-function Flight Display (MFD) and Primary Flight Display (PFD).

Within the Propulsion System Management Training Module emphasis on displays has been on developing the ICIS simulation module.

Systems Assurance

The Systems Assurance Work Package reported that the establishment of AGATE requirements on user considerations, functional decomposition, intrinsic capabilities of design, and certifiability has been completed.

The high level systems architecture solution for the AGATE project is being developed by the SAWP, within which consortium members are enabled to produce competitive architectures with resolved certification methods.

The certification team is a partnership of the FAA with the AGATE SAWP systems engineers, and is vital to reducing the cost of general aviation products. The certification team has produced changes to the Advisory Circulars for Avionics and is producing guidelines and standards for certification across the FAA organization.

The SAWP has established baseline standards for General Aviation component reliability. This baseline has been embraced by the FAA as a benchmark for certification issues of new technology in the industry.

The SAWP is developing requirements for the proposed NAS Datalink Infrastructure Facility as a national resource for general aviation research.

AGATE ALLIANCE MEMBERSHIP

Work Packages: Flight Systems (FS)
Propulsion Sensors & Controls (PS&C)
Integrated Design & Manuufacturing (ID&M)
Ice Protection Systems (IPS)
AGATE Integration Platforms (AIP)
Flight Training Curricula (FTC)
Systems Assurance (SA)
Program Management (PM)

Work Package Membership: P = Principal; A = Associate

Official Organization Name	FS WP-1	PS&C WP-2	ID&M WP-3	IPS WP-4	AIP WP-5	FTC WP-6	SA WP-11	PM WP-12
Advanced Creations Incorporated						P		
Airborne Research Associates	A							
Allied Signal Aerospace Company	P		P					
ARINC Incorporated	P							
ARNAV Systems Incorporated	P							
Aurora Flight Sciences		P						
AvroTec Incorporated	P						P	
BFGoodrich Aerospace				P				
Cessna Aircraft Company	P	P	P	P	P	P		P
Cirrus Design Corporation	P	P	P	P				
Cox and Company Incorporated				P				
Digital Equipment Corp.	P							
Embry-Riddle Aeronautical Univ.			P			P		
Florida Institute of Technology.						P		
Global Aircraft Corp.			P			P	P	
Harris Corporation	P							
Hartzell Propeller Company			P					
Honeywell Technology Center		P						
Innovative Dynamics Incorporated				P				
Jeppesen Sanderson Incorporated	P					P		
Kestrel Aircraft Company			P					
Lancair International Incorporated			P					
McCauley Propeller Systems			P					
Mod Works Incorporated			P					
NavRadio Corporation	P							
Ohio State University						P		
Raytheon Aircraft Company	P	P	P	P	P	P	P	P
Raytheon E-Systems	P							
Rockwell Collins Incorporated	P						P	
Ross Engineering	P							
Seagull Technology Incorporated	P							
Simula Technologies Incorporated			P					
Stoddard-Hamilton Aircraft Incorporated			P					
Teledyne Continental Motors		P						
Textron Lycoming		P						
Trimble Navigation Limited	P							
Unison Industries		P						
United Technologies Hamilton Standard			P	P				
Wichita State University-NIAR			A	A			A	

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AOPA-Air Safety Foundation
Executive Jet Incorporated
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General Aviation Manufacturers Association (GAMA)
Georgia Tech Research Institute
Kansas State University
Mississippi State University-Raspet Research Lab
Mitre Corporation
National Air Transportation Association (NATA)
National Business Aircraft Association (NBAA)
National Center for Atmospheric Research
New Piper Aircraft Incorporated
Research Triangle Institute
Seemann Composites Incorporated
Small Aircraft Manufacturing Association (SAMA)
II Morrow Incorporated
University of Illinois at Urbana-Champaign
University of Kansas
University of Tennessee Space Institute
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Federal Aviation Administration
NASA Langley Research Center
NASA Lewis Research Center
USAF Research Laboratories (Wright Directorate)

General Aviation Safety

(continued from page 6)

The next step in the new safety initiative was a series of focused workshops to develop detailed plans for each of the approximately 15 investment groupings. Over 10 workshops have been held. Of particular interest to GA are: (1) Aviation Weather Information (AWIN), (2) Synthetic Vision, (3) Training, (4) Systems Approach to Crashworthiness, and (5) Control in Adverse Conditions. Focused investments are planned in each of these workshop areas.

AWIN is receiving approximately $8M of early funding in 1998-1999, with up to $2.5M targeted for GA investments. Specific enabling technologies in this investment area include systems that enhance airborne use of aviation weather information (e.g., datalinks, satellites, weather information displays, and aircraft sensors). These systems will address the issues of affordability, low altitude coverage, limited coverage area, and tactical information for aircraft operating without weather radar.

Approximately $24M has been targeted for both GA and commercial transport applications in the area of Synthetic Vision for 1998-2002. Specific enabling technologies in this investment area include: a certified GPS system; terrain databases that have the appropriate integrity, granularity, maintainability, and obstacle overlay; and low-cost, retrofitable display devices. As stated by Carrie Walker, Point of Contact for the Synthetic Vision Workshop, “This technology area should greatly increase the GA pilot’s confidence and ability to safely complete a mission. The Synthetic Vision element is designed to help the Visible Meteorological Conditions (VMC) GA pilot who has inadvertently wandered into Instrument Meteorological Conditions (IMC), safely and efficiently return to the VMC environment.”

GA investments have been targeted in the area of Training for 1999. The training element will support research on training/safety issues in part 121, part 135, and part 91. “Both intramural research within NASA centers and extramural research investments will be supported,” said Key Dismukes, Chief Scientist for Human Factors at NASA Ames. “We will be looking at the areas of pilot awareness, risk assessment, how to use flight training devices in GA, improving instructor skills to better address student problems, and training methods,” he said.

Approximately $750,000 has been targeted for investments in Systems Approach to Crashworthiness in 1998. For 1999, $1.3M has been targeted for investments in the same category. As stated by Lisa Jones, Point of Contact for the Systems Approach to Crashworthiness Workshop, “There are three main areas for investment in the Systems Approach to Crashworthiness and Crash Resistant Fuel Systems. The first is in prediction methodologies for crashworthiness. This program will not develop new codes but enhance existing codes for use in crashworthiness analysis. Hopefully, this will lead to an accepted/established code that can be used for certification. The second investment area is broad and covers development and verification of airframe structures, materials, interiors and restraints for improved crash safety. There will be testing of concepts in all the areas listed as well as development of handbooks and design guides. The third area for investment is in crash resistant fuel systems. This investment area is looking at the structural parts of the fuel system (preventing/delaying post-crash fuel spillage) and at some of the military work that may be transferrable to other categories of aircraft (e.g. special valving).”

About $12M has been targeted for both GA and commercial transport applications in the area of Control in Adverse Conditions for 1998-2002. Specific technologies in this investment area include: optimal recovery and guidance strategies, fail-safe navigation and collision avoidance, pilot system management and cueing, and envelope-limiting autopilots. As stated by Carrie Walker, Point of Contact for the Control in Adverse Conditions Workshop, “This technology area should greatly increase the GA pilot’s confidence and ability to safely complete a mission. The Control in Adverse Conditions element will help the GA pilot avoid or escape from extreme flight conditions. Extreme flight conditions include abnormal attitudes, trajectories, or any other edge-of-the-envelope or outside-the-envelope conditions that could jeopardize the safe operation of the aircraft.” More information on the AvSP is available on the NASA web at http://www.hq.nasa.gov/office/aero/oastthp/programs/avsaf/avsafpro.htm. □

AIR AGATE Continues

(continued from page 5)

In addition, the material task group has continued its effort to make advanced composite materials more affordable to small companies. Significant progress has been made and the material qualification process document is now nearing completion. NASA has just recently provided to the FAA the means to make the material qualification process document available to the general public. Several composite material vendors have expressed interest in using the process to create FAA approved material design allowable databases for their material systems. “This is a major change in doing business,” said David Showers, FAA ACE-111. “In the past, the FAA relied on airframe manufacturers to qualify composite material systems for their aircraft certification programs. Now composite material vendors will be able to qualify their composite material systems and then market them to companies. This change opens the door for small companies to consider using composite materials who previously could not afford to. The result will be lower material costs, greater use of composite materials and greater access for companies to use composite materials. The FAA AIR AGATE Team has supported this program from the beginning and is pleased to see the results that are now coming forward,” he said.

For the future, the AIR AGATE Team is now looking at certification requirements for fully automated integrated flight control systems for small airplanes. A Flight Control workshop is scheduled for the Lakeland NASA/AGATE planning meeting to begin defining the issues. The AIR AGATE Team expects that certification guidelines will need to be developed in the coming years as some NASA/AGATE member companies have expressed interest in developing this technology. □

Kansas Universities Team Wins "Design It, Build It, Fly It" Competition

A vision of general aviation's future was captured by a team of students from four Kansas universities who won the "Design It, Build It, Fly It" award in the National General Aviation Design Competition, a first-of-its-kind competition sponsored by NASA, the Federal Aviation Administration (FAA), and the Experimental Aircraft Association (EAA). The team received a $10,000 award in a ceremony held at Wichita State University on December 9, 1997. At project completion, the team will fly the award-winning design as a highlight of the EAA Annual AirVenture '98 Fly-In at Oshkosh, Wisconsin and receive a $500 award from the EAA. The Air Force Research Lab and the AOPA are co-sponsors for other competition awards.

The Kansas Design Team consists of students from the University of Kansas, Lawrence; Wichita State University, Wichita; Kansas State University, Manhattan; and Pittsburg State University, Pittsburg, Kansas.

The competition seeks to involve students at U.S. engineering universities in a national effort to rebuild the U.S. general aviation sector through design efforts that meet general aviation revitalization goals. In the competition, student teams competed for an opportunity to take a well-evolved design concept with innovative general aviation applications to a proof-of-concept phase. Flight concept demonstrations included approaches such as radio-controlled models, prototype flight testing, in-flight simulation, or software in-flight demonstrations.

The Kansas Design Team's proposal is for two advanced radio-controlled (RC) models of a next generation, turbofan-powered, general aviation aircraft. Most small airplanes flying today are equipped with technologies at least 30 years old, including piston-propeller engines, and they fly at speeds below 250 mph. The aircraft design being modeled by the Kansas team would be made of lightweight composites and use the new FJX-2 small turbofan engine being developed by Williams International, Walled Lake, Michigan. This engine offers potential for a faster and quieter aircraft design capable of flying at higher altitudes than piston-powered aircraft. Dubbed "Aladdin" by the team, the design includes user-friendly (de-coupled) flight control systems predicted to offer a major improvement in ease of operation. The team hopes its work will help encourage the general aviation industry to transition from piston to small turbofan engines.

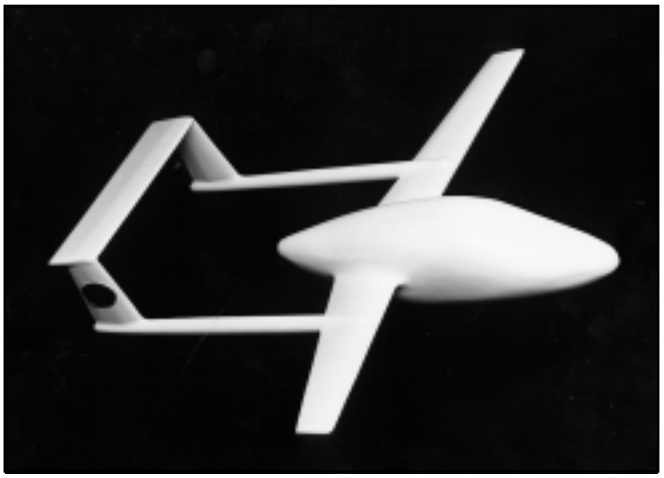

photo courtesy of Wichita State University

Display model of the Kansas Universities Team's "Aladdin" design

photo courtesy of Wichita State University

Matt Steinemetze (left), student and member of the Wichita State University Design Team, receives the $10,000 Design It, Build It, Fly It award from Bruce Holmes (right), NASA Langley Research Center. Looking on are Lanny Jines, Chief of Corporate Communications, Air Force Research Lab (second from left) and Rick Weiss, EAA Washington Representative.

The students, under the guidance of faculty advisors, plan to build two quarter-scale RC models of a four-passenger, single-engine aircraft. The first model will be flown as a conventional RC jet-powered model. The second model will be used to gather flight data which will be used to predict flying characteristics of the full-sized aircraft. The model will contain instruments, including a Global Positioning System (GPS) receiver, to provide real-time flight and position information and will be controlled via real-time imaging on a ground station that simulates the pilot's field of view. The image will be transmitted from a video camera in the model.

In addition to the $10,000 Design It, Build It, Fly It award, the team will also receive support from the Wichita State University National Institute for Aviation Research; Finley's Hobbies, Air Capitol Hobbies and Precision Pattern, all of Wichita; Foam Enterprises, Inc., Minneapolis; Shell Resins, Robart Manufacturing and The Turbine Connection, all of Plainfield, Ill.; and the Wichita State University Student Government Association. The students will produce a peer-reviewed technical report on the flight tests. The aviation safety review portion of the project will take place at EAA's "Sun and Fun" Fly-In in Lakeland, Florida in April 1998. The Kansas Design Team will also provide presentations and demonstrations at the EAA Annual Convention and Fly-In at Oshkosh, Wisconsin in August 1998.

"All of the schools that participated in the design competition had interesting and unique designs," said Rick Weiss, EAA Washington Representative. "It was difficult to have to select just one of them to be a winner because each was so special. However, we were required to pick just one finalist to continue in the process and the reviewers of the design competition were unanimous in their support for the Kansas Universities Team. Their submission was a well-thought-through design that built upon their previous experience in the regular AGATE design competitions. I was most impressed with the fact that while they were at the EAA Convention in 1997 they observed the work being done by others. In particular, it was obvious that they must have been significantly influenced by the Williams and Rutan NASA GAP Program jet engine concept because they changed their aircraft design to incorporate jet propulsion. I thought this showed an incredible amount of courage and forward thinking. I feel this is what it takes to be on the cutting-edge and be the leader of a movement rather than a follower," he said.

"The Design It, Build It, Fly It competition represents an excellent opportunity for students to learn more about the aircraft manufacturing process and environment, particularly coordinating efforts between design teams in developing a design," said Dr. Gawad Nagati, Wichita State University Design Team Faculty Advisor. "Coordinating our efforts proved to be our biggest challenge in the competition. We are working to finalize the design and construction of the model, and hope to eventually build a prototype airplane or a three-quarter scale model," he said.

The National General Aviation Design Competition also provides a range of awards for student teams developing paper designs tied to national general aviation revitalization goals. The competition is managed for the sponsors by the Virginia Space Grant Consortium. For more information, contact mls@penngrad.pgtt.odu.edu or call 757/865-0726. □

AGATE Process Facilitator: Advisor on Policy and Member Rights & Obligations

The AGATE Alliance Association, Inc. (AAAI) provides both industry and government members with assistance in answering questions regarding Alliance policy and individual member rights and obligations. This assistance is provided through a position known as the AGATE "process facilitator", and is currently filled by Paul Masson, of Paul Masson Consulting (PMC).

The process facilitator is assigned the task of researching individual policy issues raised by the Executive Council and government members on issues that affect the Alliance. Issues such as permanent archiving of AGATE outputs, distribution of commonly developed technology standards, and even methods for unified financial management have been topics of recent research. In addition, the process facilitator plays a key role in researching and answering questions about the rights and obligations of individual members. Specific areas of activity for the process facilitator include: Alliance Management & Governance Policy; Financial Rights & Obligations; Commercial Obligations; Business Administration Practices; Dispute Resolution; and AGATE Alliance Performance Measurement. □

AGATE Alliance Association, Inc.

Jack Sheehan

This past year has truly been an exciting one for the AGATE Alliance Association, Inc. I have been on board as the Executive Director for only a short nine months. Getting on board was a little like jumping on a freight train that was already moving pretty fast and gaining speed. The AGATE Alliance Association, Inc. (AAAI) is a rather unique organization solely dedicated to the development of technology to support the revitalization of our general aviation industry. In that regard the most visible function of AAAI is the business of providing the organizational and business structure necessary to allow the alliance membership to function under the JSRA. Our most important function in terms of our contribution to the future of an alliance based R&D program is that of research in the area of public/private consortia development. Within the AGATE program both the public and private partners are doing business in a new and different manner. Probably the greatest change is occurring in the public sector. Both the FAA and NASA are working with industry in a manner that truly provides a return on the taxpayers investment that far exceeds the return achieved in the typical government/contractor relationship. On the industry side of the partnership the members so accustomed to the challenges of dealing in the fiercely competitive environment are now finding their decisions based on cooperation with the competition. This has fostered the new term of *coopertition*.

The challenges in this new endeavor called AGATE far exceed the rewards to any one member but the rewards to the Nation in terms of a revitalized General Aviation industry and the establishment of the basis for a Small Airplane Transportation System will be measured in both economic and quality of life metrics enjoyed by only a select group of people today.

In doing our part, the staff here at AAAI is busy assisting members to achieve their individual research goals and develop the foundations necessary for the future. We are making significant progress in helping members recapture lost or uninvoiced funds, or get greater value from their in-kind contributions. Our communications have greatly improved by providing a more informative internal newsletter, an expanded external newsletter and a functional website.

Cost reduction is always one of our principal objectives here at AAAI and we have met or exceeded our objectives for 1997. In 1998 we are looking to further reduce expenses in our major meetings and provide better services in support of the Technical Councils. We look forward to some great meetings after Lakeland "Sun and Fun" and Oshkosh. Hope to see you there! □

The AGATE Flier

Volume IV, Issue 1 March 1998

The AGATE Flier is published by the AGATE Alliance Association, Inc., a private, non-profit, membership organization founded to stimulate the development and dissemination of general aviation technology. ***The AGATE Flier*** reports on progress in a family of technology initiative and public/private aviation related activities to revitalize the U.S. GA industry, called AGATE-Advanced General Aviation Transport Experiments. The NASA Langley Research Center is the lead center for this program.

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The AGATE Flier

Information on developing technologies for business and personal transportation aircraft

Volume III, Issue 1

Revitalization Efforts Soar With AGATE

AGATE is helping to pave the way to a safer, more affordable, and more convenient means of personal, business, and recreational travel. The development of new technologies, implementation of new training methods, and means for certifying their operational use are improving the capacity and accessibility of our national airspace system. Through this innovative spirit, AGATE is making the romance and freedom of personal air travel available to more people.

"AGATE is making significant progress. Seventy companies are working together with government toward a common goalCrevitalizing general aviation, and we are beginning to see products being prepared for market introduction," said Randy Nelson, AGATE Executive Council Chairman.

AGATE's greatest contribution is in the area of standards for new technology applications. In addition to eliminating many of the negatives associated with small airplane operations, these cost-effective technologies are making flying more desirable to pilots. New cockpit display and communication technologies are being developed and test flown aboard aircraft to alleviate pilot workload. For example, no longer will pilots have to rely on radio voice cues for flying through adverse weather conditions. Instead, AGATE-developed computer-generated cockpit displays will graphically guide pilots around harsh weather to their destinations.

AGATE is facilitating the emergence of new aircraft communication technologies.

New free flight technologies will enable pilots to fly along their chosen aerial routes with less reliance on ground communication, navigation, and surveillance systems. Many of these technologies were proven in the Heli-STAR project conducted at the Olympic Games in Atlanta last summer. Other advancements are also being made with databus and datalink communication systems. In 1996, AGATE member NavRadio was awarded the Aviation Week & Space Technology Laurels Award for their development of the low-cost VDL Mode 2 airborne radio. The radio provides pilots with higher bandwidth communication capability at lower cost.

E. Randy Nelson
Chairman, AGATE Executive Council

"AGATE is making significant progress. Seventy companies are working together with government toward a common goal, revitalizing general aviation, and we are beginning to see products hit the market."

AGATE members are also working to implement propulsion control systems that reduce pilot workload while enhancing aircraft performance. Flight tests of highly efficient, simple

(Continued on page 6)

A Cirrus Design Corp. experimental configuration constructed with advanced composites and airbags undergoes crash tests at the NASA Langley Impact Dynamics Facility.

From the desk of Dr. Bruce J. Holmes

Program Manager NASA

AGATE at Mid-Life

AGATE at mid-life. In operation since 1994, AGATE is approaching the half-way point in its project life cycle. What has AGATE accomplished? What is left to do? What happens after AGATE? The answers to these questions lead to our original goal of revitalization of the U.S. general aviation industry. The results will mean new levels of industry competitiveness in airplane price, performance, and quality.

What has AGATE accomplished?

AGATE's partners have chosen to collaborate to create a future none of us could create independently. As in any collaboration, AGATE members satisfy a carefully selected subset of their strategic corporate objectives through the alliance. Each member has established their own level of practical expectations for contributing to and gaining from AGATE collaboration. Those mutual expectations form the basis of the alliance. NASA's strategic purpose is to stimulate revitalization of U.S. general aviation. At the highest level AGATE has accomplished a national technology strategy to achieve this purpose.

In the simplest language possible, AGATE is:

1. A national public standards organization for general aviation manufacturers and training industries,
2. An industry forum for the establishment of best design practices and guidelines, and
3. A partnership to reduce the risks of certification of products derived from new technologies.

These functions support the prime AGATE products: Guidelines, Standards, and Certification Methods (GS&C). Revitalization depends on AGATE's success in establishing GS&Cs that are robust enough to survive the industry's product development decision-making once AGATE is complete. Those industry decisions will address such technologies as aircraft computer resources, computer operating systems, flight systems operating and hardware architecture, datalink radio architecture, Flight Information System (FIS) datalink infrastructure architecture, materials properties, airbag design standards, electronic engine control system architecture, and new pilot training and operating procedures in AGATE-derived aircraft. AGATE has succeeded in establishing and operating a unique industrial partnership necessary to accomplish these key functions.

What is left to do?

AGATE is transitioning beyond its technology-driven formative years into the next critical System Synthesis phase. During this transition, AGATE investment decisions will become increasingly driven by market objectives. This next phase requires complete synthesis of AGATE component concepts into a whole system. Pieces of AGATE must coordinate and interact. These interactions are between the various AGATE Work Packages. It is during this phase that we will reap the benefits of investing in sound systems engineering documents and configuration management processes. This phase requires that we assemble and fly the AGATE system. The AGATE System Standards Team's (SST) testbed aircraft will serve these purposes in the coming months. Based on demonstrating the AGATE features and capabilities in the real world flight environment, we will prepare for the final phase of the AGATE project: publication of the GS&Cs.

What happens after AGATE?

As AGATE draws to a close in 2001, industry will be prepared for new levels of competition in the marketplace for both retrofit and new products. On the government side, NASA's strategic plan supports the long-term vision for a small aircraft transportation system. The NASA Administrator's objectives for national aeronautics investments include technology support for the goal of 20,000 new aircraft deliveries per year within 20 years. Several Federal investments move us closer to that vision, including AGATE, along with the General Aviation Propulsion (GAP) Program, the Advanced Air Transportation Technology (A^2T^2) Program, the FAA Flight 2000 Program, and the new NASA Aviation Safety Research Program (ASRP). AGATE will deliver vital GS&Cs for key avionics and airframe features we have chosen for investment. We will have exciting new engines from GAP, new free flight capabilities from A^2T^2 and Flight 2000, with new levels of air transportation system safety from ASRP. The results of these investments will give us the basis for revitalization of the existing markets for general aviation aircraft. The rest of the story for a small aircraft transportation system requires airport infrastructure planning and investment on a national scale. Our current Federal research programs are not chartered to address infrastructure. Infrastructure investment decisions lie with the Federal, State, and local private and public sectors. Based on the historical precedent of the automobile, the creation of the practical vehicle must come first. When the practical automobile was ready, the infrastructure (highways) followed. AGATE and its sister programs will deliver practical aircraft. Highways in the sky will follow.

The AGATE membership has grown slightly and the outyears budget is stable. The 1997 partners to date include 38 Principal, 4 Associate, 24 Supporting, and 3 Government Members. These are the partners and programs committed to bringing revitalization to U.S. general aviation, and a small aircraft transportation system to the United States.□

SBIR/STTR: Ingredients for Success

Displays Showcase General Aviation Successes

Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) Program companies are showcasing innovative general aviation technology in NASA's Oshkosh Exhibits. The SBIR/STTR program is serving a crucial role in achieving General Aviation (GA) revitalization and advancing the U.S. aerospace industry. The establishment of relations between businesses, government, and universities through SBIR/STTR is leading to innovation as shown in these advanced displays. The displays will be exhibited at the annual Oshkosh Fly-In this year.

The exhibit "NASA Partnership With Small Business" highlights the NASA/SBIR success story. New propulsion technologies have been a major focus of NASA/SBIR related activity. One of the most exciting systems to be recently developed is the single lever power control (SLPC) system. The exhibit stresses the advantages of this new simplified control system, which eliminates the need for multiple engine controls. A portion of the exhibit, developed by Aurora Flight Sciences Corporation, stresses their concept, a FADEC/mechanical system, and its ease of installation in aircraft. The system is being test flown on general aviation aircraft and unmanned aerial vehicles (UAV).

In another section of the exhibit, the Global Aircraft Corporation presents several of their developments designed to enhance aerodynamic performance as well as the production of their highly efficient GT-3 trainer. The design developments include Global's Quasi-Constant Speed Composite Propeller—a lightweight propeller designed for improved aircraft performance—and new propeller/cowl systems.

In a panel dedicated to improving airfoil designs, Innovative Aerodynamic Technologies sheds light on advancements in computer technology. Their LAMDA product (Laminar Airfoil Manager for Design and Analysis), enables engineers to efficiently design better airfoils.

In a separate exhibit, Seagull Technologies highlight some of the latest enhancements brought to the general aviation cockpit. The exhibit highlights advancements in cockpit instrument/display systems including multifunction navigational and weather displays, a GPS/inertial flight sensor system known as Flight Sense, and a datalink communication system known as FlightLink.

An exhibit by Mod Works illustrates the movement toward simplification in the cockpit design for human factors. Mod Works' and Florida Institute of Technology's Instrumentation Integration and Certification procedures promise to reduce the number of control panel instruments and provide aircraft retrofitting flexibility and affordability.

Cox & Company, Inc. contributed an exhibit that explains the company's joint development with Innovative Dynamics, Inc. of an advanced deicing system. Their Electro-Mechanical Expulsion De-icing System (EMEDS) saves weight and cost for ice protection.

The theme of flier safety is stressed in an exhibit prepared by the National Institute for Aviation Research (NIAR) at Wichita State University. The exhibit focuses on the success and benefits of energy-absorbing structures developed by Terry Engineering, NIAR, and Cirrus Design through SBIR funding.

The SBIR/STTR displays make for true attention grabbers at Oshkosh. The exhibits portray the true essence of the general aviation movement today and feature interactive computer attractions that will provide audiences with excitement, enjoyment, and an enlightening education of leading-edge advances being made in general aviation flight. □

The General Aviation SBIR/STTR displays feature the latest in general aviation technologies and interactive computer attractions.

AGATE Holds First Certification Workshop

Air AGATE Works to Set General Aviation Standards

Following up on what proved to be a productive year for general aviation last year, the AGATE Alliance held its first Certification Workshop at the Sheraton City Center Hotel in Washington, DC, on May 19-21. The workshop focused on strategies for setting standards for aircraft technologies and operations. Seventy-five AGATE members attended sessions covering issues ranging from parts certification to flight testing and training. Tim Smyth, FAA ACE-111, was the Air AGATE Certification Workshop Coordinator.

One of the most extensive sessions involved the application processes for Type Certifications (TC) and Supplemental Type Certifications (STC) under 14 CFR, part 21. Regulations for parts manufacturing according to Parts Manufacturing Association (PMA) standards were discussed, including how to secure approval for production of specific parts through a manufacturing certificate. Inspection requirements for parts, airworthiness approval, and experimental certification issues were also addressed for fixed-wing aircraft as well as rotorcraft. The discussion was led by Bruce Kaplan, FAA AIR-130.

Another matter of great interest under FAR Part 21 has been changes in the TSO (Technical Standard Order) aircraft design approval procedures and TSOs developed by the Radio Technical Commission for Aeronautics (RTCA). The types of TSOs are now available on the Internet.

On May 20, participants engaged in discussions related to aircraft systems and propulsion as covered under parts 23, 33, and 35 of 14 CFR. Speakers David Showers, FAA ACE-111, Mark Rumizen, FAA ANE-110, and Jay Turnberg, FAA ANE-110, led briefings on aircraft design and structural certification, and flight airworthiness standards for engines and propellers. The aircraft design and structures portion of the talks included certification and safety requirements for airframes, seats and restraints, and wings/winglets/stabilizers. The presentations also included safety requirements for aircraft landing gear systems. As stated by Smyth, "It is interesting to note that airworthiness certificates in America for small aircraft are issued according to aircraft type, aircraft engine, or propeller." Smyth also pointed out that "many suggestions for meeting standards for flight controls systems were raised during the Workshop and taken into consideration."

Propulsion-related certification discussions covered several engine design and safety issues. The issues ranged from passenger comfort and requirements for new electronic systems to environmental concerns such as fuel emissions and noise reduction.

Pilot Training and aircraft maintenance issues were also discussed, including requirements for manuals, part replacement and upgrades, and inspections. "Cost, value, and safety continue to be major concerns at the FAA. We want to keep in line with our program objectives of reducing GA accidents 5-fold in 10 years," said Smyth.

"There was much coordination between the AGATE Technical Councils and Membership regarding certification and products that have been developed. Agreement was reached for work relations regarding the certification issues resolution process," he said.

Many participants left the Workshop with a sense of accomplishment. As stated by Curtis W. Wray, Vice President of Advanced Creations Incorporated, in a follow-up letter to Smyth, "By the end of the workshop we felt that the future holds promise. It seems that you folks represent the best in the FAA and share a common vision of the future of General Aviation in this country. More importantly, you seem to be firmly committed to making that vision an achievable reality." □

AGATE Coordinates With Government Programs

AGATE Coordinates with Government Agencies in Flight 2000, GAP, AATT, and ASIST Programs

AGATE is working with other Government programs to develop technologies that will support the vision for a small aircraft transportation system. Potential for the development of this system is now being realized at the highest levels of government. As stated by NASA Administrator Daniel S. Goldin in his "The Three Pillars of Success for Aviation and Space Transportation in the 21st Century" speech presented to the Aero Club, AIAA, and NAC on March 20, 1997:

"The seventh goal in our Global Civil Aviation pillar is to invigorate the general aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 aircraft annually within 20 years. . .With fail-safe avionics, ultra-reliable engines, whole-airplane parachutes, and simplifications enabled by 'Free Flight,' which allows pilots to choose their own routes, small airplanes can enjoy the levels of safety previously standard only on larger aircraft."

Flight 2000 and Free Flight

The FAA and AGATE are working together to bring free flight technology into widespread use. The air traffic management procedures for conducting operations using new navigational communication and surveillance systems, will be validated through a program known as FAA Flight 2000.

"Government and industry partners are working to establish

requirements for global positioning satellite (GPS) augmented systems, Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) for cockpit displays, and Automatic Dependent Surveillance-Broadcast (ADS-B) datalink and databus communication systems. We are also submitting requests for multifunctional displays in the cockpit of terrain and cockpit display of traffic information (CDTI)," says David Tuttle, Flight 2000 Program Manager.

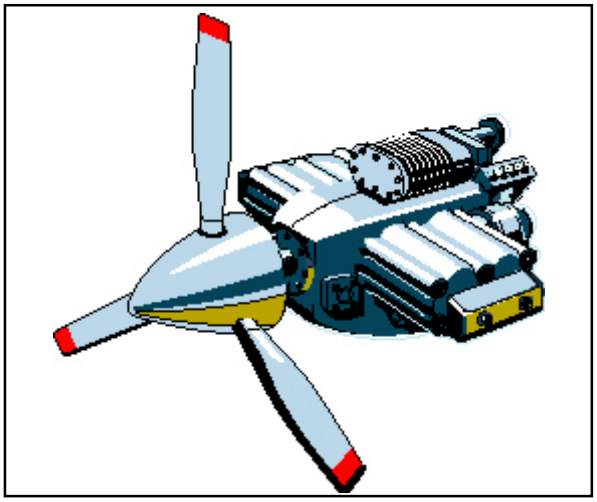
The program is building on the success of project Heli-STAR which served as a proving experiment for communication/navigational surveillance and datalink technologies at the 1996 Atlanta Olympic Games. AGATE technical teams are negotiating with the Flight 2000 planners on cockpit system equipment requirements.

General aviation, commercial, and military aircraft will participate in Flight 2000 with operations commencing in Hawaii and Alaska in the year 2000. Once the free-flight capabilities have been demonstrated in the skies over Hawaii and Alaska, similar operations and technologies will spread throughout the rest of the continental U.S. The White House has set the goal of deploying the Free Flight initial operating capability in the lower 48 states by the year 2005.

GAP and New Engines for General Aviation

The effort to reduce propulsion cost for aircraft in both present and future general aviation fleets is shifting into high gear. NASA has joined industry in the effort to develop two new engines for both propeller-driven and jet aircraft under the auspices of the General Aviation Propulsion (GAP) program. The two engines, the Intermittent Combustion (IC) Engine Element and the Turbine Engine Element, form the basis of GAP. The two engine types are slated for completion by the year 2000, when the NASA/industry team will flight demonstrate prototype piston and turbofan engines for the public at the EAA Oshkosh Fly-In.

The main objective of the IC element is to cut engine prices in half while improving maintenance, operation, and passenger comfort. Teledyne Continental Motors and its partners (Aerotronics, Cirrus Design, GS Engineering, Hartzell Propeller, Lancair International, New Piper Aircraft, and subcontractor Perkins Technology) have teamed with NASA to develop the CSD 283 four cylinder, liquid cooled, two-stroke diesel engine capable of producing 200 hp. Combined with advanced low-speed propellers, the engine will offer quiet, efficient, vibration-free operations using jet fuel and a single lever power control (SLPC). As stated by NASA Lewis GAP Manager Leo Burkardt, "Interfacing with the AGATE Acoustic Team will be critical to the IC Engine."



Advanced horizontally opposed four cylinder diesel engine

The turbine engine element will address the needs of higher performance aircraft capable of cruising speeds of 200 knots or more. An extremely challenging goal for this element is to reduce the price of small turbine engines by a factor of 10 (from hundreds of thousands to tens of thousands of dollars). Williams International and its partners (California Drop Forge, Cessna Aircraft, Chichester-Miles Consultants, Cirrus Design, New Piper Aircraft, Forged Metals, subcontractors Producto Machine, Scaled Composites and consultant Raytheon Aircraft) have teamed to produce the FJX-2 lightweight high bypass ratio turbofan engine in the 700 lb thrust class. Turbine engine costs will be reduced by stressing simplification, reduced part count, advanced manufacturing processes and high production volumes. The Williams VJET-II testbed aircraft will be flown at Oshkosh '97.

AATT and Air Traffic

AGATE members are also active in the NASA-FAA Advanced Air Transportation Technology (AATT) Element of the Aviation System Capacity Program, a broad-based program aimed at significantly improving the capacity, efficiency, and safety of the air traffic management system for all vehicle classes. AATT focuses on human factors and automation that will assist pilots, controllers, and dispatchers develop and facilitate the free-flight concept. "We would like the program to branch out with business aircraft, commuters, and other aviation communities. Removing restrictions on the technologies has been a major concern," said AATT Program Manager Bob Jacobsen.

Key areas to be addressed in the program include delays associated with weather, indirect routing, taxi delays, and cruise inefficiencies. "We are working on improved interaction between ground control systems and aircraft. We expect to see a change in responsibilities for ground and flight crews, particularly in roles and responsibilities for IFR separation. The controller is responsible for separation but the aircrews need to be more involved," said Jacobsen.

"Through the program, we hope to take advantage of new communication technologies to help aircraft make more effective descents," he said. Air traffic at lower altitudes is concentrated in the terminal area and this can pose major problems for pilots and ground controllers, but according to Jacobsen, "there is freedom for coordination of functions and collaboration of airspace requirements. Descents have been a problem at Dallas, Ft. Worth. Currently, the FAA is responsible for making the call for the descent, but the users want to have flexibility for making the call. This flexibility requires situational awareness and, consequently, needs for better position information and displays presented to aircraft." General aviation free flight requirements are being developed and managed by the AATT Program.

ASIST and Light Aircraft Safety

The President has set the national goal to "reduce fatal accidents in aviation by 80 percent." NASA and the FAA have recently collaborated on a new national initiative stimulated by this directive from the White House. Specific goals for the

(continued on page 7)

AGATE Alliance Association, Inc. (AAAI) Ready for Business

Industry Takes on Administrative and Management Support Roles

AGATE industry members have joined efforts to form the AGATE Alliance Association, Inc. (AAAI), a non-profit organization, to support and stimulate research of advanced general aviation technology. AAAI was created by the AGATE Executive Council in 1996 to manage AGATE members' administration using the flexibility offered by a non-profit business status. AAAI began interim operations in November 1996, with Mr. Paul Masson serving as interim Executive Director, until 1997 when the organization became fully operational assuming functions formerly performed by the NASA Langley General Aviation Program Office.

In June 1997**, Mr. John F. (Jack) Sheehan**, a graduate of Embry-Riddle Aeronautical University and the Defense Systems Management College, was appointed permanent Executive Director of AAAI. He is a professional aviator, with a strong

Jack Sheehan
Executive Director of AAAI

project management and research and technology background. Mr. Masson will continue to work as Facilitator, an advisory and management support function for the Alliance leadership.

AAAI also provides a variety of research program services to the Alliance. These services include legal advice, audit support, and facilitation management as well as providing facilities for meetings, newsletters, membership information, and archival storage of data and information. AAAI offices are located at 3217 N. Armistead Ave., Suite M, Hampton, Virginia, and the office staff can be reached at 757-766-7512 or fax at 757-766-2299. □

Raytheon Receives Award of Excellence for Development of Horizontal Stabilizer

AGATE member Raytheon Aircraft Co. received an Award of Excellence from the Composites Institute on January 29, 1997, in recognition of its development of a resin horizontal stabilizer for general aviation aircraft. The stabilizer was one of several products entered in the Development Category of the Products Awards Competition held in concert with the Composites Institute's International Composites EXPO '97. The stabilizer was manufactured using AGATE-derived Resin Transfer Molding processes. □

AGATE Facilitator-Masson Receives NASA Public Service Medal

Dr. Jeremiah F. Creedon (left), Director of the NASA Langley Research Center, presents the NASA Public Service Medal to Paul Masson.

In recognition of his contributions to the AGATE Alliance since 1993 and the unique public/private management structure of the AGATE Alliance, Mr. Paul Masson was presented the prestigious Public Service Medal by NASA at its annual Honor Awards Ceremony at the Langley Research Center on June 19, 1997. This medal is the highest recognition conferred by NASA on non-NASA individuals for exceptional service to the NASA mission. □

Revitalization Efforts Soar *(continued from page 1)*

to use, Single Lever Power Control (SLPC) systems are being flown. "Airplanes with new controls and engine systems are scheduled to be displayed at the EAA (Experimental Aircraft Association) Oshkosh Fly-In. All the preliminary tests are done for this year and we are on schedule," said Nelson.

Work is continuing on icing condition avoidance procedures, as well as new lower noise propellers. "We are making good progress particularly in terms of aircraft crash safety," said Nelson.

To train present and future pilots to these and other advanced technologies in less time and at a lower cost, AGATE has developed a series of new training products. These products will be developed by the AGATE Alliance Flight Training Curricula Work Package (see page 8). AGATE is also capturing further public interest by displaying the AGATE Cockpit Concept Demonstrator at major aviation expositions. Surveys are now being conducted at Oshkosh and planned for the Aircraft Owners and Pilots Association (AOPA) Convention in Orlando, FL, October 23-25, 1997.

Advancements are also being made regarding certification issues. "The FAA has set up the Air AGATE for specific technologies so certification will not be a stumbling block. The process for submitting certification issue papers is beginning to take form for some of these technologies now," says Nelson. "We hope that general aviation airplanes will be safer to fly, more enjoyable to fly, and cheaper to fly. We would like to make flying an airplane as easy as driving an automobile."□

Kansas Universities Team Wins 1996-97 General Aviation Design Competition

Students Engage in Stimulating Studies of Advanced General Aviation Concepts

Innovation served as a major theme in the 1996-1997 National General Aviation Design Competition. For the second time in three years, a joint design team from the **University of Kansas**, **Wichita State University**, and **Kansas State University** took first place with their "Adagio" aircraft design. The design offers performance similar to the Cessna 172R, but at a reduced cost of approximately $75,000. Adagio is easy to build (construction time of about 200 hours), powered by a diesel engine, and features a unique inverted "V" tail.

The second place award was presented to Aerospace Engineering students at **The Pennsylvania State University**. The Penn State team design, "The Stingray," is a pusher aircraft, with a turbocharged engine, composite construction, multifunctional display cockpit, and retractable landing gear. Third place was awarded to **Virginia Tech** for an amphibious, propeller-driven, sport utility aircraft with hydraulic retractable landing gear.

A special Retrofit Award, sponsored by the Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation, was presented to **Jennifer Wilson of Princeton University** for simplification of cockpit instrumentation through the use of a heads-up-display (HUD). Wilson's award was the first competition award given for a design submitted by an individual.

The Competition is held among university student teams and faculty to involve students in general aviation revitalization. The third annual National General Aviation Design Competition was coordinated for NASA and the FAA by the Virginia Space Grant Consortium during the past academic year, and winners will be announced at the 1997 Oshkosh Fly-In.

Students are invited to compete in designing systems and subsystems of a single-pilot, fixed-wing, single-engine, propeller-driven airplane accommodating 2 to 6 passengers. Students at U.S. engineering colleges work with faculty advisors to design innovative configurations and systems that address technical and economic challenges facing the general aviation market.

Teams were asked to address the following areas: integrated cockpit systems; propulsion; noise and emissions; integrated design and manufacturing; aerodynamics; operating infrastructure; and radical new vehicle designs. The resulting designs are judged on the basis of technical superiority, cost, and aesthetic value by a panel of government, industry, and university experts. In addition to three cash prizes offered by NASA and the FAA, the AOPA Air Safety Foundation offers a cash award for the student team design with greatest retrofit potential. Winning team members receive cash awards of up to $3,000 and the university department of the first place team receives a $5,000 cash award for their efforts.

The 1997-98 competition features two new awards, the EAA "Design It, Build It, Fly It" award and an Air Force Research Laboratory dual use technology award. Guidelines can be obtained from the Virginia Space Grant Consortium in August at 757/865-0726 or via e-mail at the following address: msandy@pen.k12.va.us. □

AGATE Coordinates With Government

(continued from page 5)

program include reducing the fatal accidents by a factor of 5 in 10 years, and by a factor of 10 in 20 years. Preparation for planning the necessary research program to achieve these aggressive goals began in early spring 1997 with the formation of an effort named the Aviation Safety Investment Strategy Team (ASIST) Process.

ASIST activities consisted of government, industry, DoD, and university representatives meeting for a series of four in-depth workshops to discuss accident causal factors, issues, and solutions involving approaches to accident prevention, mitigation, and modeling. Specific requirements for technology development for the general aviation community were considered by the participants, who included a number of AGATE members.

The new safety program is scheduled to begin in 1998 through NASA funding. "AGATE is following up on recommendations from NASA and has served as an effective means for working with the general aviation industry," said Mike Lewis, Manager of NASA's new Safety Initiative. AGATE and the ASIST program are coordinating investments in safety technologies. □

Schedule of Events

July 30-August 5:
Oshkosh, WI
AGATE Concept Demonstrator, NASA AGATE/GAP and SBIR exhibits, and AGATE Demonstrator Aircraft exhibits at new East Building Hangar

August 1:
Oshkosh, WI
AGATE Press Conference, NASA-FAA-AOPA National General Aviation Design Competition Winners

GAP Program Press Conference, Williams Int'l. GAP Turbine Engine Testbed Aircraft, VJET-II

August 2:
Oshkosh, WI
GA R&D Press Conference

August 5-7:
Oshkosh, WI
AGATE Annual All-Members' Plenary Session
AGATE Executive Council and Technical Council Meetings (principal members)

August 20-22:
Norfolk, VA
Virginia Aviation Conference

September 8-10:
Tulsa, OK
NASAO Conference

September 9-10:
Kansas City, MO
Air AGATE/SAWP Meeting

September 16-18:
Orlando, FL
RTCA

September 23-25:
Dallas, TX
National Business Aircraft Association (NBAA)

October 9-10:
NATA Flight Training Meeting

October 15-16:
Washington, DC
FY 1988 Executive Council Meeting

October 23-25:
Orlando, FL
AOPA EXPO '97
AGATE Concept Demonstrator public display

November 18-20:
Williamsburg, VA
AGATE Annual Planning Retreat

December 9-10:
Flight Systems Technical Council Meeting

Crash Workshop
NIAR

AGATE Alliance Flight Training Curricula Work Package

"The Executive Council (EC) of the Advanced General Aviation Transport Experiment (AGATE) consortium wishes to form a strategic alliance with the Federal Aviation Administration (FAA) in the area of flight training curricula. New standards and methods for pilot certification are a critical element of the AGATE concept that revolutionizes situational awareness and flight safety for the future general aviation pilot."

— Letter from Randy Nelson, Chairman, AGATE Executive Council and Cessna Aircraft Company to Guy Gardner, Associate Administrator, Regulation and Certification, AVR-1, FAA

The FAA and NASA have established an agreement on funding and leadership for the FAA-led Flight Training Curricula Work Package. NASA has agreed to provide $1.5 million for the FY 1998 project year, with the FAA to provide funding in the out-years. The FAA leadership team includes Mr. Peter Hwoschinsky, AND-710, Mr. John Lynch, AFS-830, and Mr. Hooper Harris, Orlando FSDO. The industry members of the work package formed one Curriculum Development Team and submitted a proposal for review by the Government Partners. The final announcement of the terms and conditions for the industry team selection is awaiting approval by the FAA Selecting Official and announcement at Oshkosh '97. The team submitting the proposal is led by Embry-Riddle Aeronautical University, with team members including Jeppesen-Sandersen, Advanced Creations Inc. (ACI), Cessna Aircraft, Raytheon Aircraft, and the Florida Institute of Technology. Before final approval of the 1998 Research plan, extended team members from other universities and aircraft manufacturers will be included. The schedule of tasks planned for the Work Package is as follows:

October 1, 1997 to September 30, 1998

1) **Unified ("One-Step") Instrument-Private Pilot Curriculum¾** A new course is being developed for AGATE that will serve as the standard for training contemporary and future general aviation pilots. The cost-effective course will accelerate pilot training and certification using aircraft of today by combining private and instrument flight training syllabi into a single curriculum. The course will involve the use of existing equipment for training purposes and set aircraft equipment requirements. The course is intended to result in substantial reductions in training time and costs. Students will be evaluated according to private and instrument pilot Practical Test Standards (PTS). The results of this curriculum validation effort will serve as a benchmark for the following tasks 2-8.
2) **Integrated Cockpit Information System Display (ICIS) Learning Module¾** As a supplement to the unified instrument-private curriculum an Integrated Cockpit Information System (ICIS) display module will be instituted that includes several piloting functions designed to reduce workload. Flight planning/replanning, weather, navigation, pilot-owner handbook usage, Cockpit Display of Traffic Information (CDTI), and aircraft systems management will be included. Students will be evaluated according to the Private Pilot/Instrument Rating PTS, with final evaluations being provided to the Flight Systems Work Package. These display systems and training procedures will be valuable in supporting the FAA Flight 2000 goals.
3) **Propulsion System Management (Single Lever Power Control [SLPC]) Learning Module¾** In tandem with the unified instrument-private curriculum and ICIS display module, the PSM Learning Module will integrate critical elements of propulsion systems operations including powerplant operations, engine diagnostics, and abnormal operations. Students will be evaluated according to the Private Pilot/Instrument Rating PTS, with final evaluations being provided to the Propulsion Sensors & Controls Work Package.

October 1, 1998 to September 30, 1999

4) **Primary Flight Display (PFD) Learning Module¾** In combination with the unified instrument-private curriculum, ICIS, and SLPC, a Primary Flight Display (PFD) Learning Module will be developed that includes flight director-style navigation information, terrain following PFD, and improved traffic following PFD. Students will be evaluated according to the Private Pilot/Instrument Rating PTS, with final evaluations being provided to the Flight Systems Work Package.
5) **Icing Condition Operations Learning Module¾** As a supplement to the ICIS, PFD, and SLPC Modules, an Icing Condition Operations Learning Module will give students the opportunity to learn more about advanced operations intended to avoid the effects of hazardous ice formation on aircraft. The Module offerings include flight planning/replanning, ice avoidance, deicing operations, and ice buildup. Students will be evaluated according to the Private Pilot/Instrument Rating PTS, with final evaluations being provided to the Ice Protection Systems Work Package.
6) **Free Flight Learning Module¾** In preparation for FAA Flight 2000, a Free Flight Learning Module will be offered that incorporates Datalink Communications capabilities among other ICIS related subjects. The module is specifically designed for pilots in Hawaii and Alaska. The Free Flight Learning Module will be provided to the FAA Flight 2000 project team.

October 1, 1999 to September 30, 2000

7) **Integrated AGATE Curriculum¾** The Integrated AGATE Curriculum will culminate all modules successfully completed and offer a comparison between data obtained in the baseline unified instrument-private curriculum. Students will be evaluated according to the Private Pilot/Instrument Rating PTS. The goal is to demonstrate substantial savings in training cost and higher proficiency compared to the benchmark curriculum. This curriculum will incorporate all of the previous AGATE components from tasks 2-6.

October 1, 2000 to September 30, 2001

8) **General Aviation Propulsion (GAP) Turbine Aircraft Learning Module¾** As part of the unified instrument-private curriculum, students will have the opportunity to learn about advanced general aviation engine operations through a GAP Turbine Aircraft Learning Module. The module will include enhanced altitude and speed for single-engine turbofan-powered aircraft outfitted with the latest AGATE cockpit and deicing equipment, and provide information required for the FAA to determine the pilot rating process for such aircraft. Final evaluations will be provided to the GAP Program team.

Management and Technical Progress Highlights

Flight Systems

In preparation for Flight 2000, AGATE Flight Systems technical teams are continuing development and implementation of new communications, navigation, surveillance, and display technologies and operational procedures for free flight.

Principal Member NavRadio has achieved a technical breakthrough in the form of an affordable software radio for VDL Mode 2 Flight Information Systems Datalink applications.

The AGATE Flight Systems Communications Team has established a transition plan for affordable communications systems capable of bringing advanced digital radio features and capabilities to GA cockpits.

Associate Member Airborne Research Associates is continuing its development of the Airborne Total Lightning Advisory System (ATLAS), designed to provide pilots with lower cost lightning and storm intensity information.

Associate Member company Seagull, Inc., has completed their SBIR Phase II development of an affordable, GPS-based, solid-state Attitude and Heading Reference System. Further development of the concept is being coordinated with the Flight Systems team.

The AGATE Concept Demonstrator and a Cessna 210 aircraft, equipped with multifunctional navigational and weather displays and low-cost datalink communication equipment, will be displayed at Oshkosh by AGATE.

Propulsion Sensors and Controls

A Cessna 182 aircraft equipped with the mechanical Single Lever Power Control (SLPC) will be test flown in July and is scheduled for display at Oshkosh.

As part of SBIR Phase II, a Cessna O-2A with an electronic engine control system outfitted by Aurora Flight Sciences, will be flight tested in July and is currently scheduled for display at the 1997 Oshkosh Fly-In.

The Ohio State University completed the Supporting Member task to validate an IC engine transient model. The work originated under grant to NASA LeRC and Honeywell is presently using the validated engine model for Diagnostic development work on IC engines.

Integrated Design and Manufacturing (ID&M)

The Global Aircraft Corporation has developed a new composite propeller for general aviation aircraft known as the Quasi-Constant Speed Composite (QCS) Propeller. The lightweight propeller offers several performance advantages over conventional metal propellers including improved take-off capability, airspeed, thrust, and quieter flights. The propeller will be on display at Oshkosh.

The Integrated Design and Manufacturing (ID&M) Task Group reported that a new AGATE composite material database will be established from new composite certification procedures. The Group is also working on a new qualification process for composite aircraft components. The new materials database and processes save manufacturers significant time and cost.

Ice Protection Systems

The Ice Protection Systems Work Package members attended the National Center for Atmospheric Research (NCAR) held in Boulder, CO, June 3-4. The Work Package observed weather systems that might be incorporated in the icing avoidance and exit systems of AGATE aircraft.

Tests of the first entry of two ice protected NLF wings was conducted on June 13 in the NASA LeRC Icing Research Tunnel (IRT). A second entry, with two additional protected wings, was conducted on July 3.

Systems Assurance

Baselining of AGATE Systems engineering documents was completed for the month of June and the Work Team is continuing work with the FAA on certification issues.

For media information, please contact: Keith Henry, NASA Langley Research Center, Office of Public Affairs, Mail Stop 115, Hampton, VA 23681-0001 (757) 864-6124

AGATE ALLIANCE MEMBERSHIP

Work Packages:
Flight Systems (FS)
Propulsion Sensors & Controls (PS&C)
Integrated Design & Manufacturing (ID&M)
Ice Protection Systems (IPS)
AGATE Integration Platforms (AIP)
Flight Training Curricula (FTC)
Airspace Infrastructure (AI)
Program Analysis (PA)
Systems Assurance (SA)

Type of Membership: P = Principal; A = Associate

	Work Package Membership					
Official Organization Name	**FS**	**PS&C**	**ID&M**	**IPS**	**AIP**	**FTC**
Aircraft Modular Products			P			
Allied Signal Aerospace Company	P					
Airborne Research Associates	A					
ARINC	P					
ARNAV	P					
AvroTec	P					
BFGoodrich Aerospace				P		
Cessna Aircraft Company	P	P	P	P	P	P
Cirrus Design Corporation	P	P	P			
Cox and Company				P		
Digital Equipment Corp.	P					
Embry-Riddle Aeronautical Univ.			P			P
Florida Institute of Technology.						P
Global Aircraft Corp.			P			P
Harris Corporation-ATCSD	P					
Honeywell Technology Center		P				
Innovative Dynamics, Inc.		P				
Jeppesen Sanderson Co.	P					P
Kestrel Aircraft Company			P			
Lancair International Inc.			P			P
NavRadio	P					P
Ohio State University						P

1997 AGATE Consortium Supporting Members

Advanced Creations Inc.
AEROCAR LLC
Aircell, Inc.
AOPA-Air Safety Foundation
BIHRLE Applied Research Inc.
CTA Simulation Systems
Experimental Aircraft Association (EAA)
General Aviation Manufacturers Association (GAMA)
Georgia Tech Research Institute
Hartzell Propeller Inc.
Kansas State University (EPSCOR Team)
Mississippi State Univ-Raspet Labs Research Center
MITRE Corporation
Mod Works
National Air Transportation Association (NATA)
National Business Aircraft Association (NBAA)
National Center for Atmospheric Research (NCAR)
New Piper Aircraft, Inc.
Seemann Composites Inc.
Small Aircraft Manufacturers Association (SAMA)
University of Central Florida
University of Kansas
University of Tennessee Space Institute
University of Illinois at Urbana Champaign
Williams International

Work Packages:

Flight Systems (FS)
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	Work Package Membership								
Official Organization Name	**FS**	**PS&C**	**ID&M**	**IPS**	**AIP**	**FTC**	**AI**	**PA**	**SA**
Raytheon Aircraft Company	P	P	P			P		P	
Raytheon CO/E Systems-Space Montek Div.	P	P				P		P	
Rockwell Collins Commercial Avionics							P		
Ross Engineering Company	P						P		
Seagull Technology, Inc.	A					A			
Simula Government Products Inc.			P				P		
Stoddard-Hamilton Aircraft, Inc.			P						
Teledyne Continental Motors									P
Textron Lycoming Reciprocating Engine Div									P
Trimble Navigation Ltd.	P								P
Unison Industries		P							P
United Technologies Hamilton Standard		P							P
University of North Dakota							P		P
WSU-National Institute for Aviation Research			A		A				A

Government Partners

Federal Aviation Administration (FAA)
National Aeronautics and Space Administration (NASA)
USAF Research Laboratories (Wright Directorate)

The AGATE Flier

Volume III, Issue 1 July 1997

The AGATE Flier is published by the AGATE Alliance Association, Inc., a private, non-profit, membership organization founded to stimulate the development and dissemination of general aviation technology. ***The AGATE Flier*** reports on progress in a family of technology initiative and public/private aviation-related activities to revitalize the U.S. GA industry, called AGATE-Advanced General Aviation Transport Experiments. The NASA Langley Research Center is the lead center for this program.

For address corrections and additions, please write to:

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For more information about AGATE please see the following website: http://agate.larc.nasa.gov

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GA focused NASA SBIR Success Stories

These success stories linked on the left describe the GA technology innovation developed by each small business and its commercial success. Company contact information is also provided. Some of the se have more detailed links to other documents about the technology or company.

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9/9/99

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Purchase Probability
Former Pilot Information
Rational

Author: William D. Hammers

Email:
s.a.siddiqi@larc.nasa.gov

Home Page:
http://sats.nasa.gov

Former Pilot Aircraft

Last Flown

Likelihood of Resuming

Potential Pilot Information

Number of Times

Reasons

Learning Importance

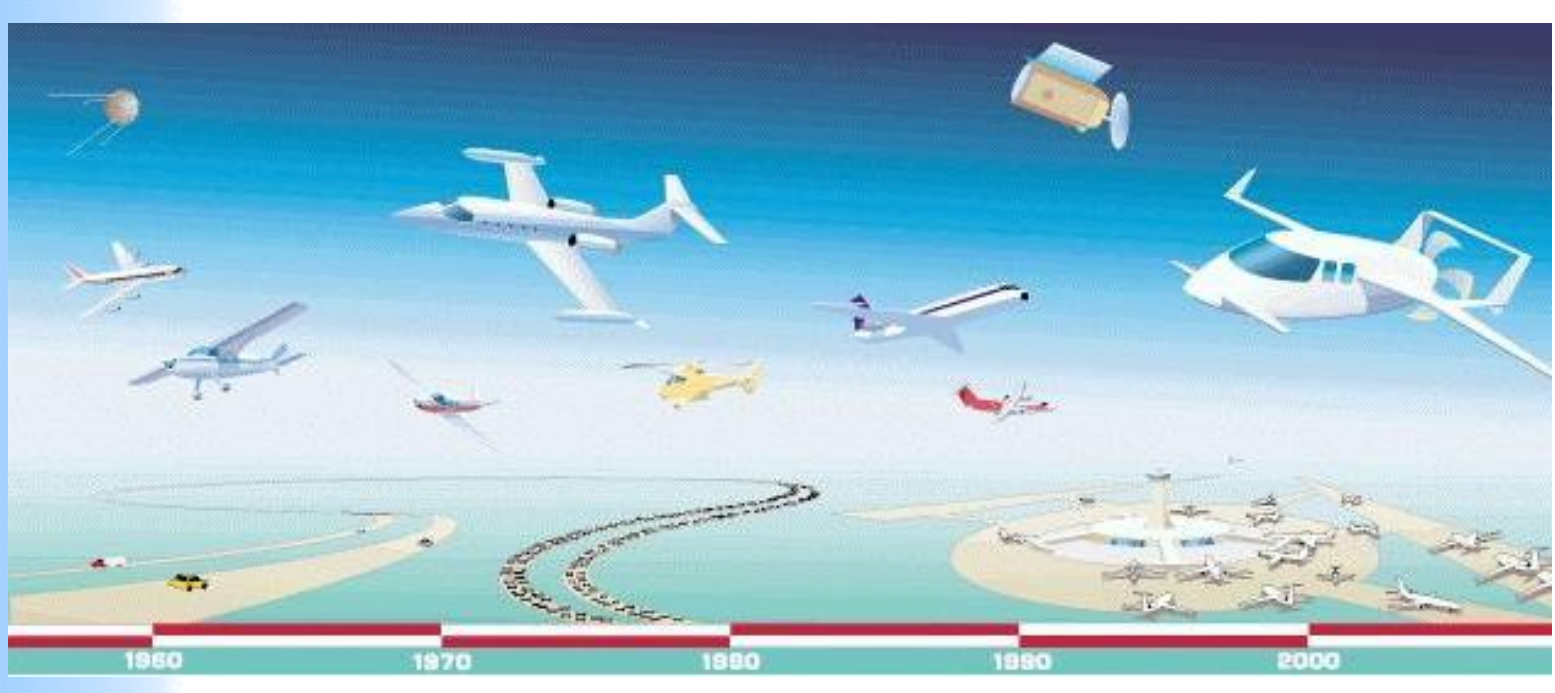
Personal Aspects

Practical Aspects

Learning Likelihood

Barriers

Survey Address



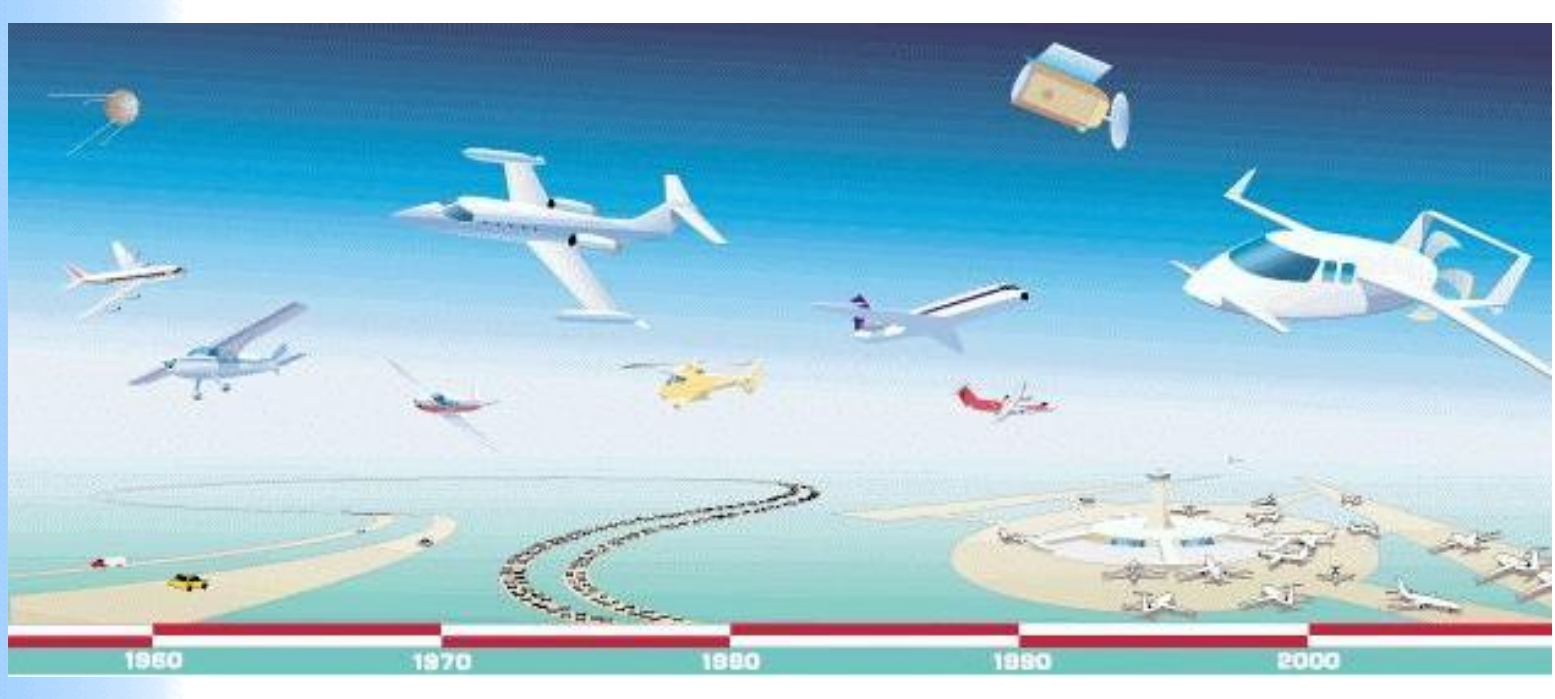
AGATE Survey Results

Introduction

Preliminary Observations from Survey Data
(http://apats.org)

Current To:

June 11, 1999

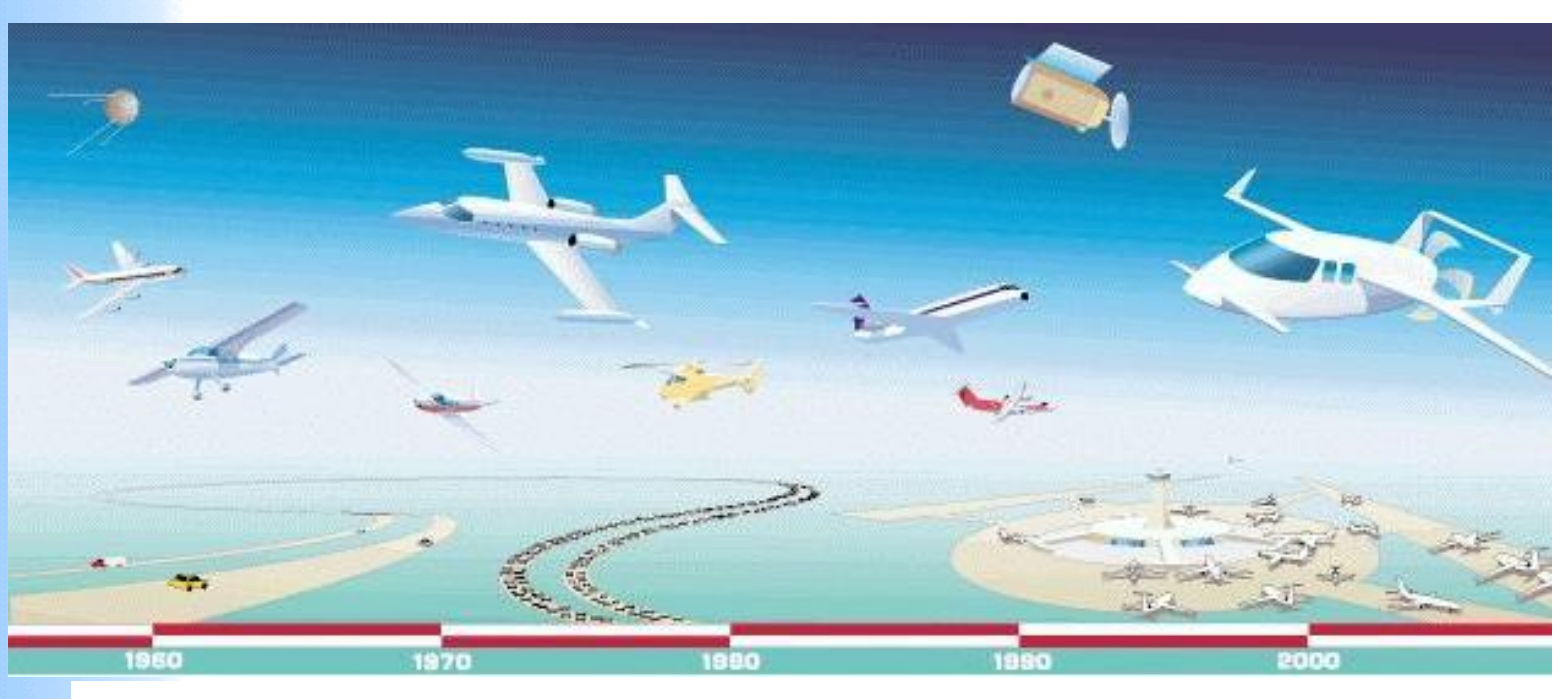


AGATE Survey Results

Demographics

Survey

Demographics

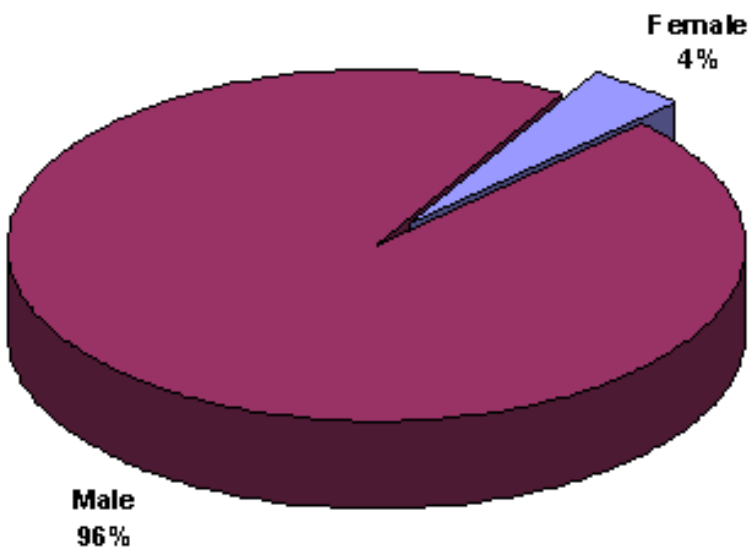


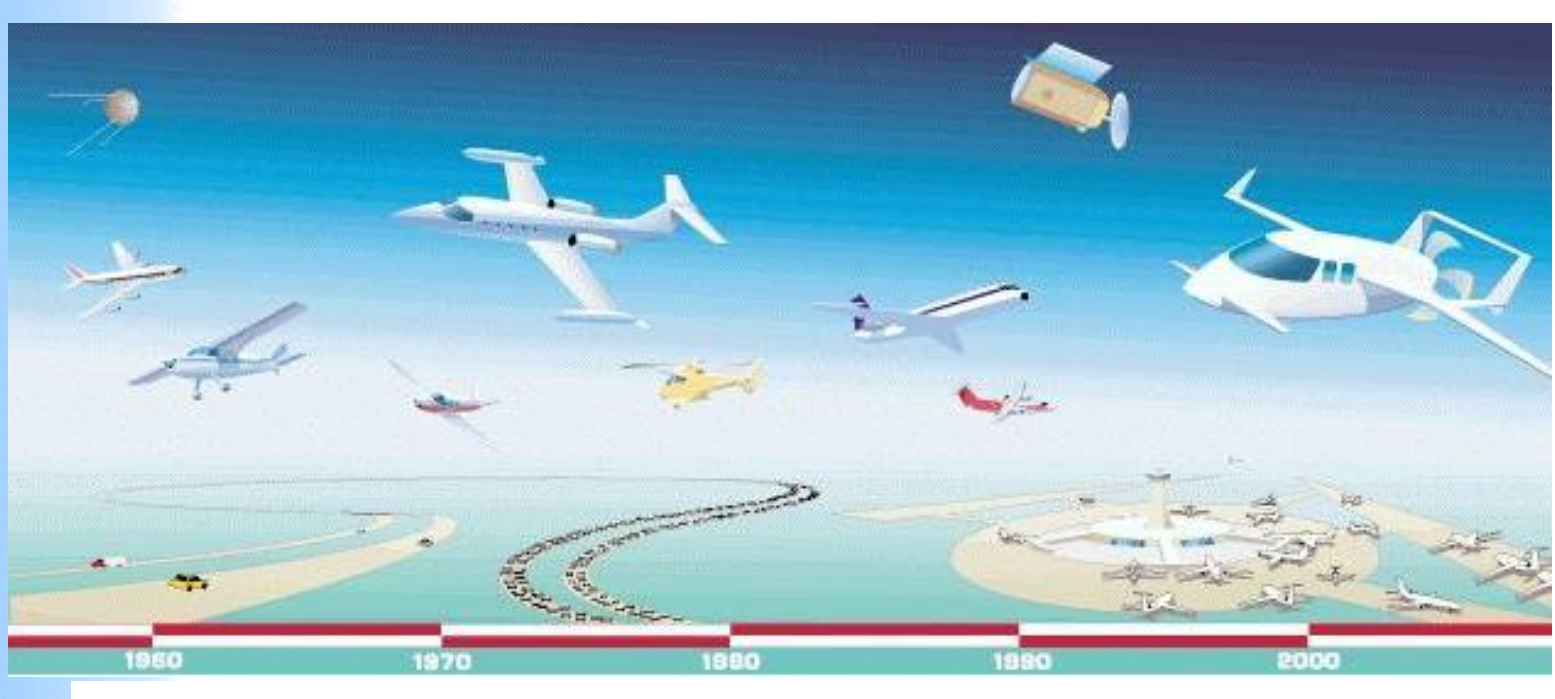
AGATE Survey Results

Gender

Respondent Gender

3903 Respondents

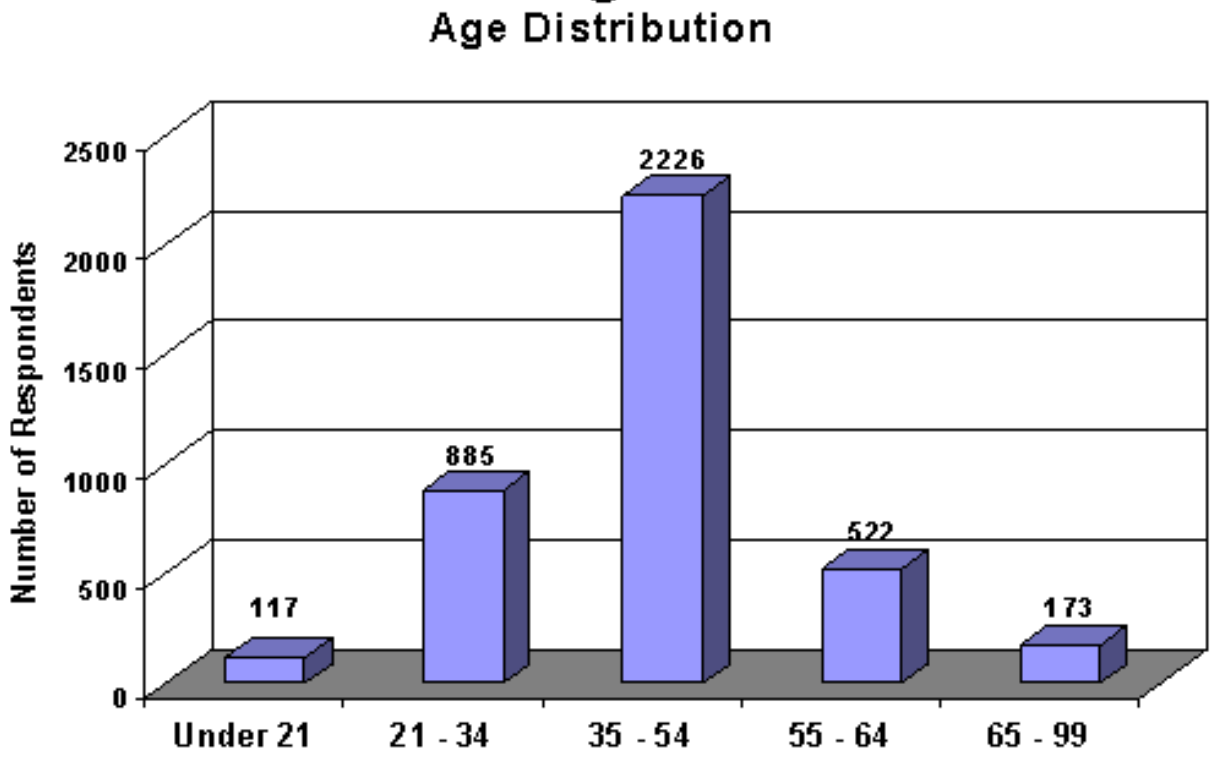


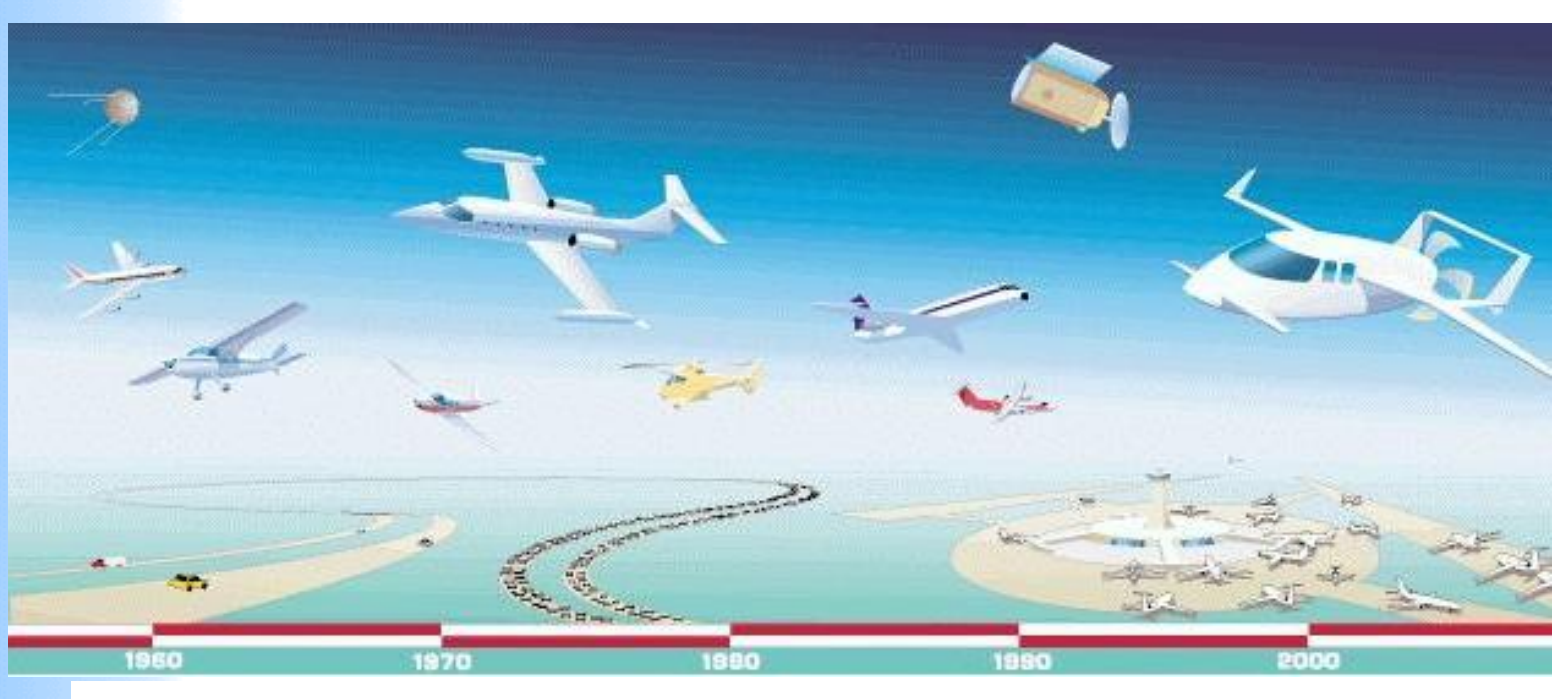


AGATE Survey Results

Age

Age Distribution

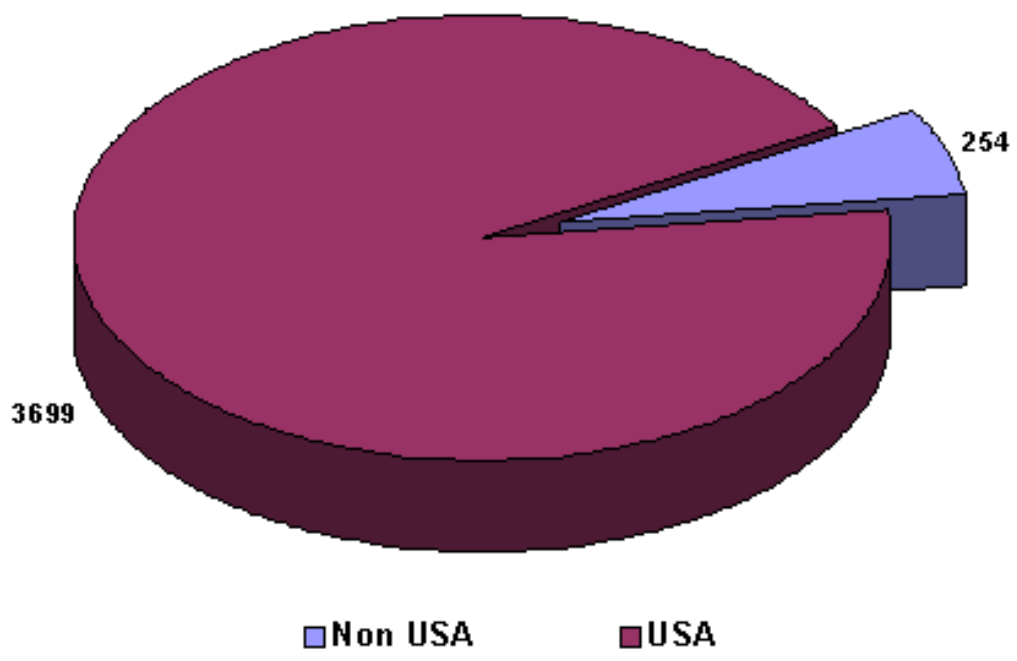


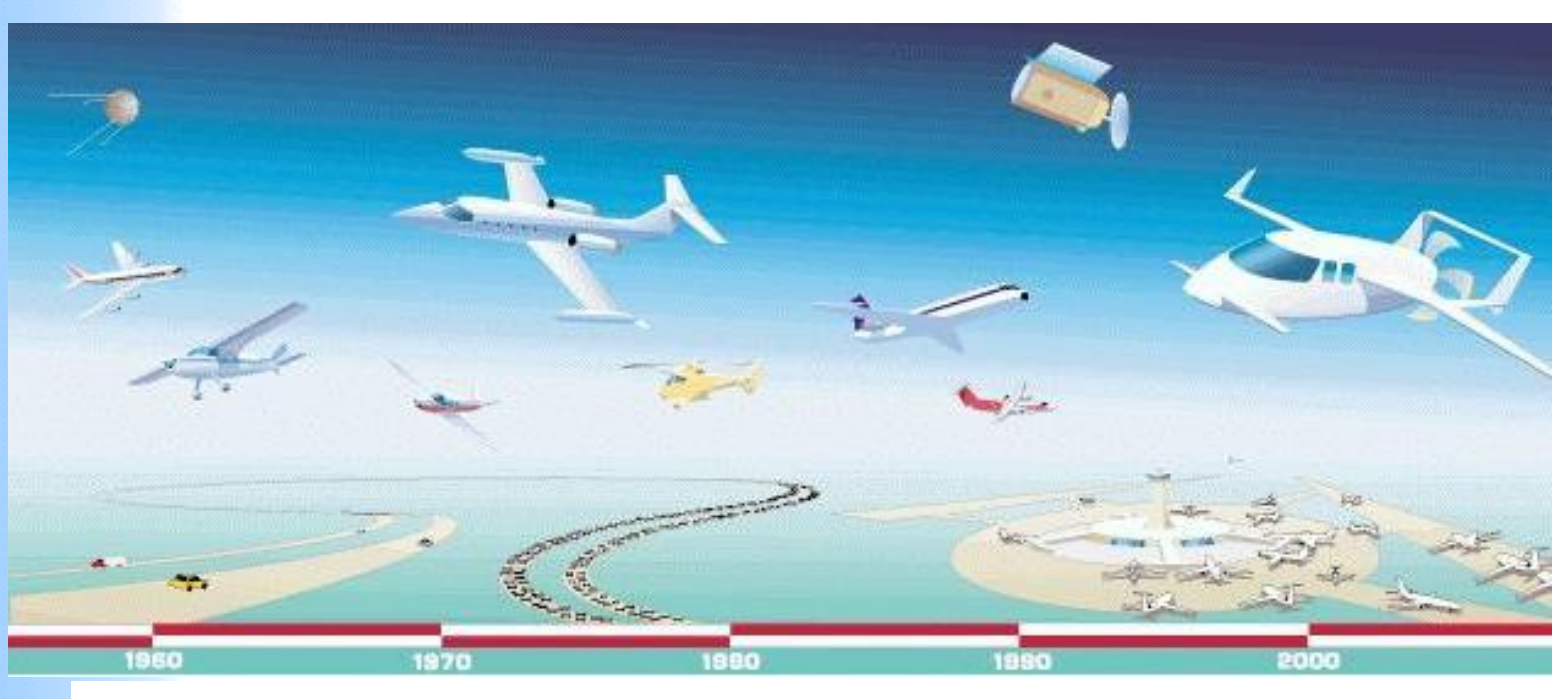


AGATE Survey Results

Gender

Country Distribution





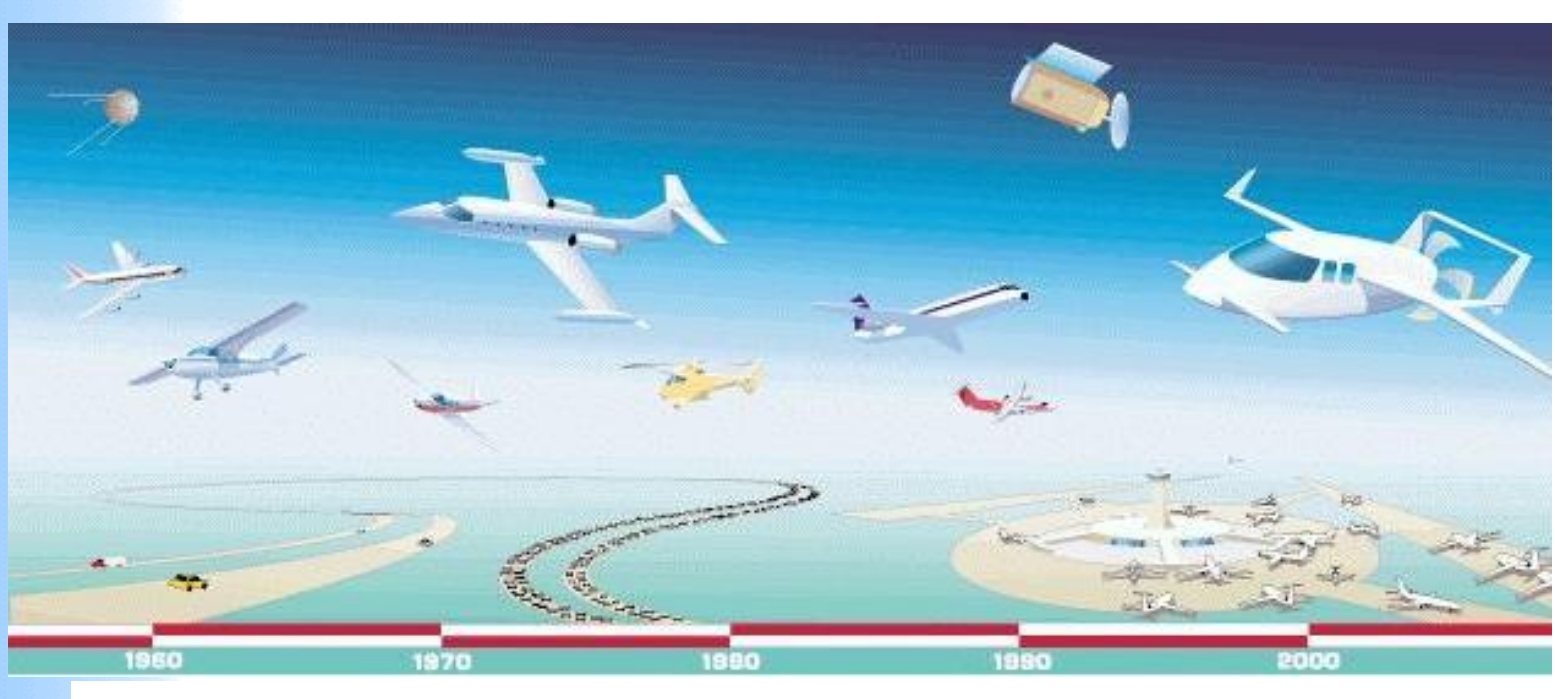
AGATE Survey Results

States

Survey Respondent Distribution by State

Alabama	37
Alaska	28
Arizona	83
Arkansas	26
California	507
Colorado	111
Connecticut	43
Delaware	11
District of Columbia	4
Florida	211
Georgia	99
Hawaii	5
Idaho	35
Illinois	116
Indiana	66
Iowa	35
Kansas	81
Kentucky	39
Louisiana	32
Maine	14
Maryland	93
Massachusetts	101
Michigan	116
Minnesota	83
Mississippi	12
Missouri	63

Montana	7
Nebraska	23
Nevada	25
New Hampshire	28
New Jersey	105
New Mexico	36
New York	114
North Carolina	79
North Dakota	15
Ohio	124
Oklahoma	65
Oregon	65
Pennsylvania	111
Rhode Island	8
South Carolina	27
South Dakota	8
Tennessee	44
Texas	296
Utah	28
Vermont	10
Virginia	169
Washington	142
West Virginia	10
Wisconsin	68
Wyoming	14



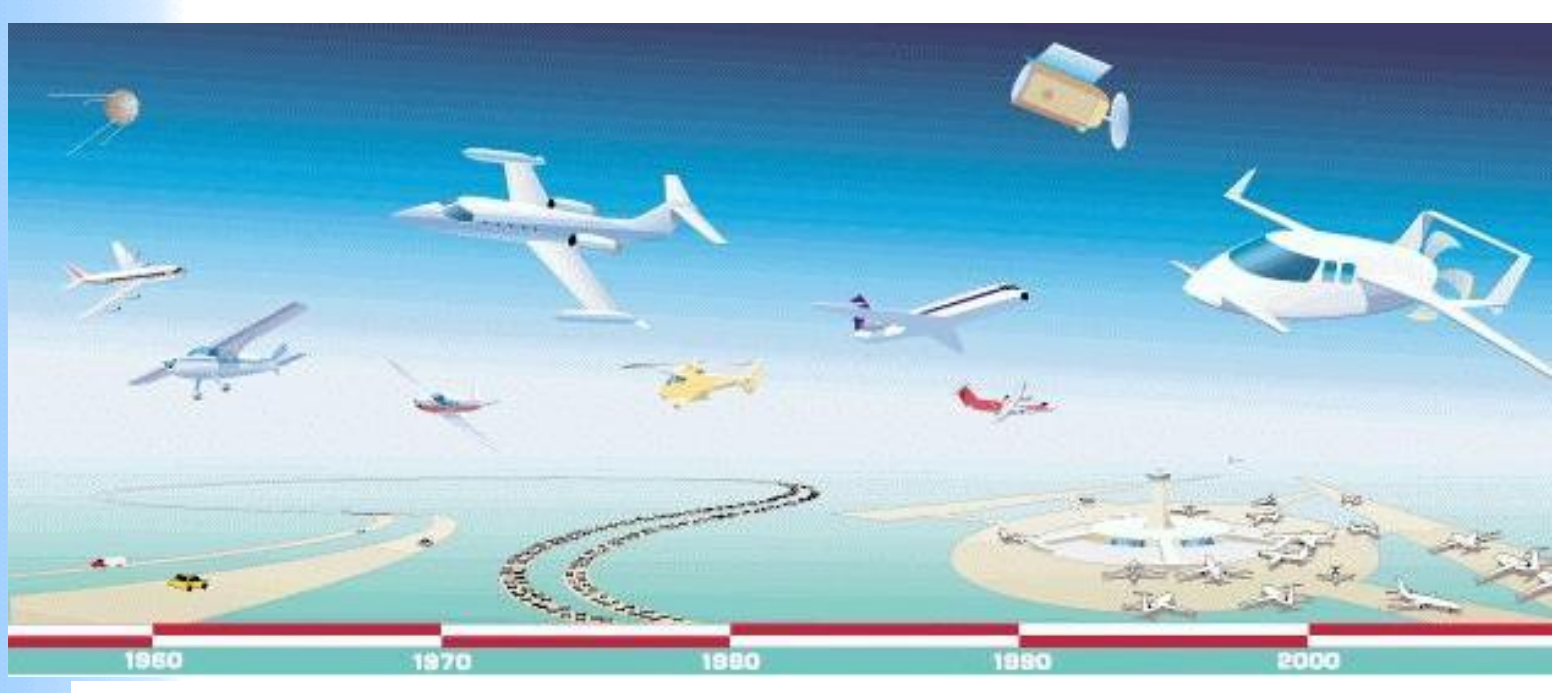
AGATE Survey Results

Country

Survey Respondent Distribution by Country

CANADA	72
OTHER	22
AUSTRALIA	21
GERMANY	13
SWITZERLAND	12
ITALY	9
NETHERLANDS	9
NEW ZEALAND	6
SWEDEN	5
ARGENTINA	4
AUSTRIA	4
CHILE	4
FRANCE	4
BELGIUM	3
BRAZIL	3
NORWAY	3
PORTUGAL	3
SINGAPORE	3
TURKEY	3
DENMARK	2
HONG KONG	2

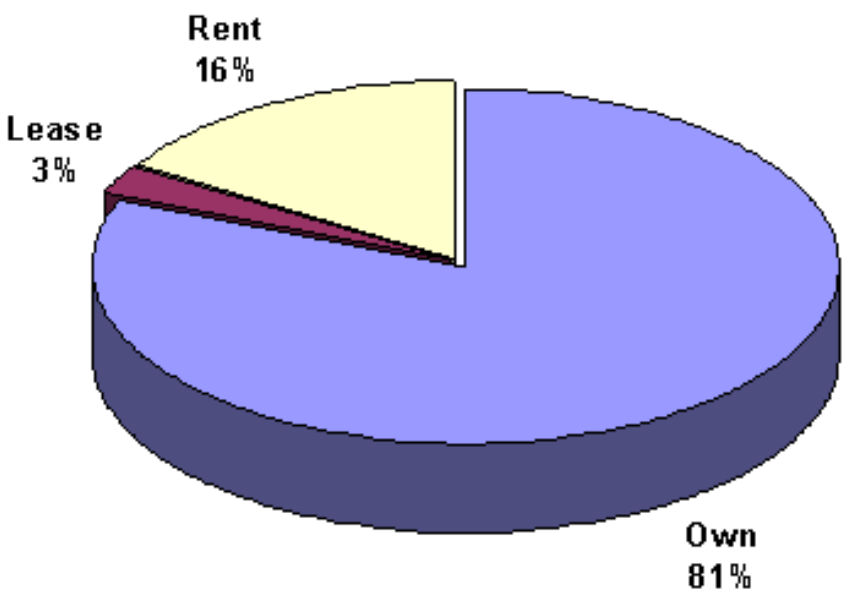
IRELAND	2
ISRAEL	2
KOREA, REPUBLIC OF	2
POLAND	2
SAUDI ARABIA	2
SOUTH AFRICA	2
BANGLADESH	1
COLOMBIA	1
ECUADOR	1
FINLAND	1
GAMBIA	1
GREECE	1
GUADELOUPE	1
JAPAN	1
MALAYSIA	1
PANAMA	1
PARAGUAY	1
RUSSIA	1
TANZANIA	1
UNITED KINGDOM	1
VENEZUELA	1
VIRGIN ISLANDS	1

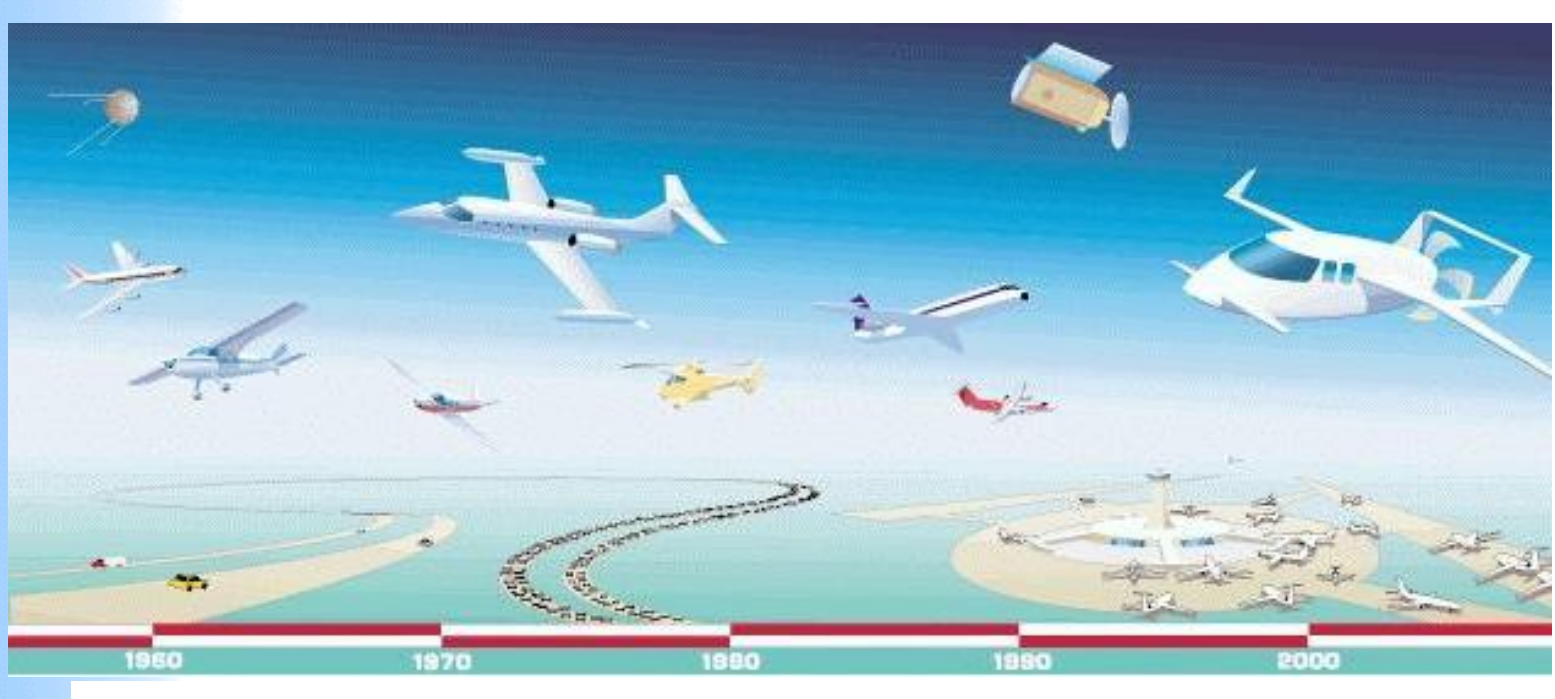


AGATE Survey Results

Domicile

Home Ownership

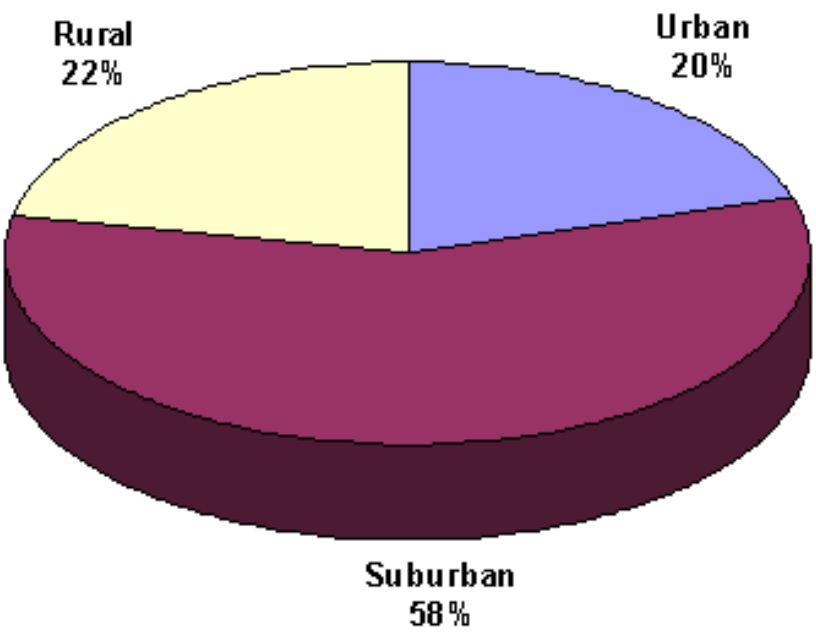


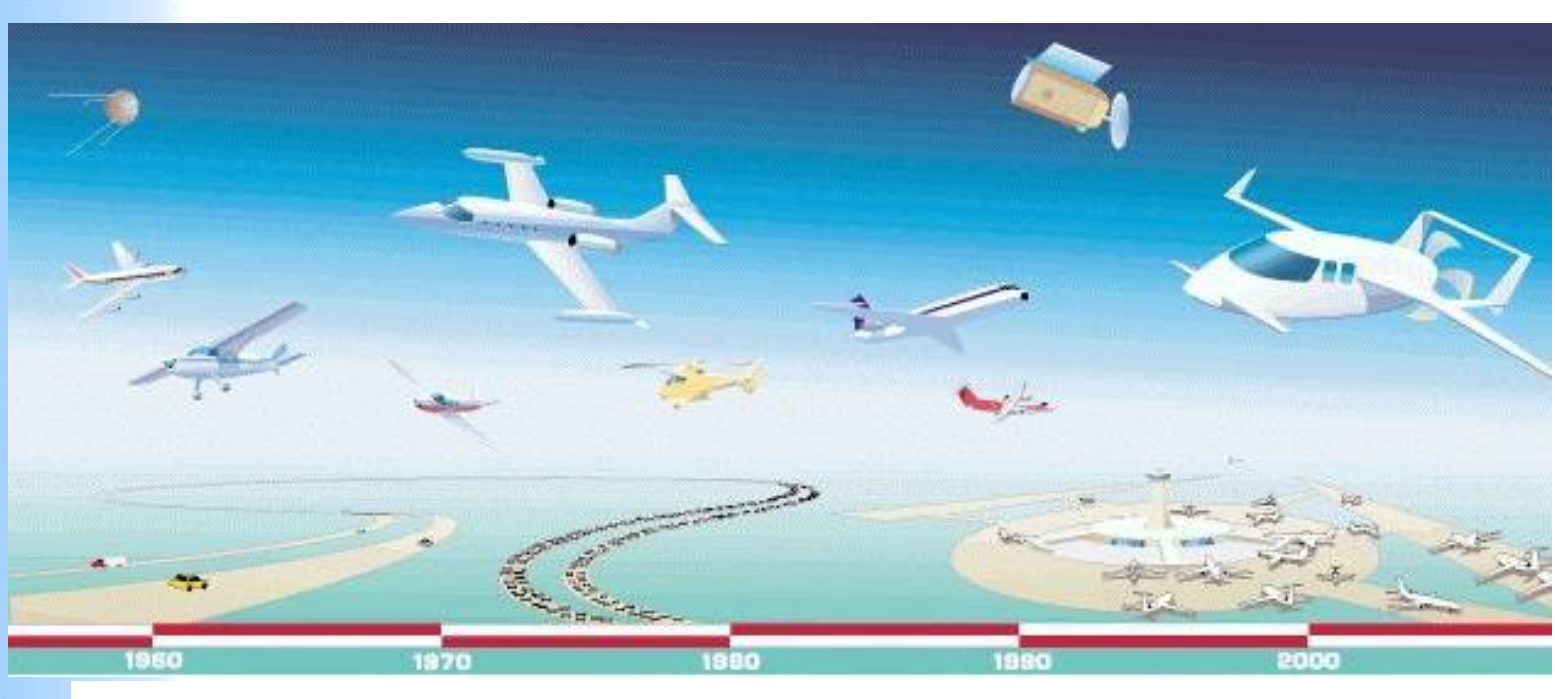


AGATE Survey Results

Location

Home Location

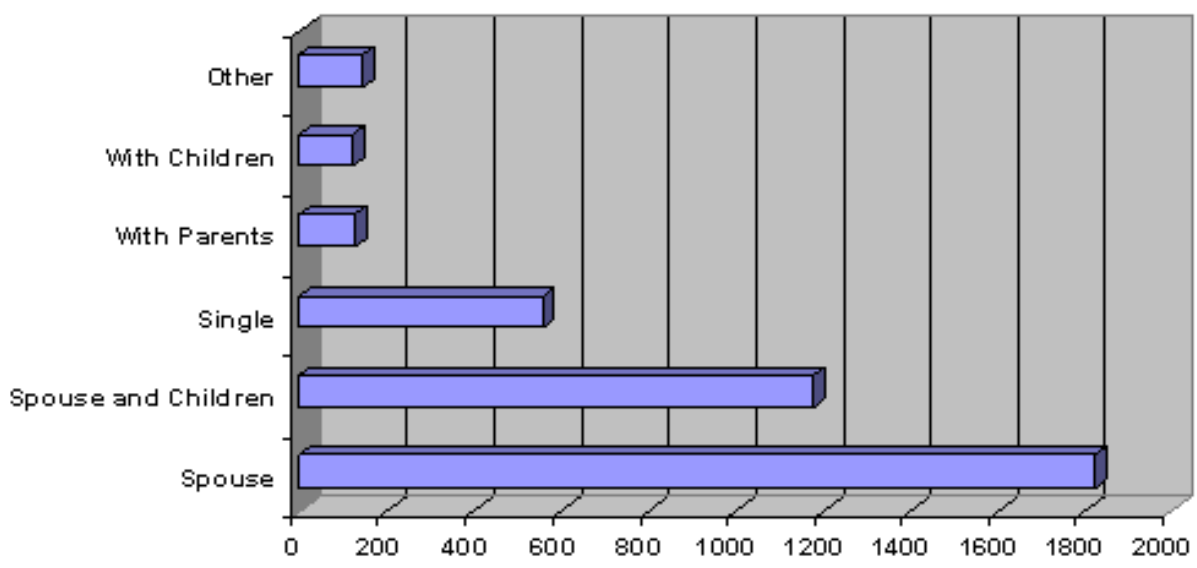


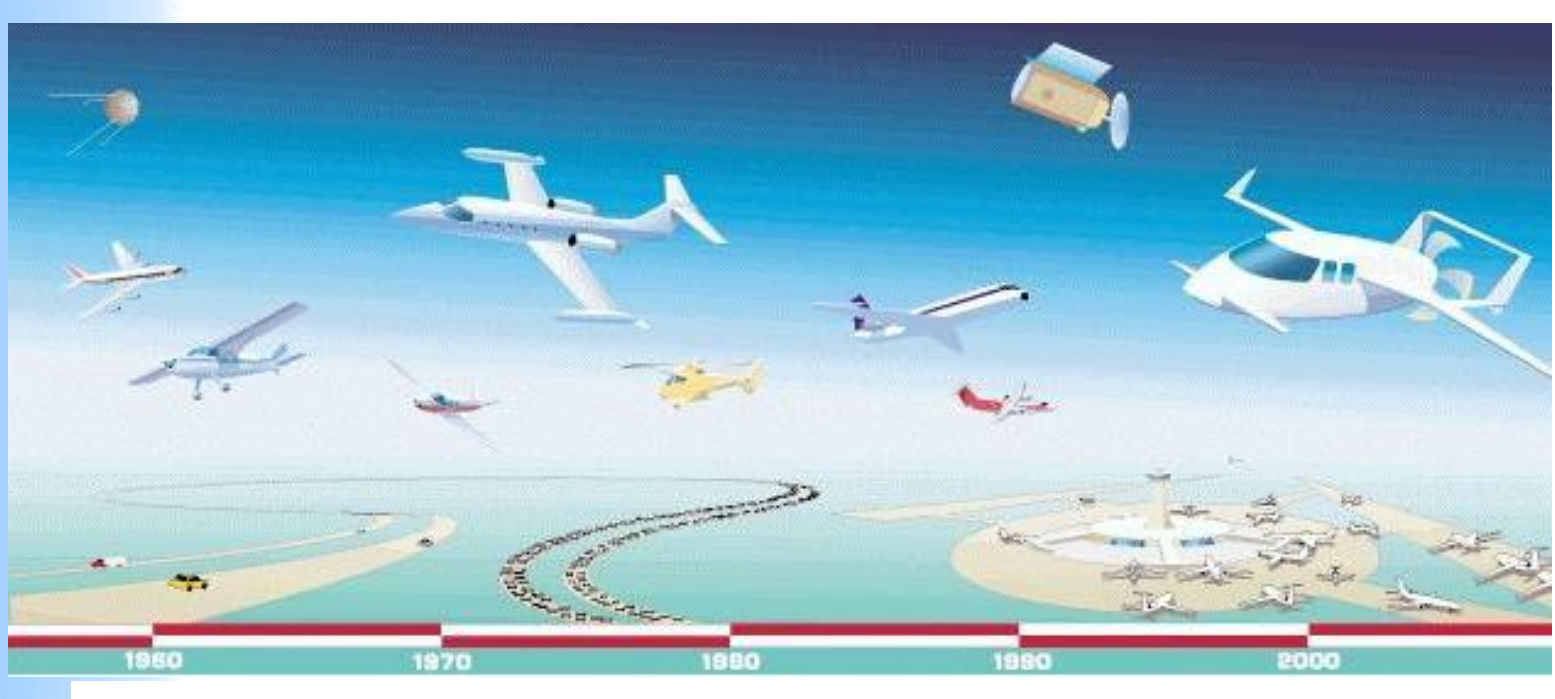


AGATE Survey Results

Living Arrangement

Respondent Lives With

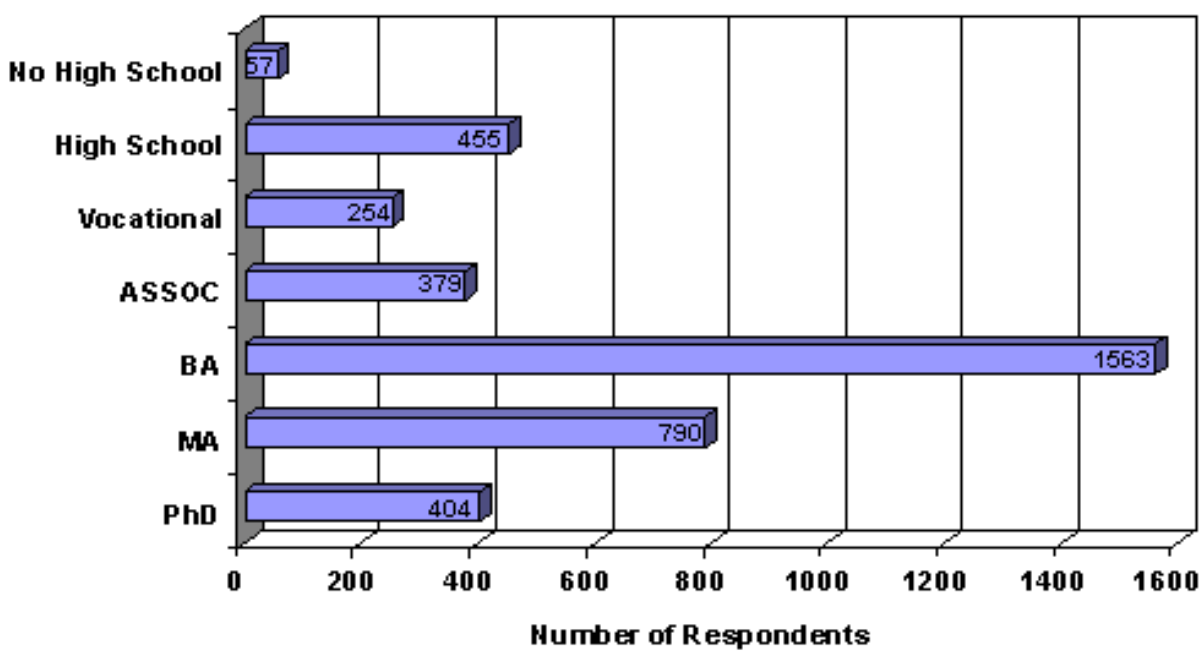


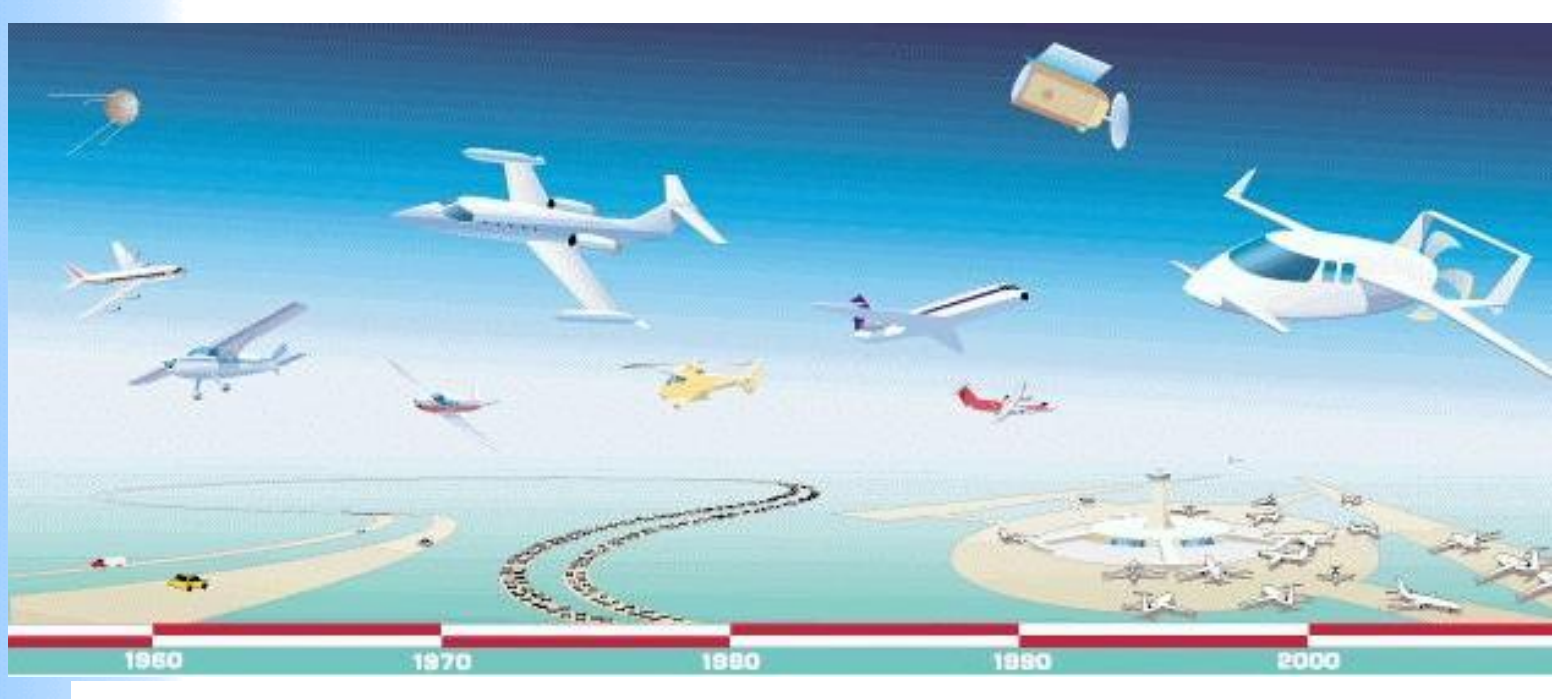


AGATE Survey Results

Education

Education Distribution

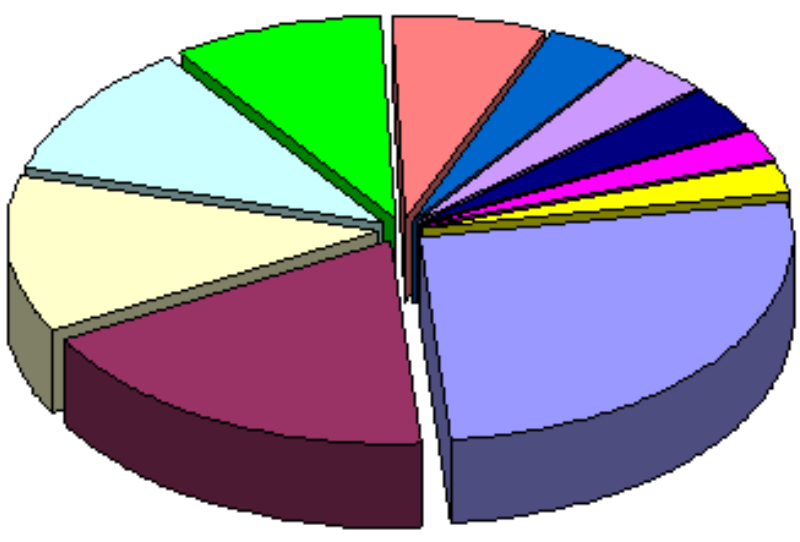


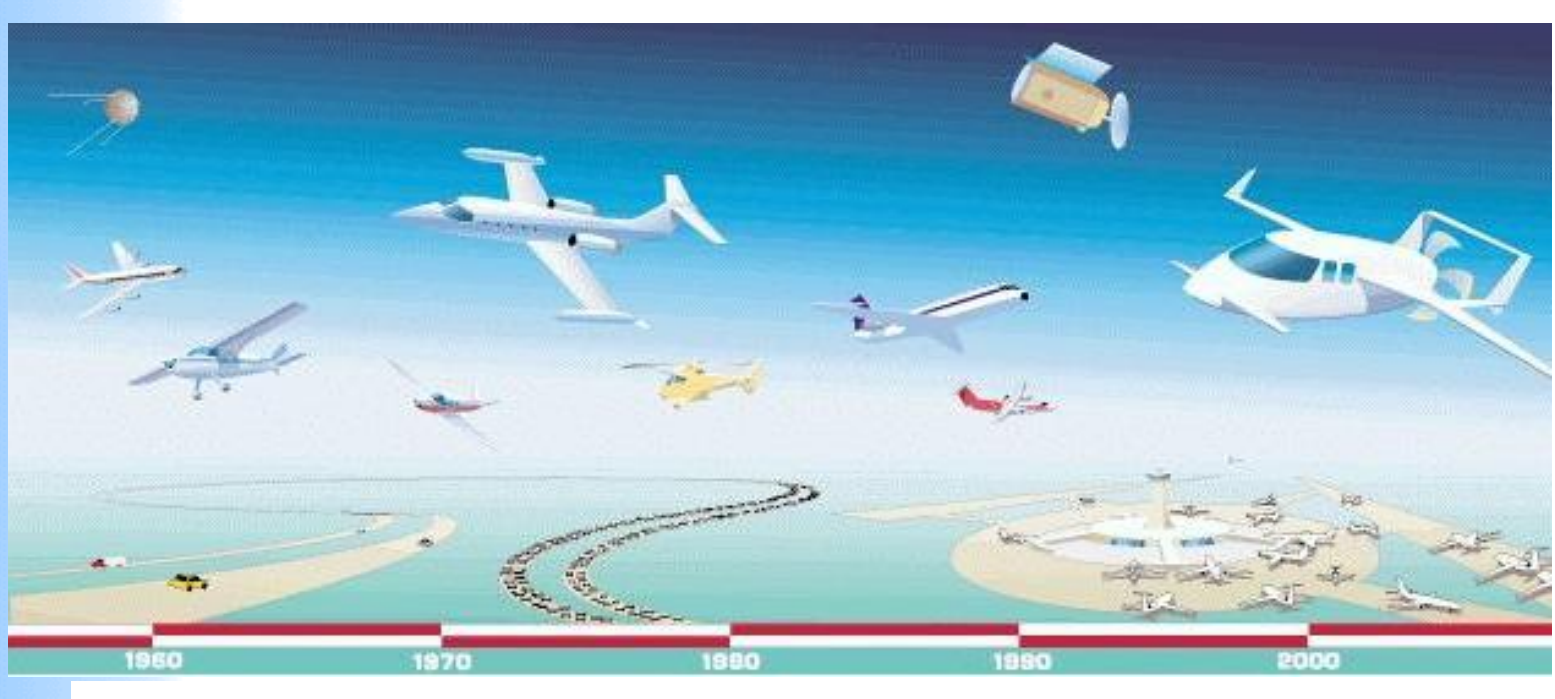


AGATE Survey Results

Occupation

Occupation Distribution

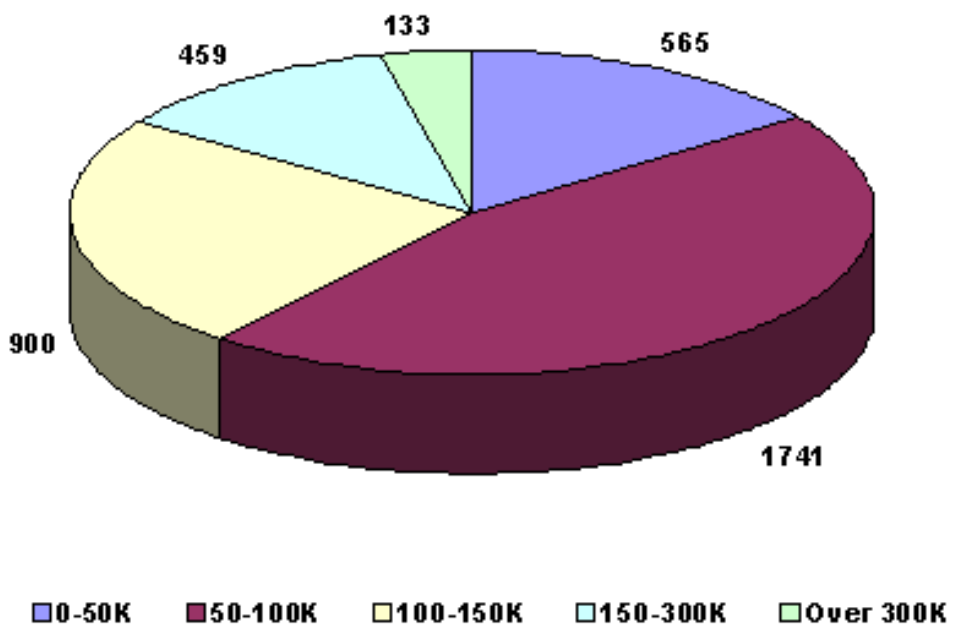


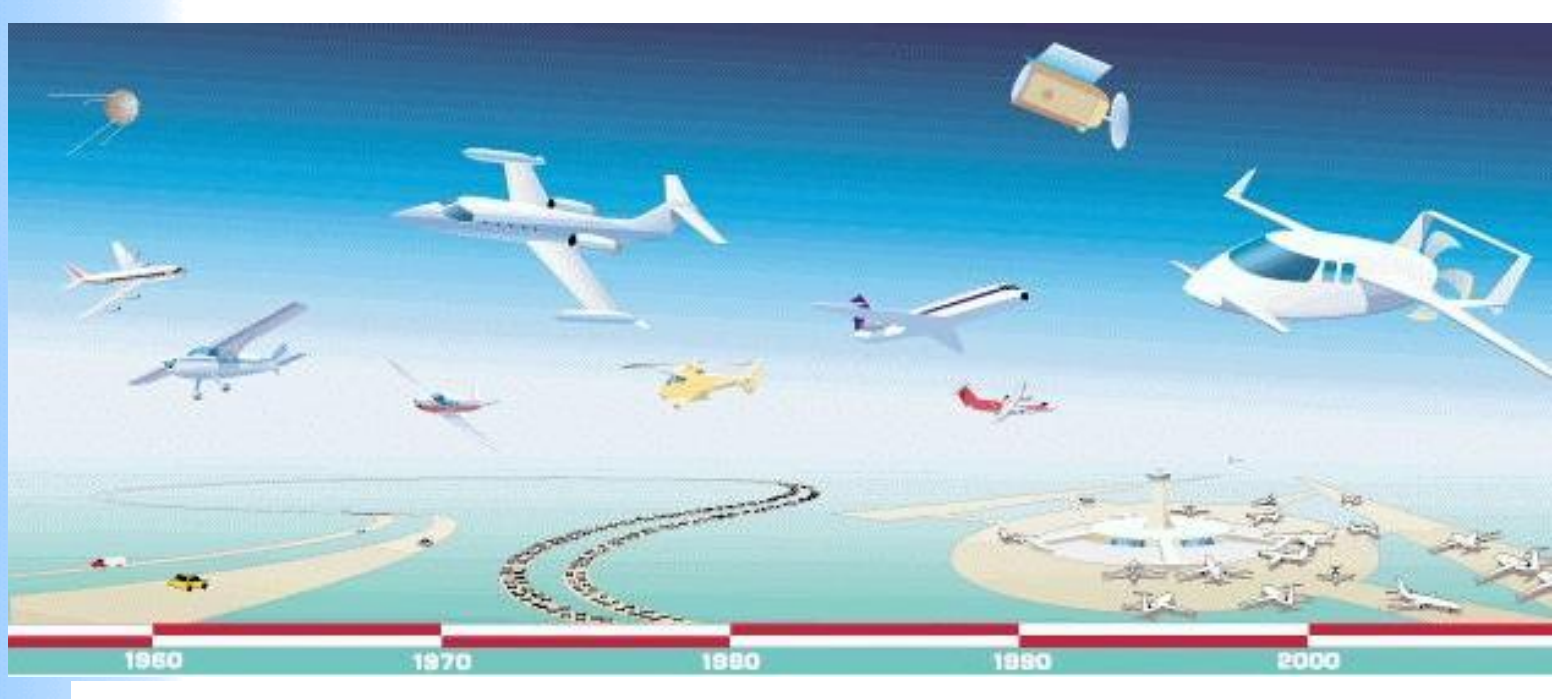


AGATE Survey Results

Income

Income Distribution

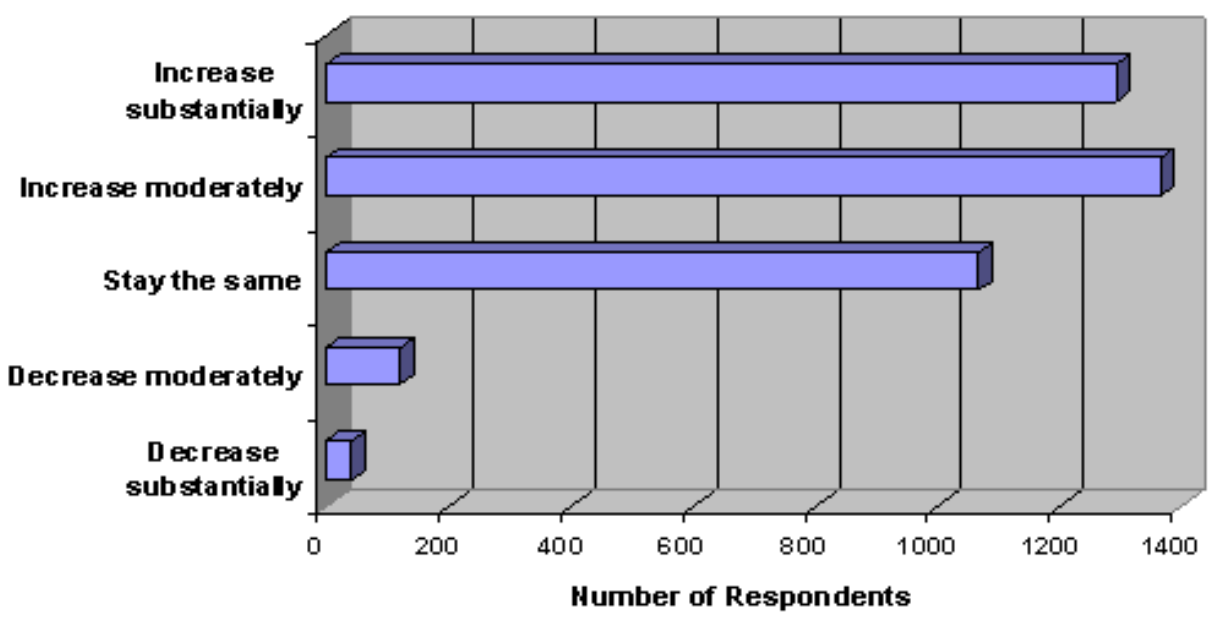


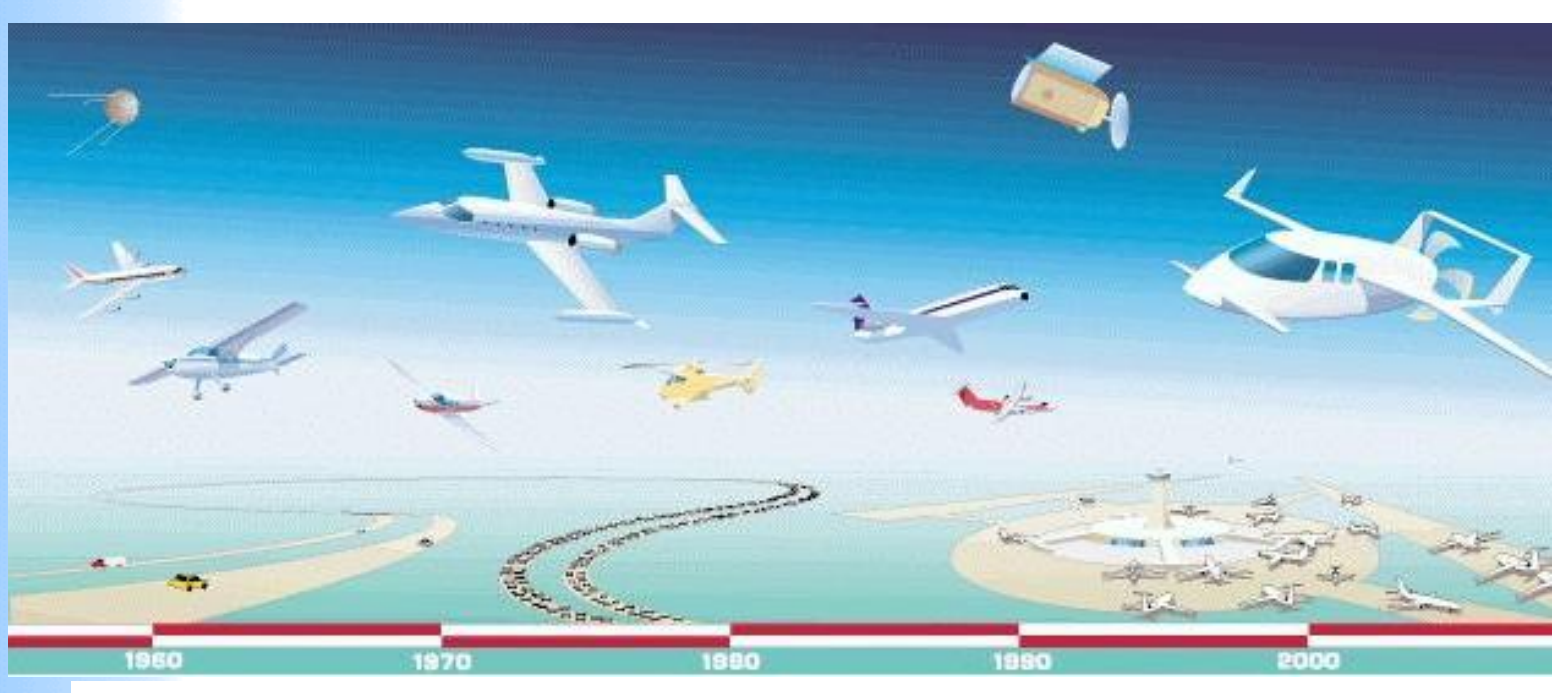


AGATE Survey Results

Income Expectations

Family Income 5 Year Expectation

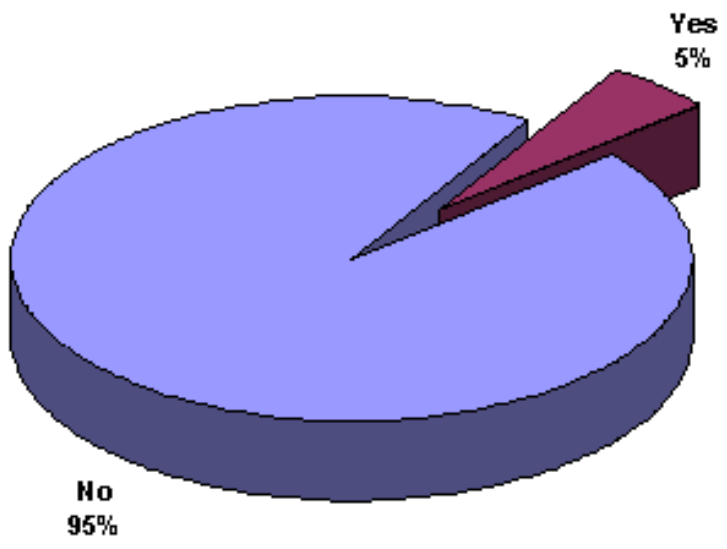


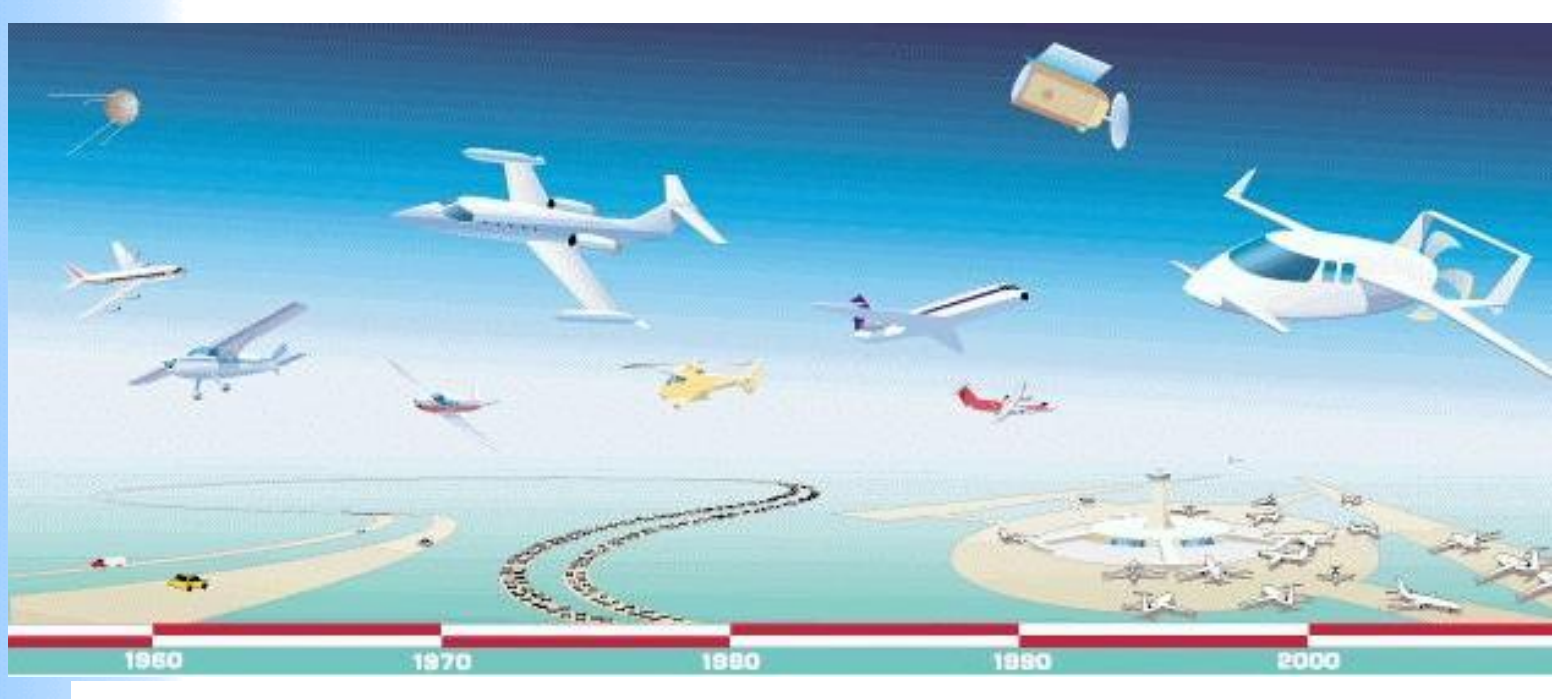


AGATE Survey Results

Learning How to Fly

Want Information on Learning How to Fly

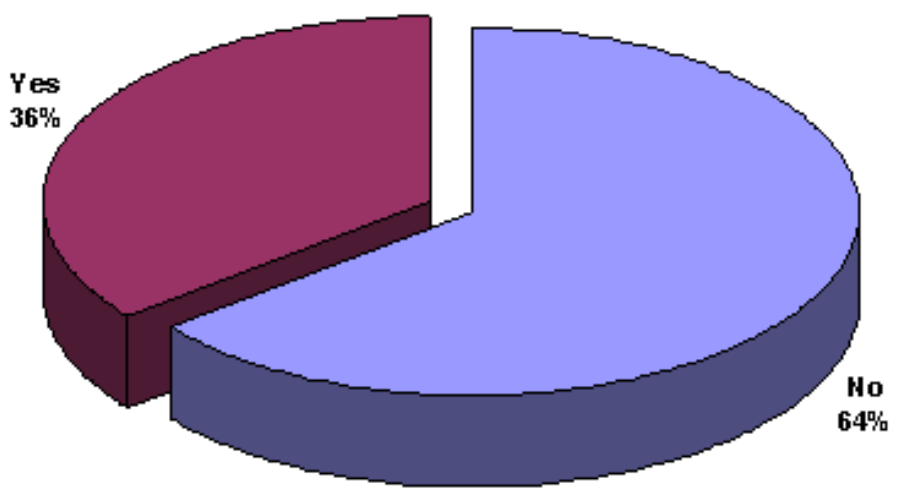


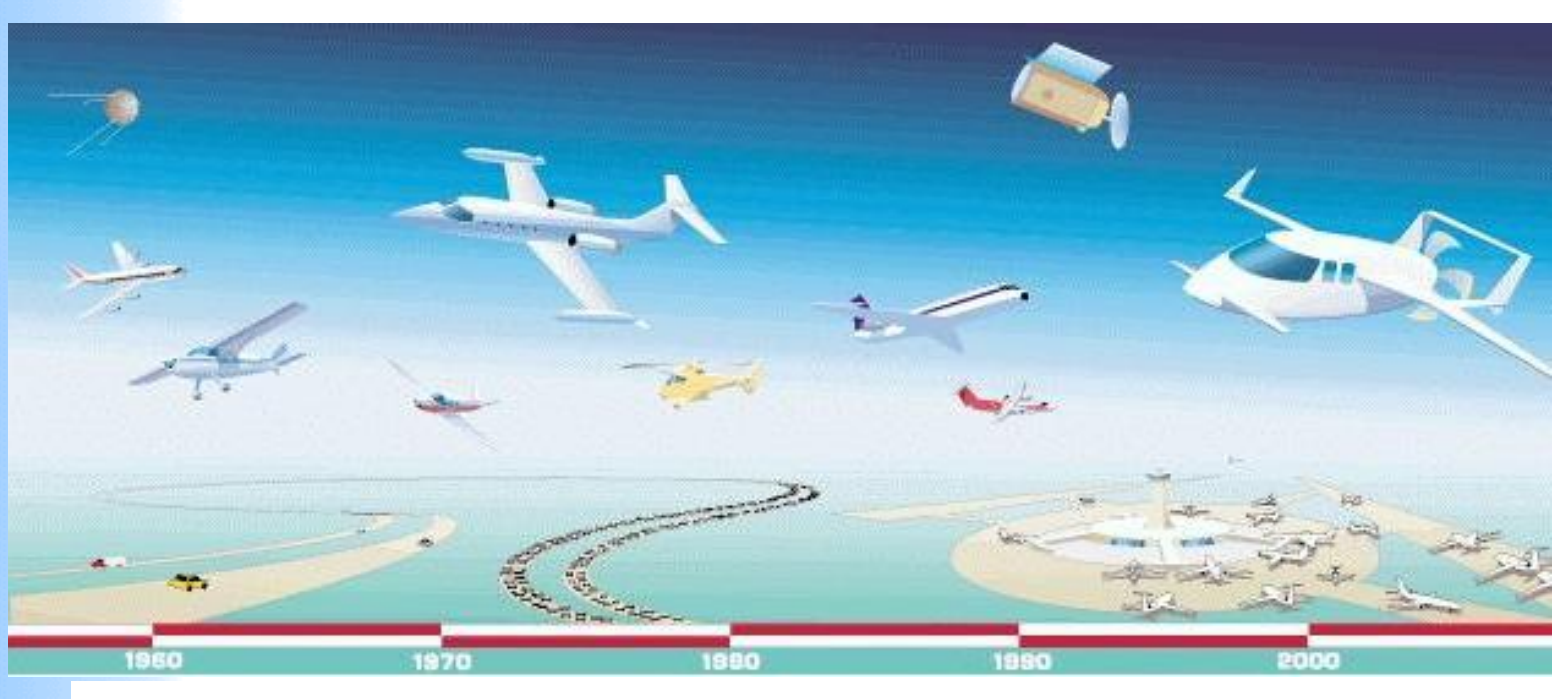


AGATE Survey Results

Information on Purchasing

Want Information on Purchasing an Airplane

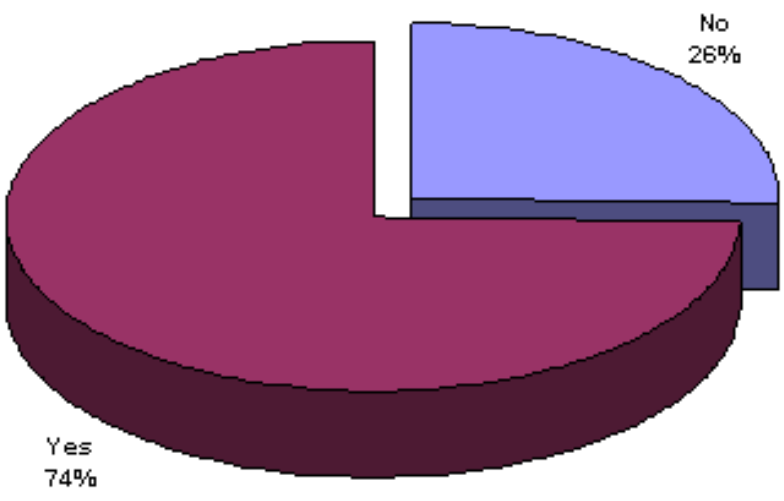


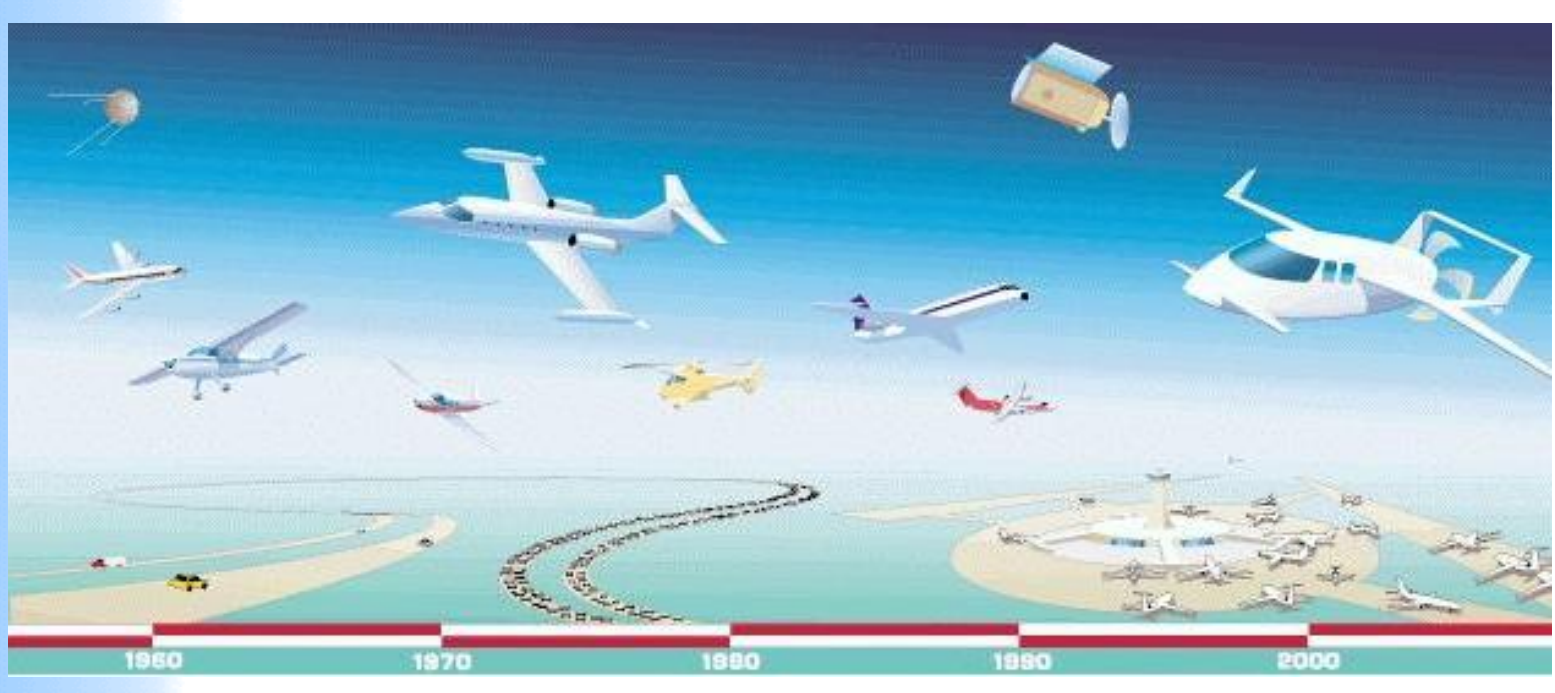


AGATE Survey Results

eMail Address Response

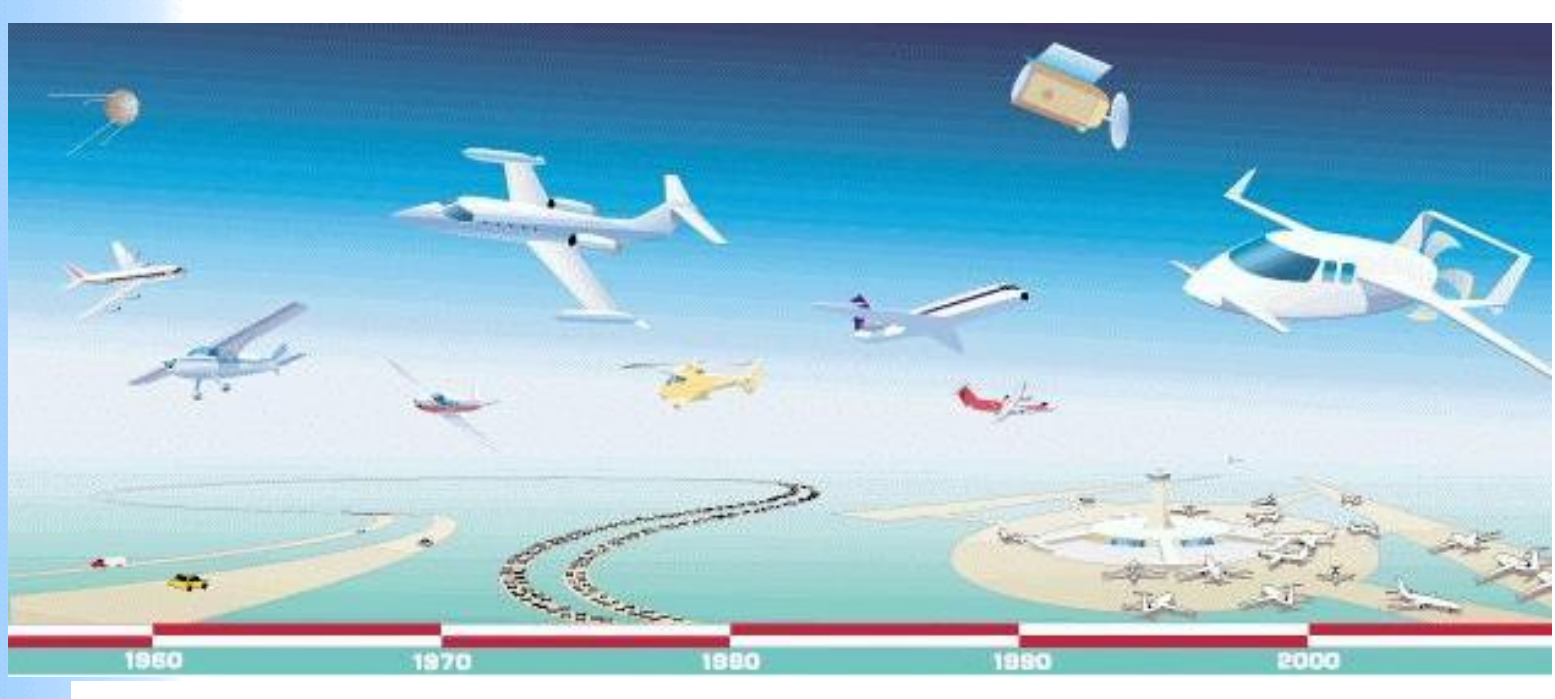
Provided eMail Address





AGATE Survey Results

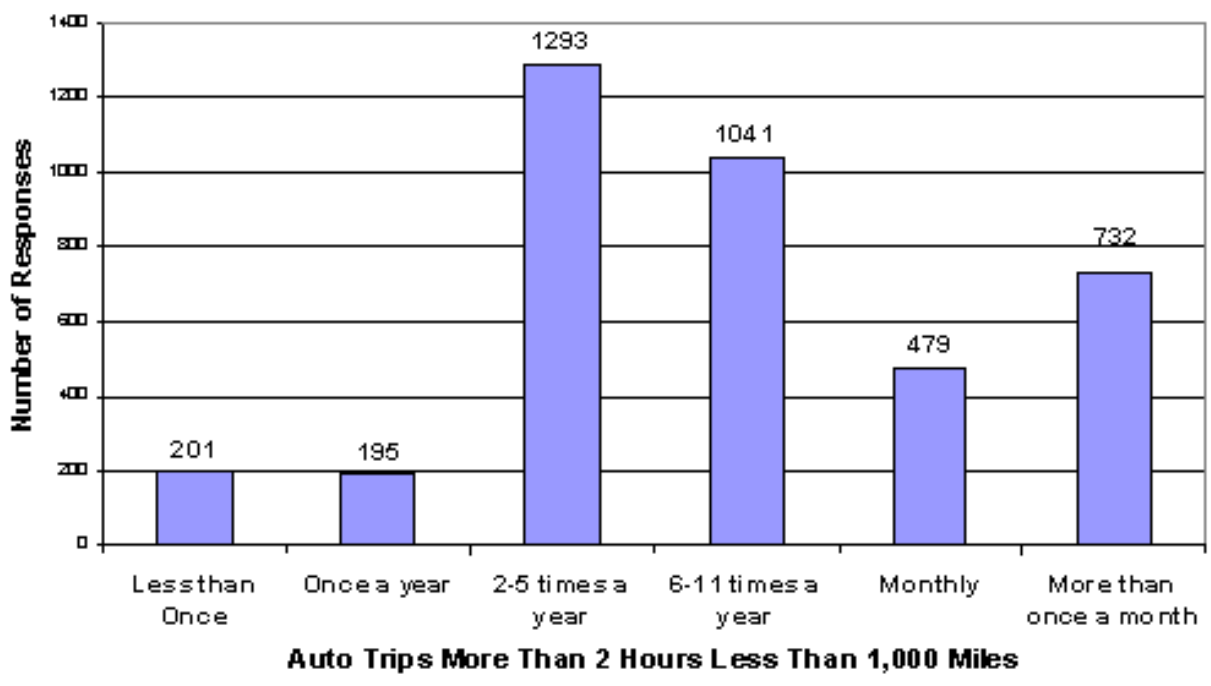
Travel Information

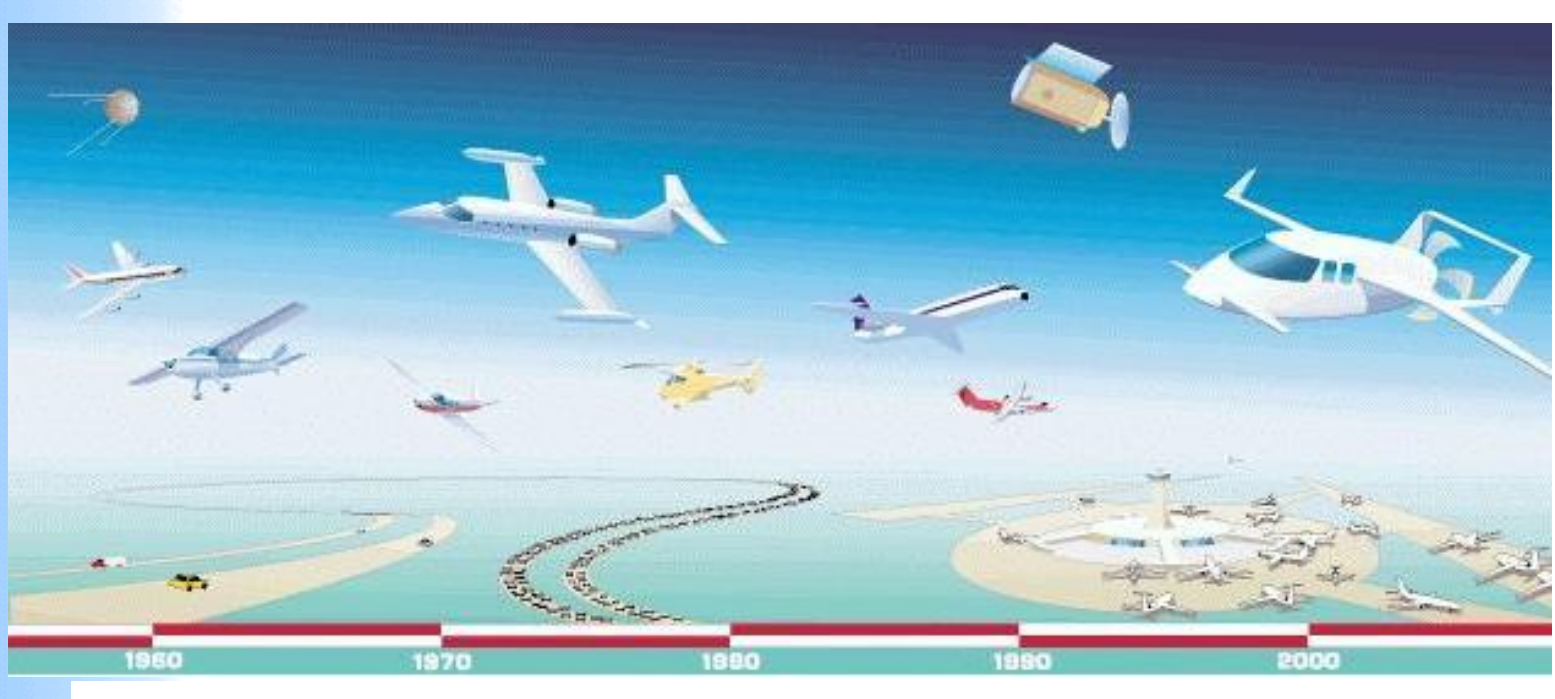


AGATE Survey Results

Number of Trips

Travel Frequency

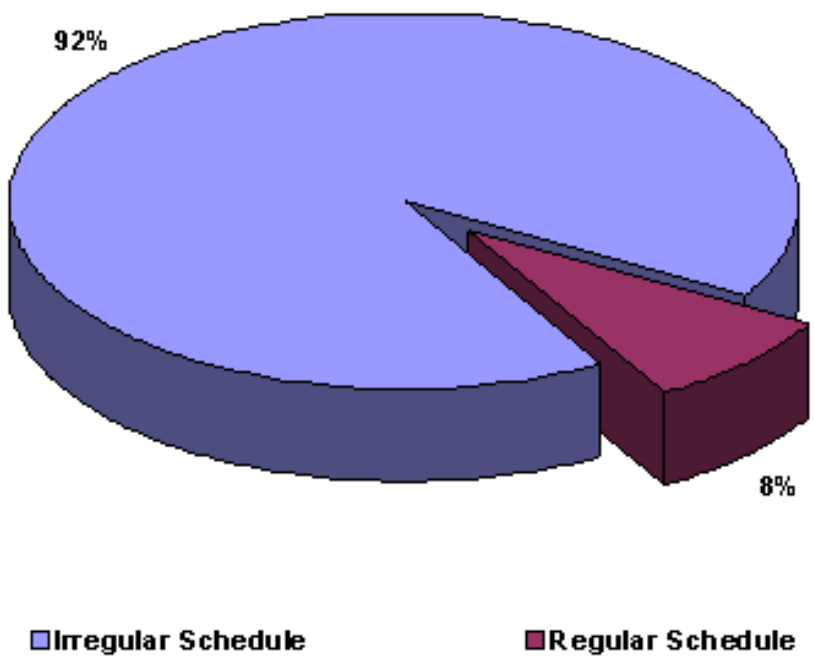


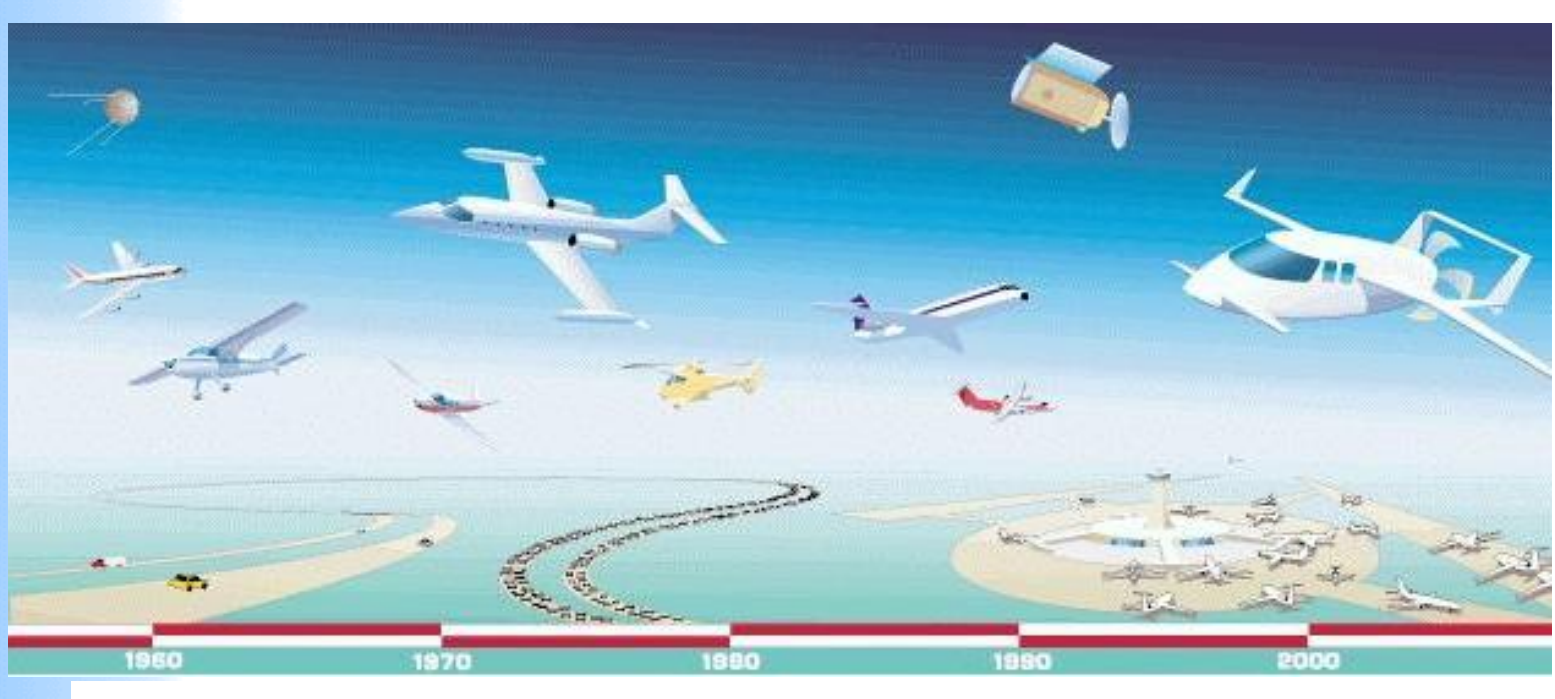


AGATE Survey Results

Type of Travel

Travel Schedule

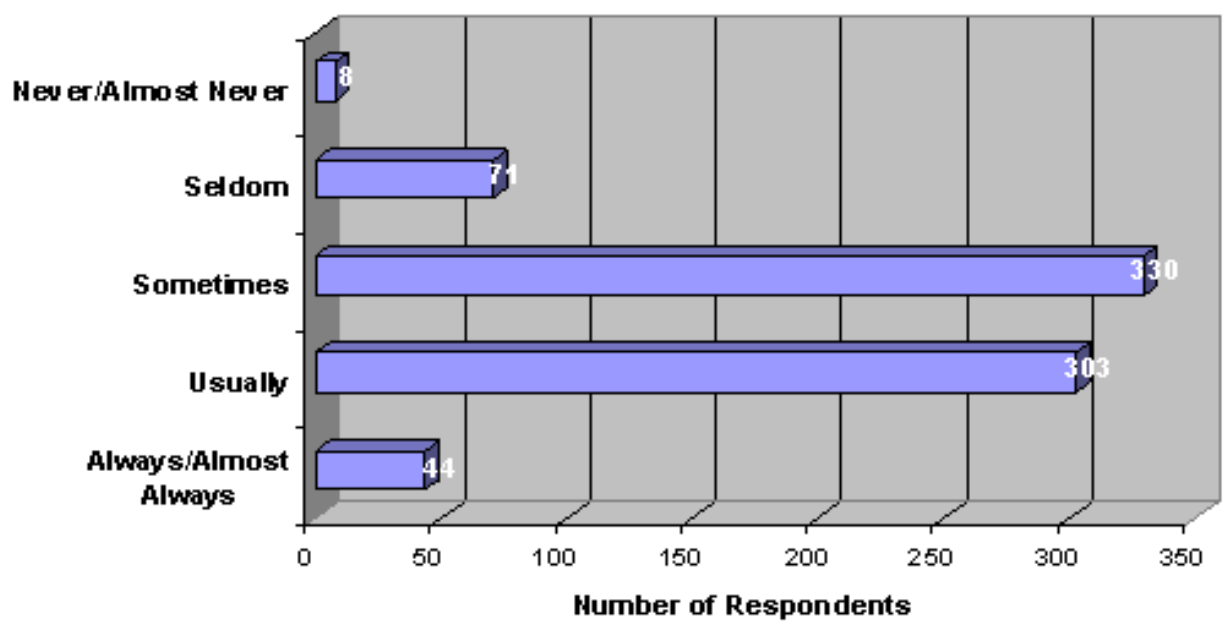


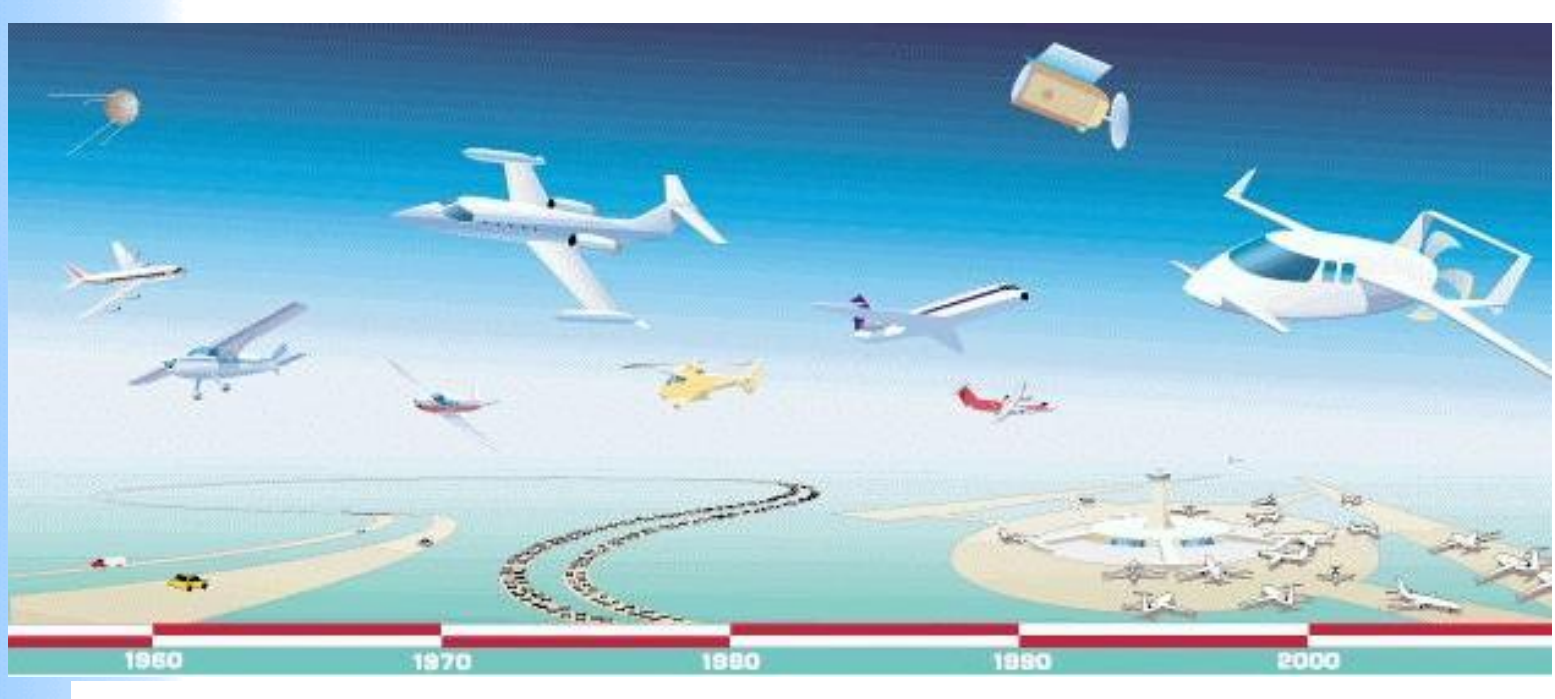


AGATE Survey Results

Destinations

Travel To Same Destination

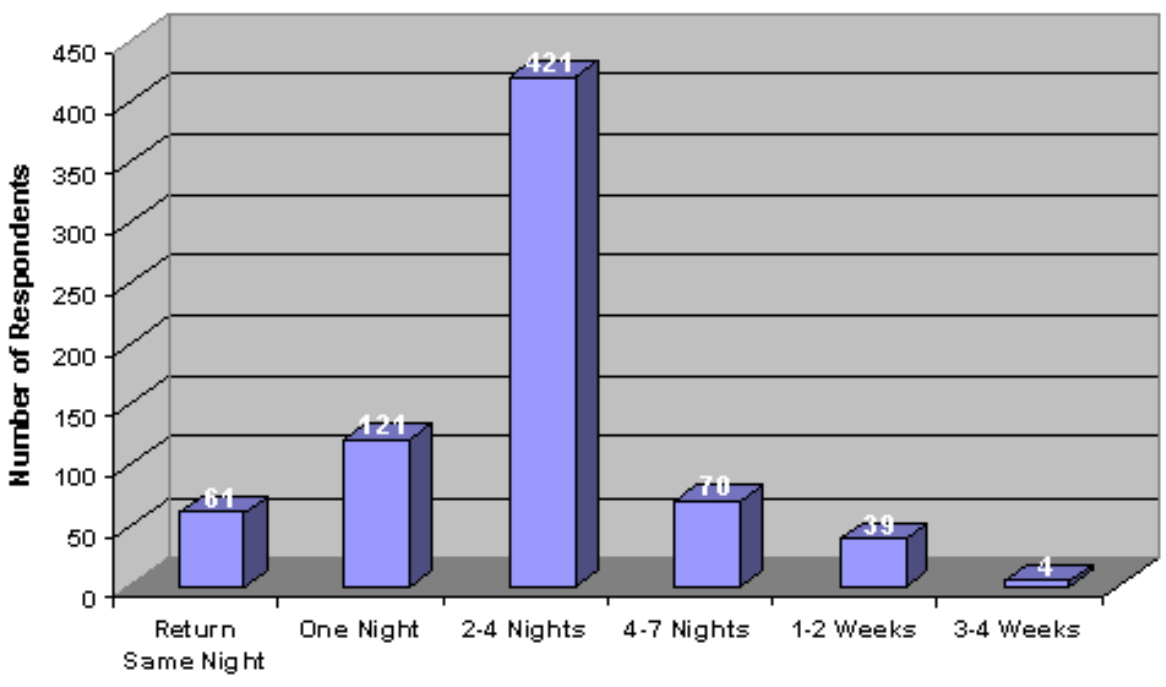


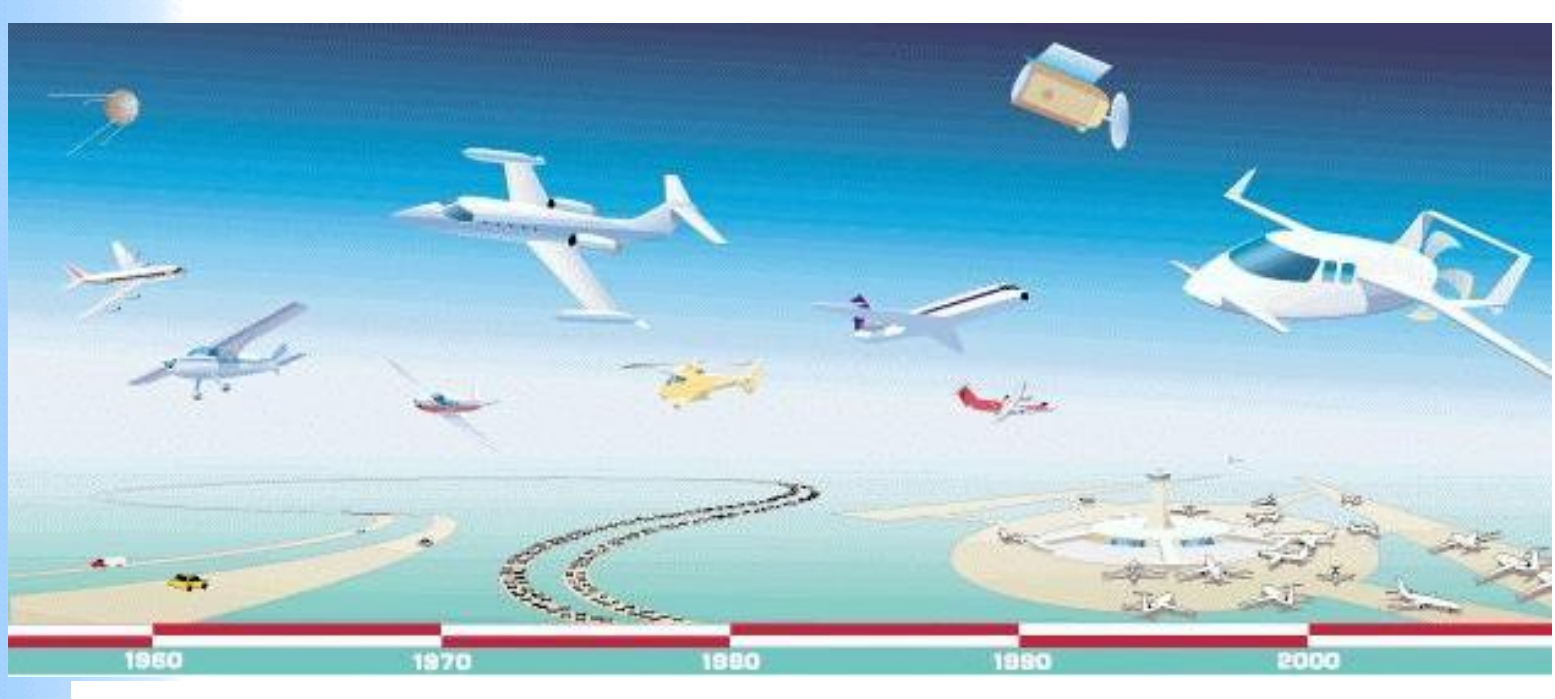


AGATE Survey Results

Days Away

Time Usually Away on a Trip

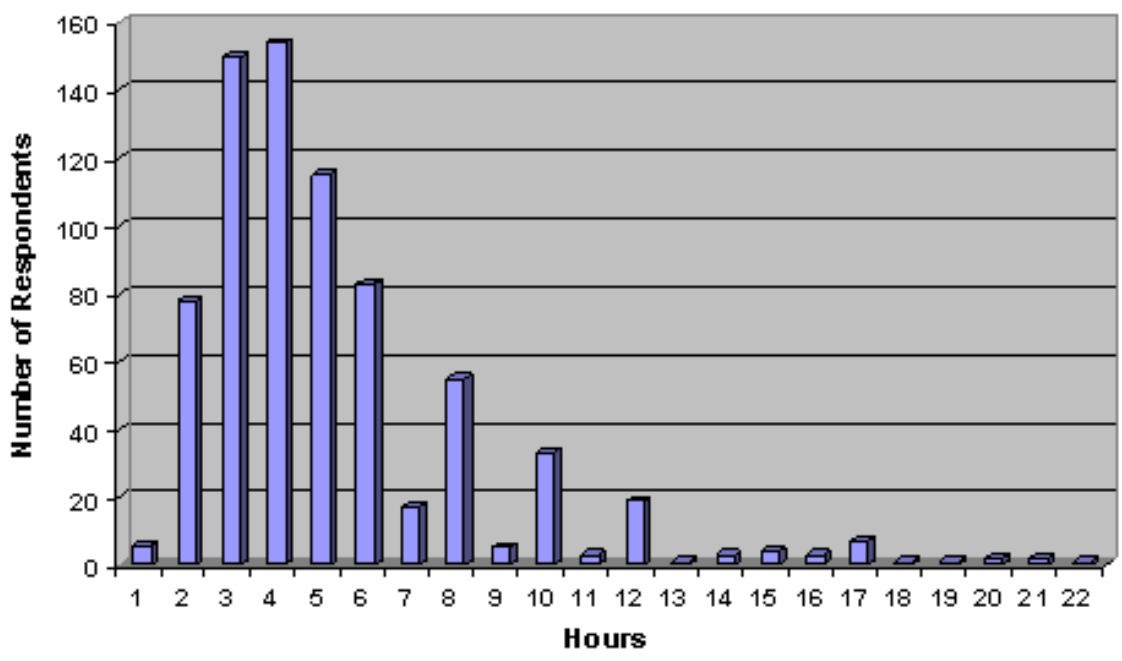


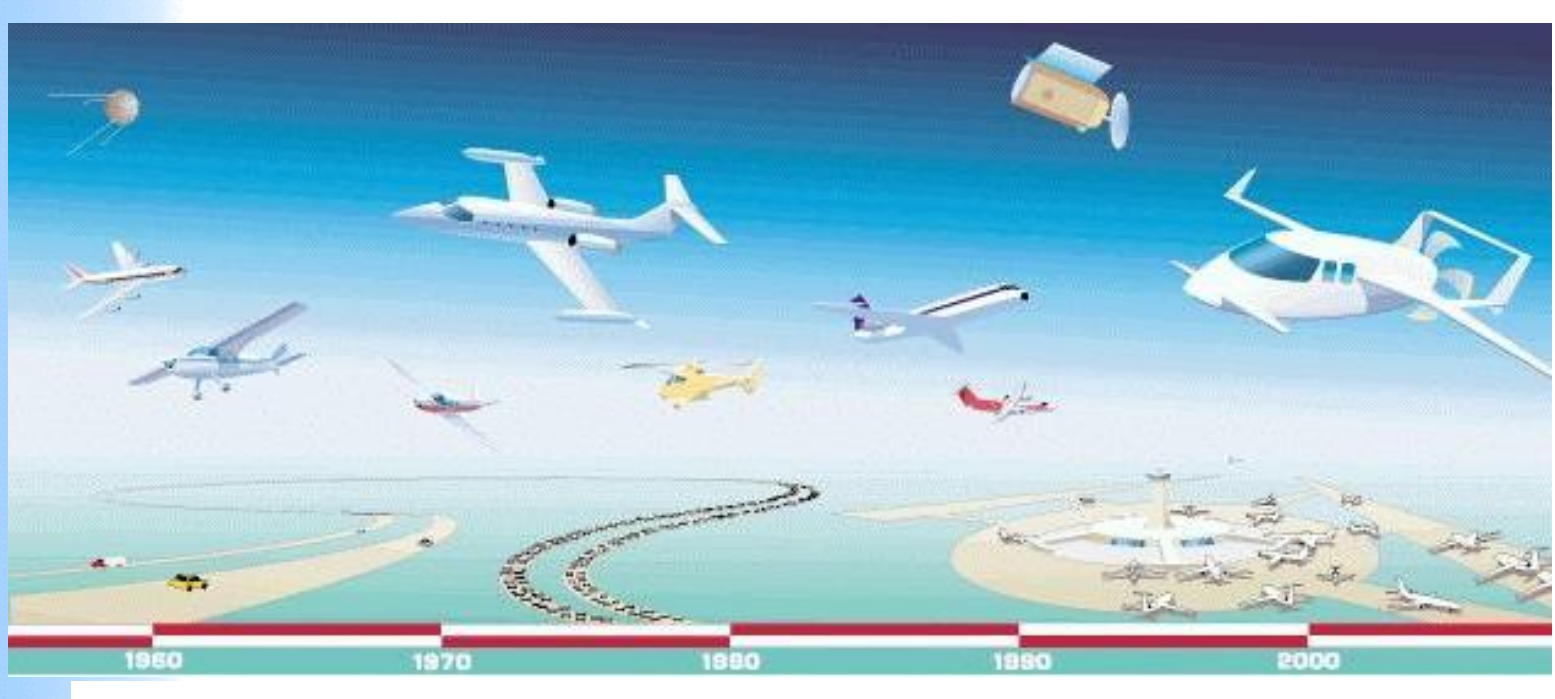


AGATE Survey Results

Travel Time

Hours Spent Traveling per Trip

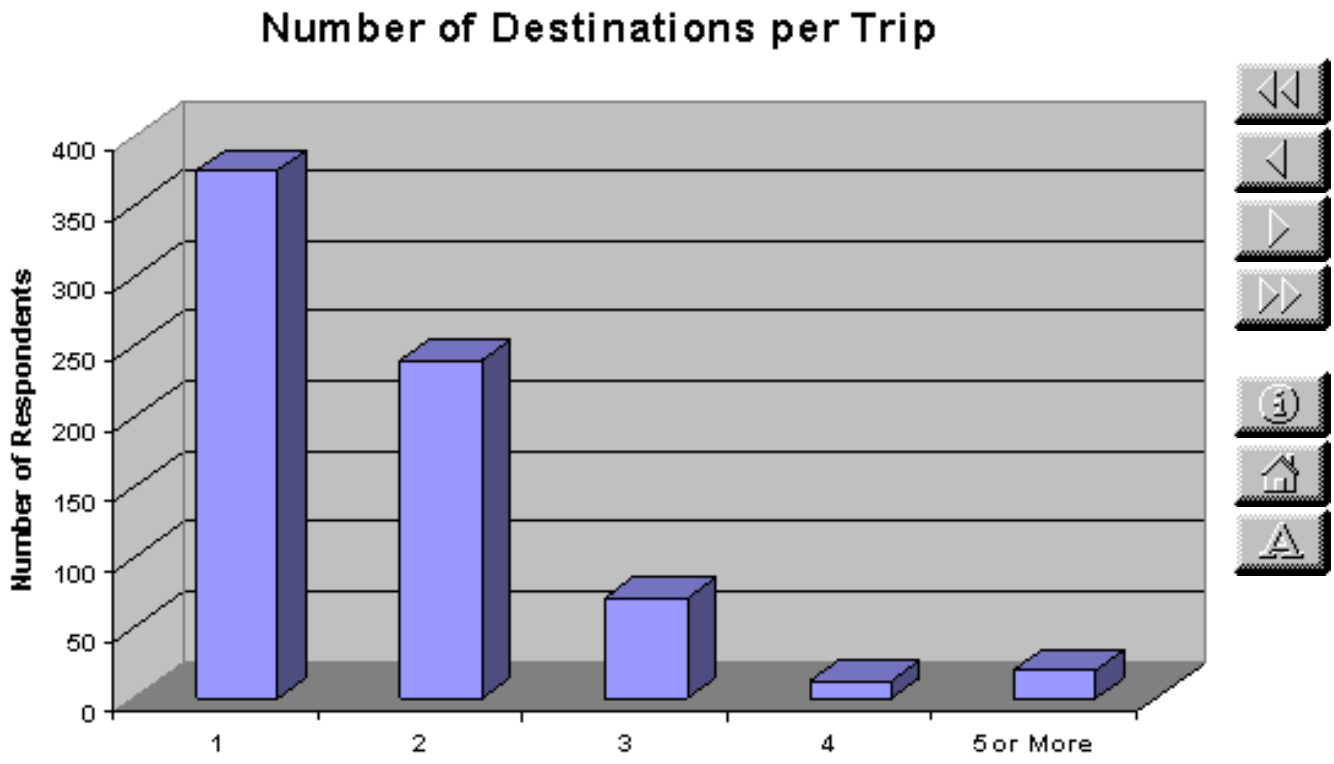


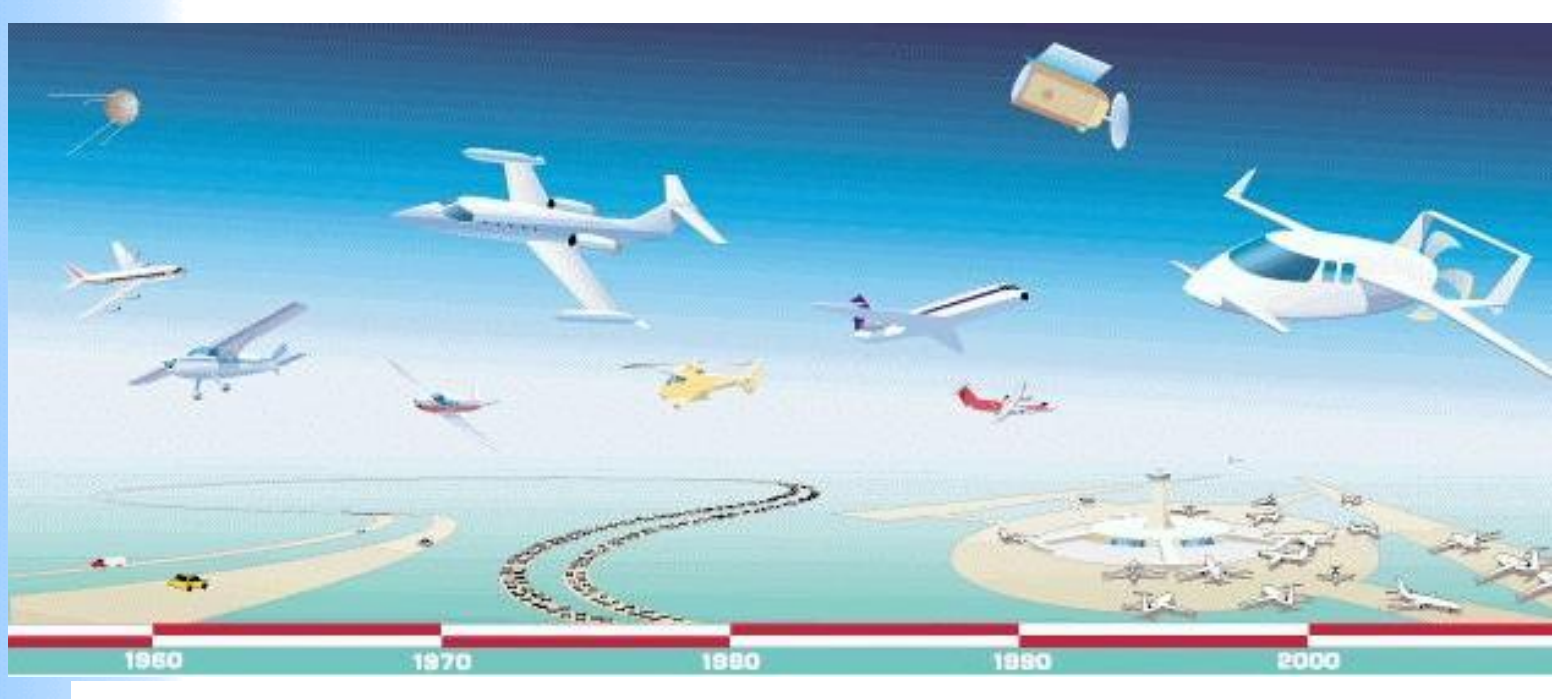


AGATE Survey Results

Number of Destinations

Number of Destinations per Trip



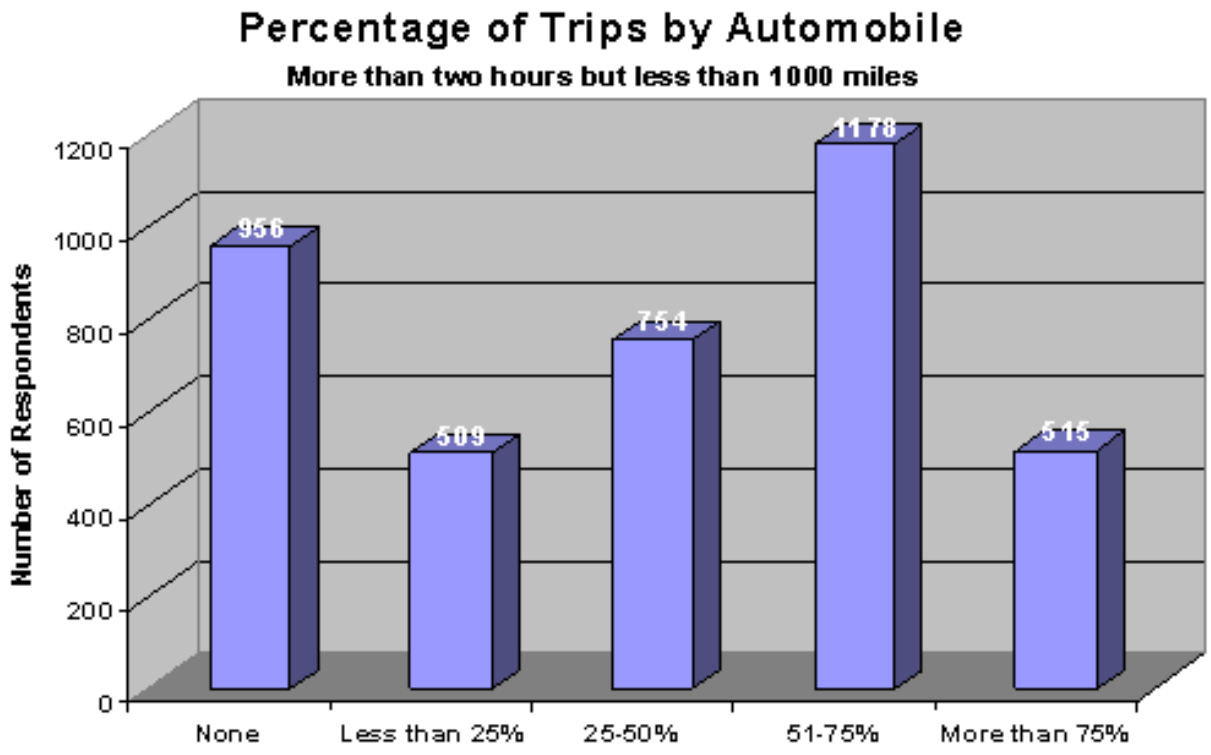


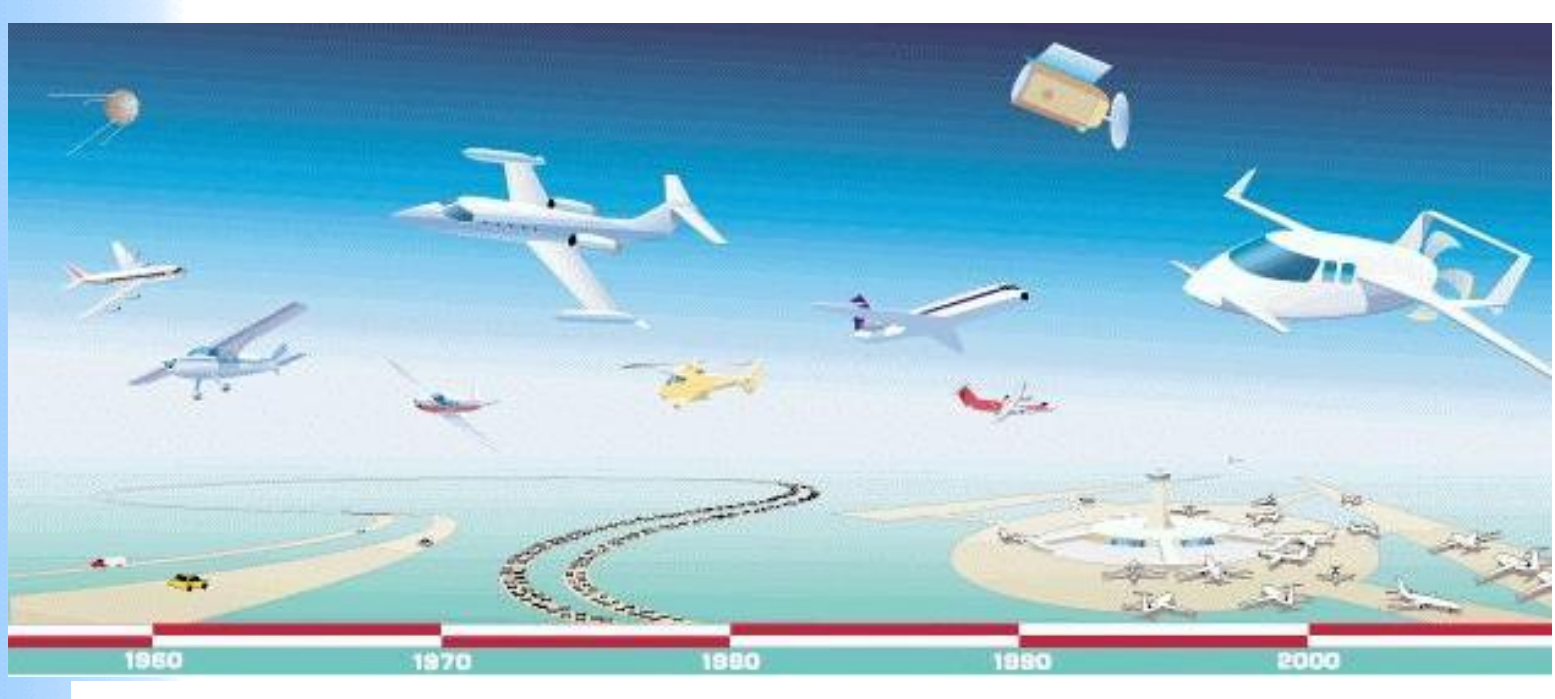
AGATE Survey Results

Automobile Trips

Percentage of Trips by Automobile

More than two hours but less than 1000 miles



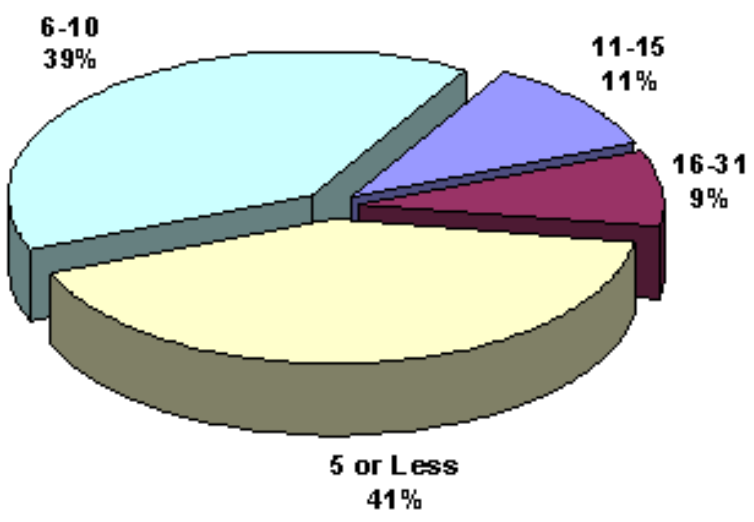


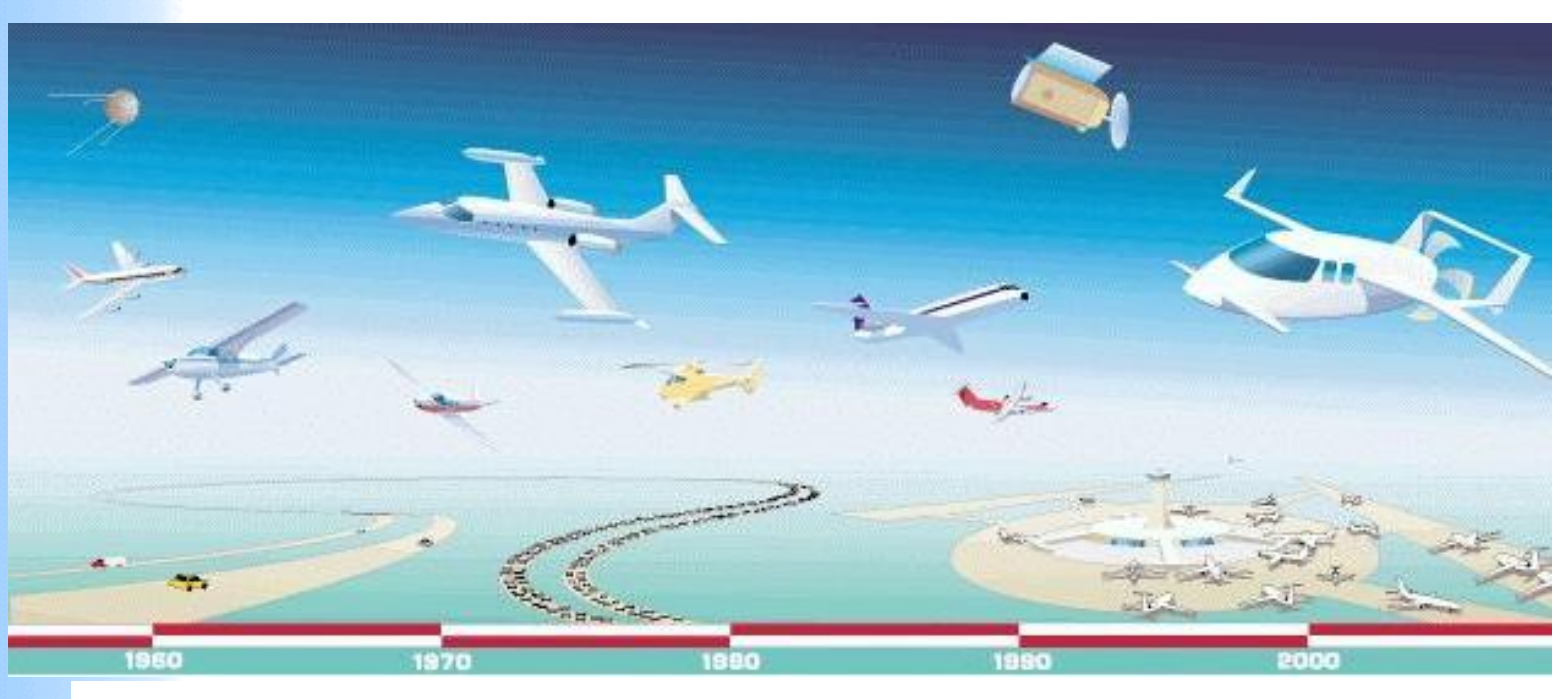
AGATE Survey Results

Business Travel Frequency

Business Travel Days per Month

People who travel frequently (Question 1>3)
and travel often on business (Question2>3)



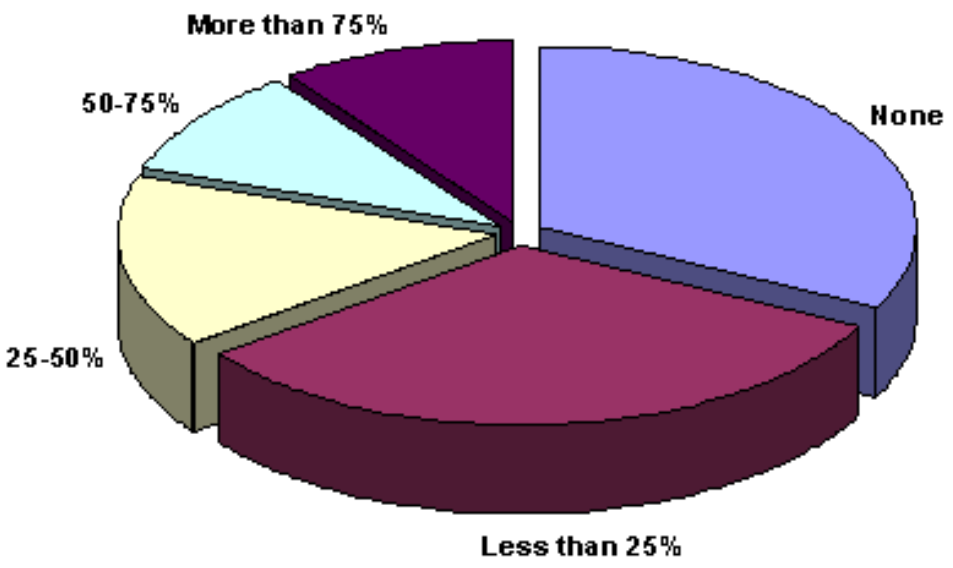


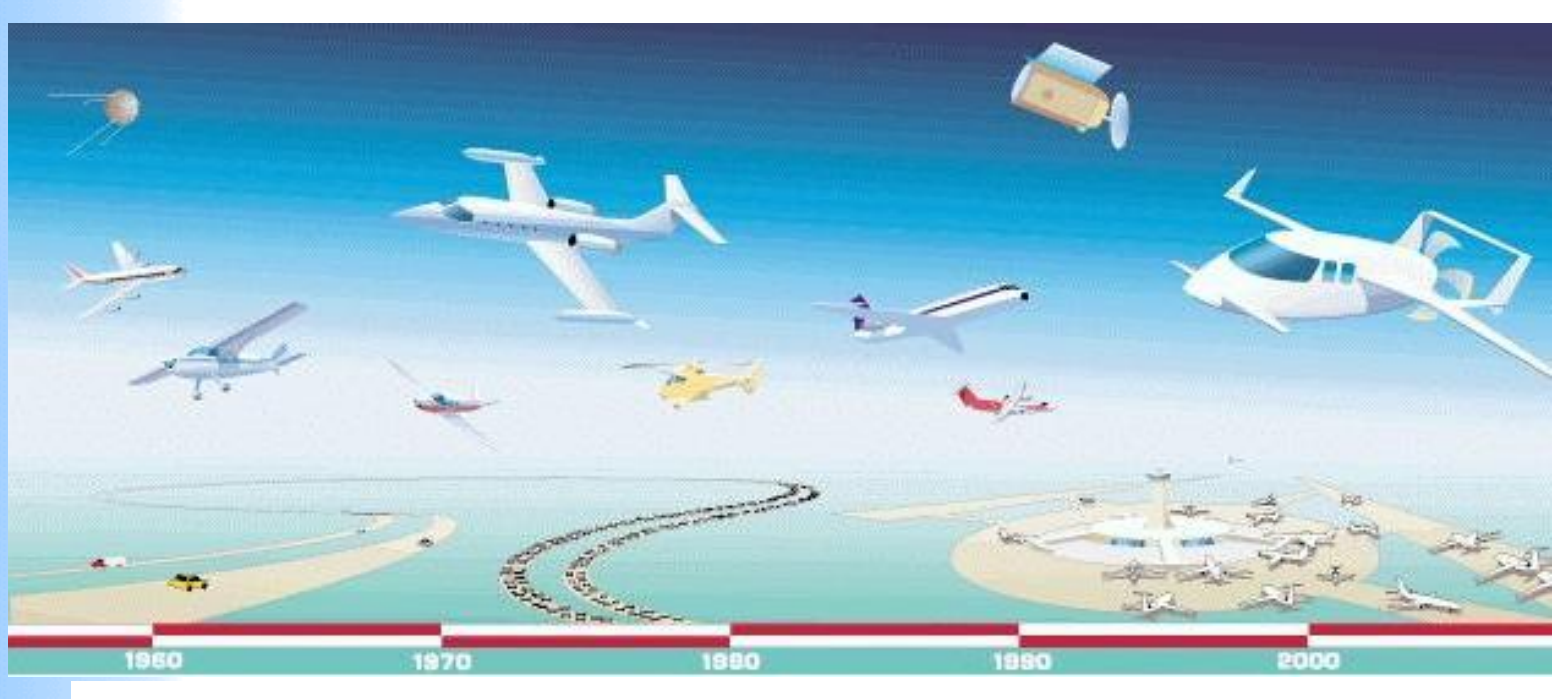
AGATE Survey Results

Business Auto Travel

Auto Travel For Business

(Trips Exceeding 2 Hours But Less Than 1,000 Miles)

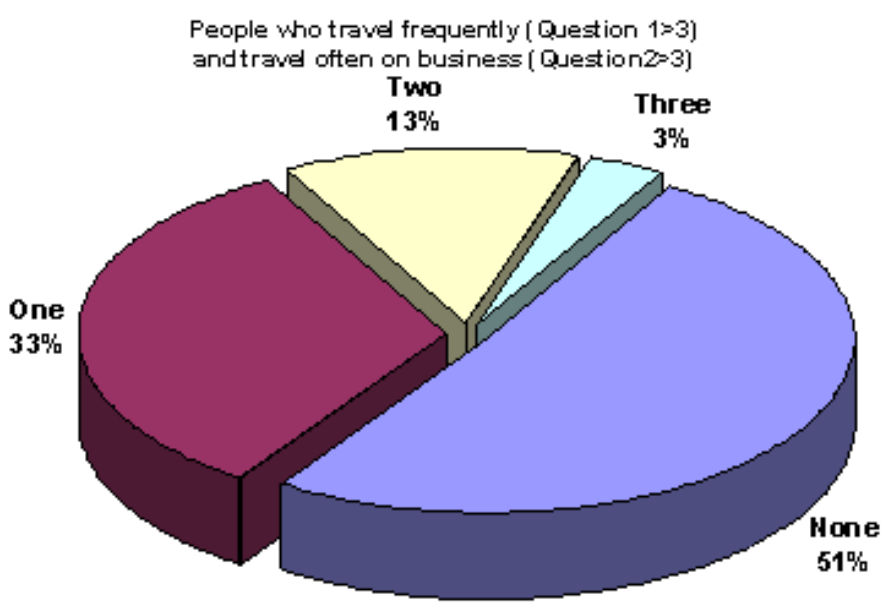


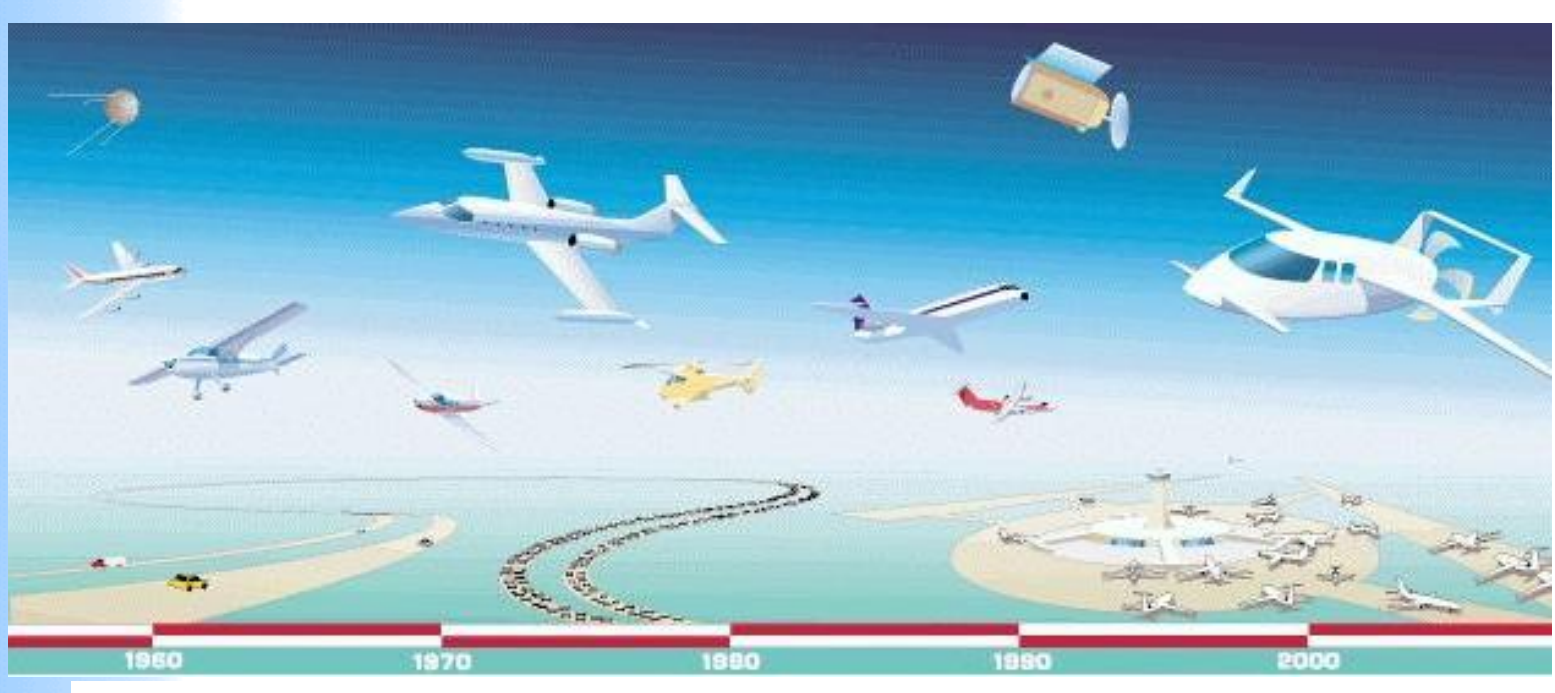


AGATE Survey Results

Number of Business Travelers

Traveling Business Partners

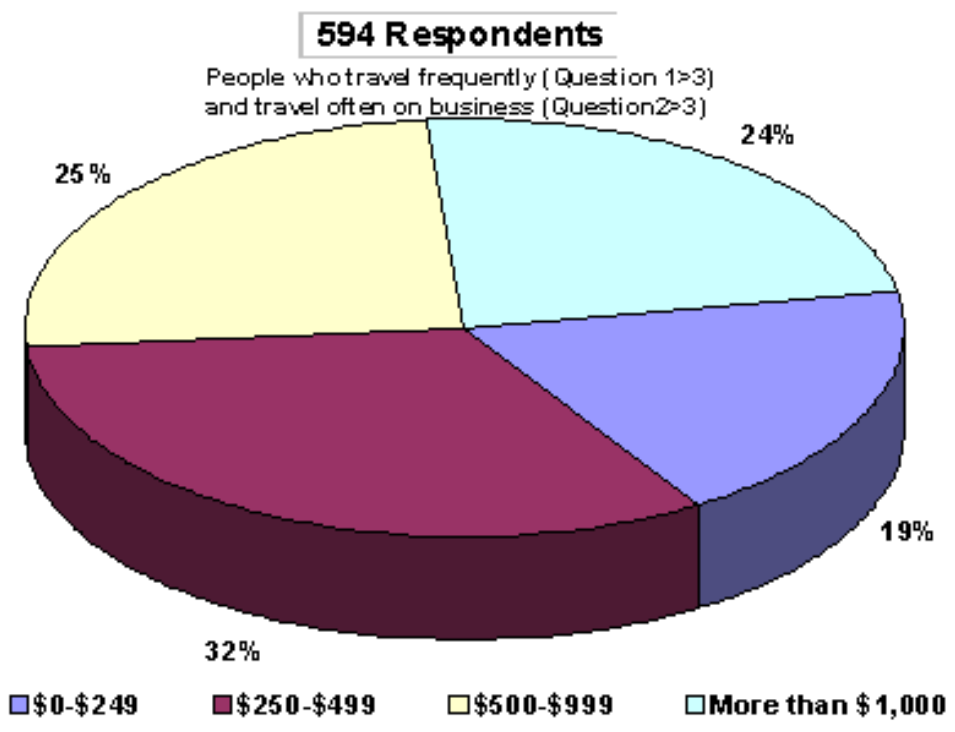


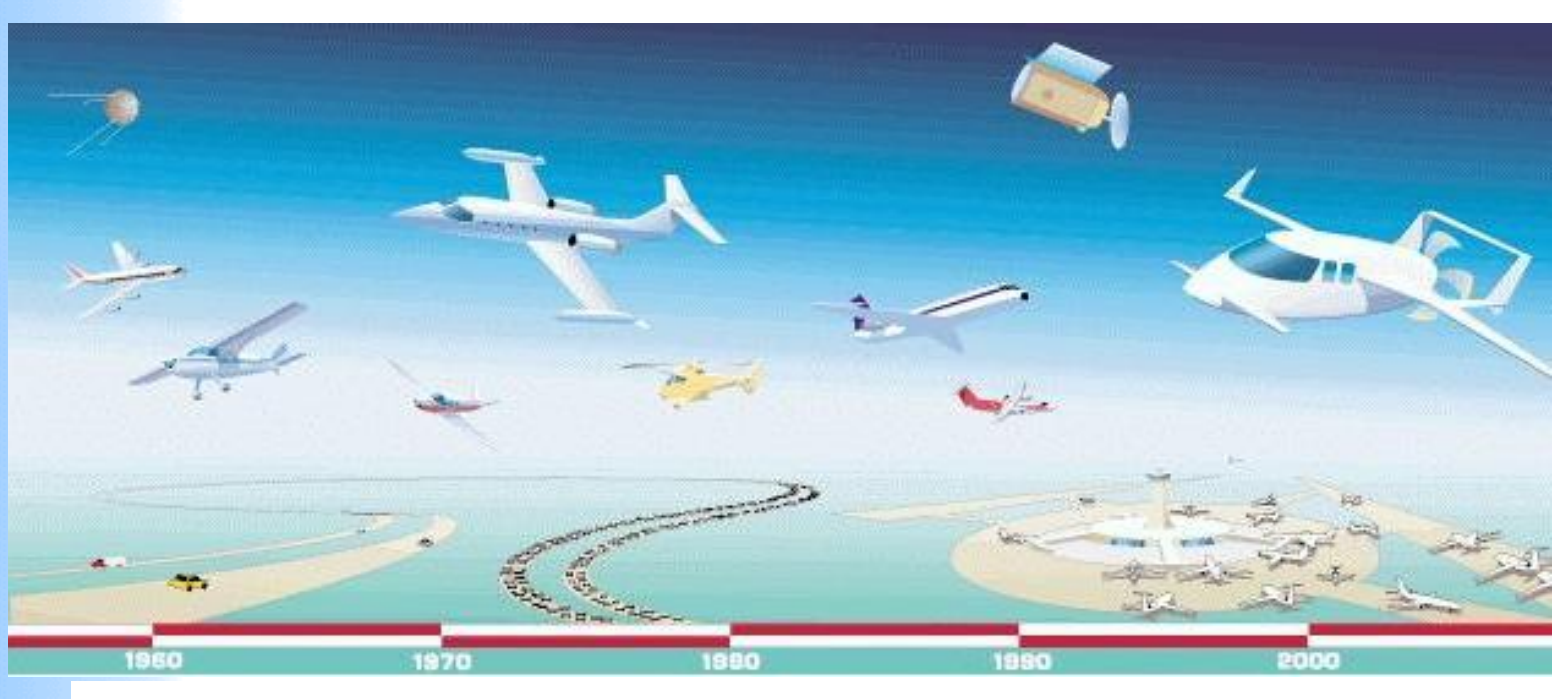


AGATE Survey Results

Business Travel Expense

Monthly Expenditure For Business Travel

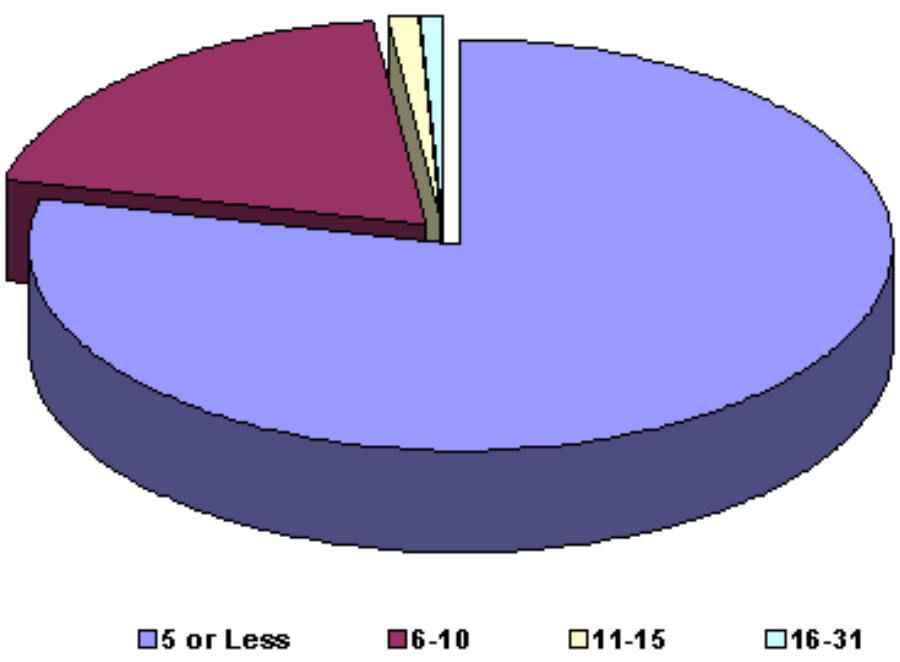


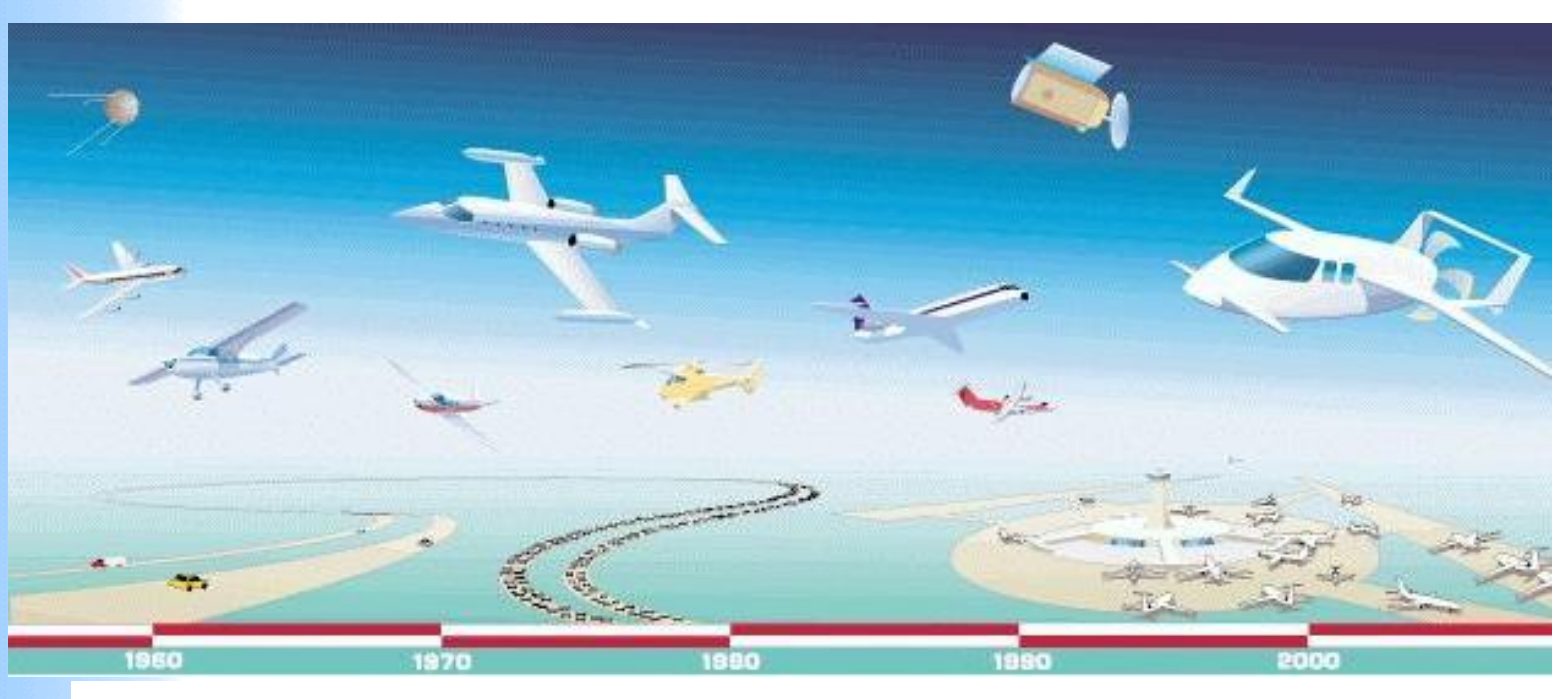


AGATE Survey Results

Personal Travel Frequency

Personal Travel Days Per Month

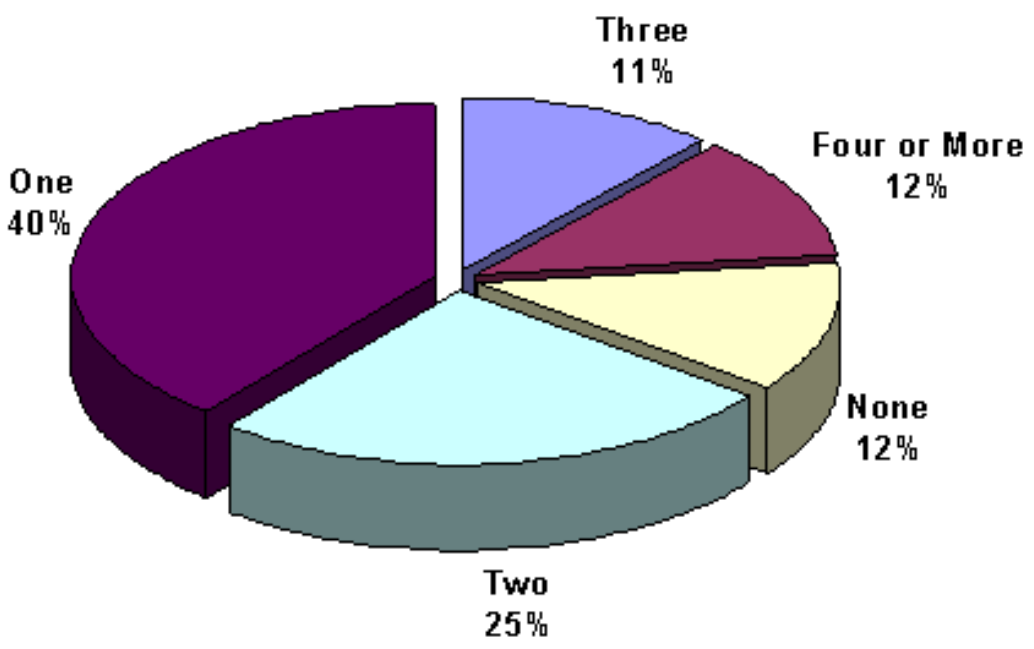


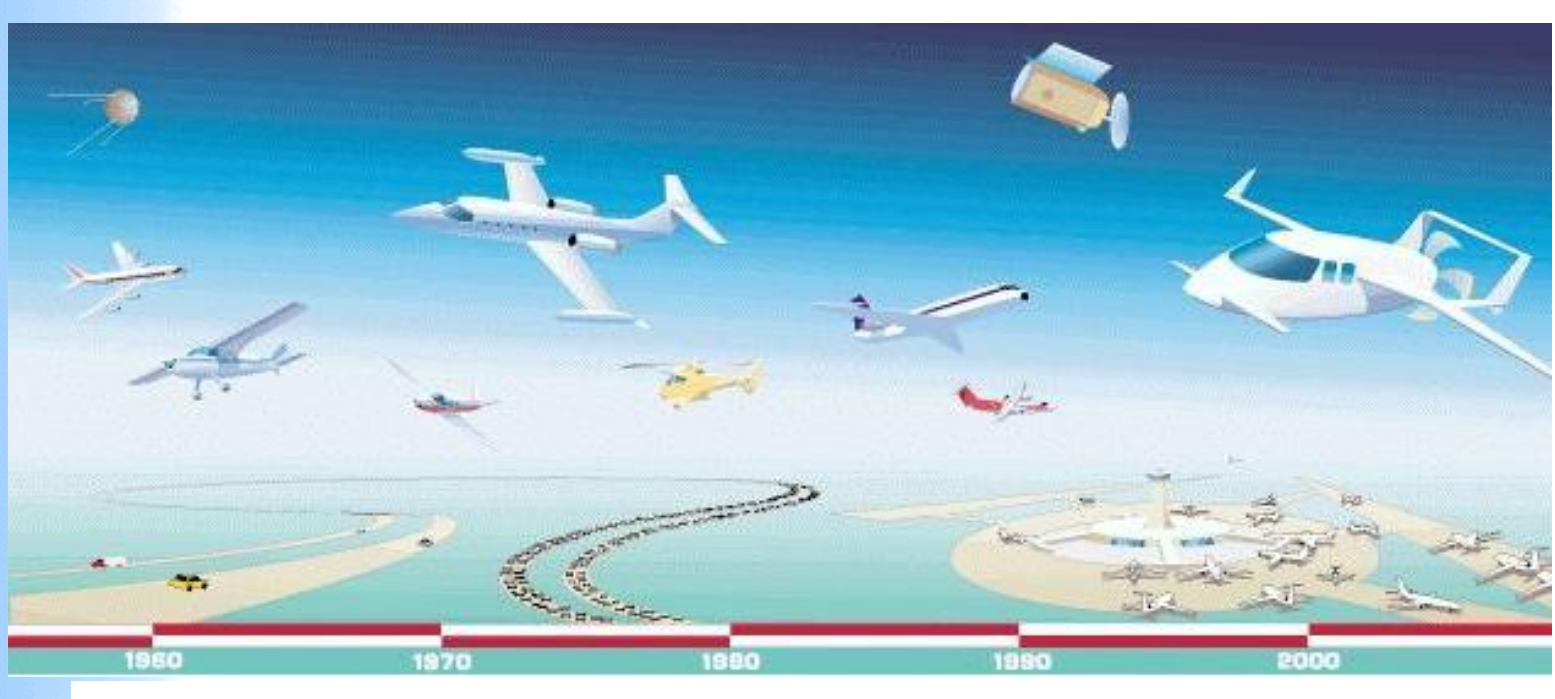


AGATE Survey Results

Number of Personal Travelers

Personal Travel Partners





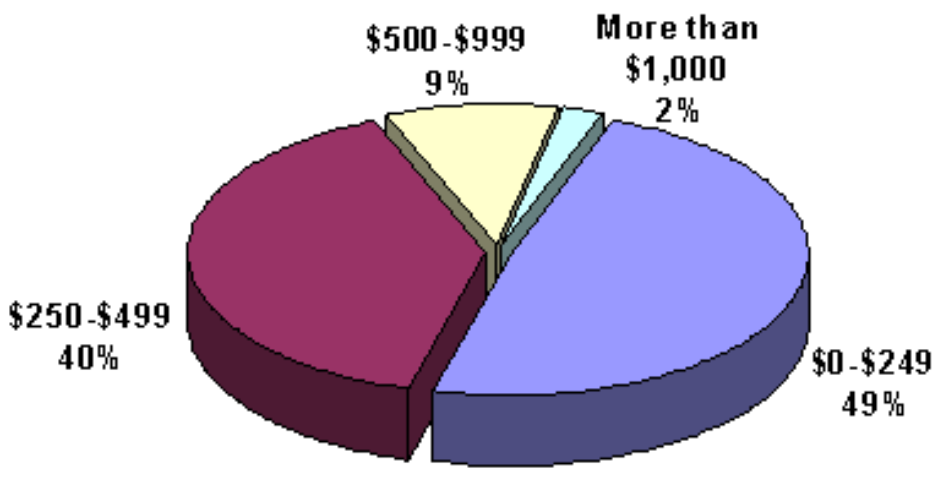
AGATE Survey Results

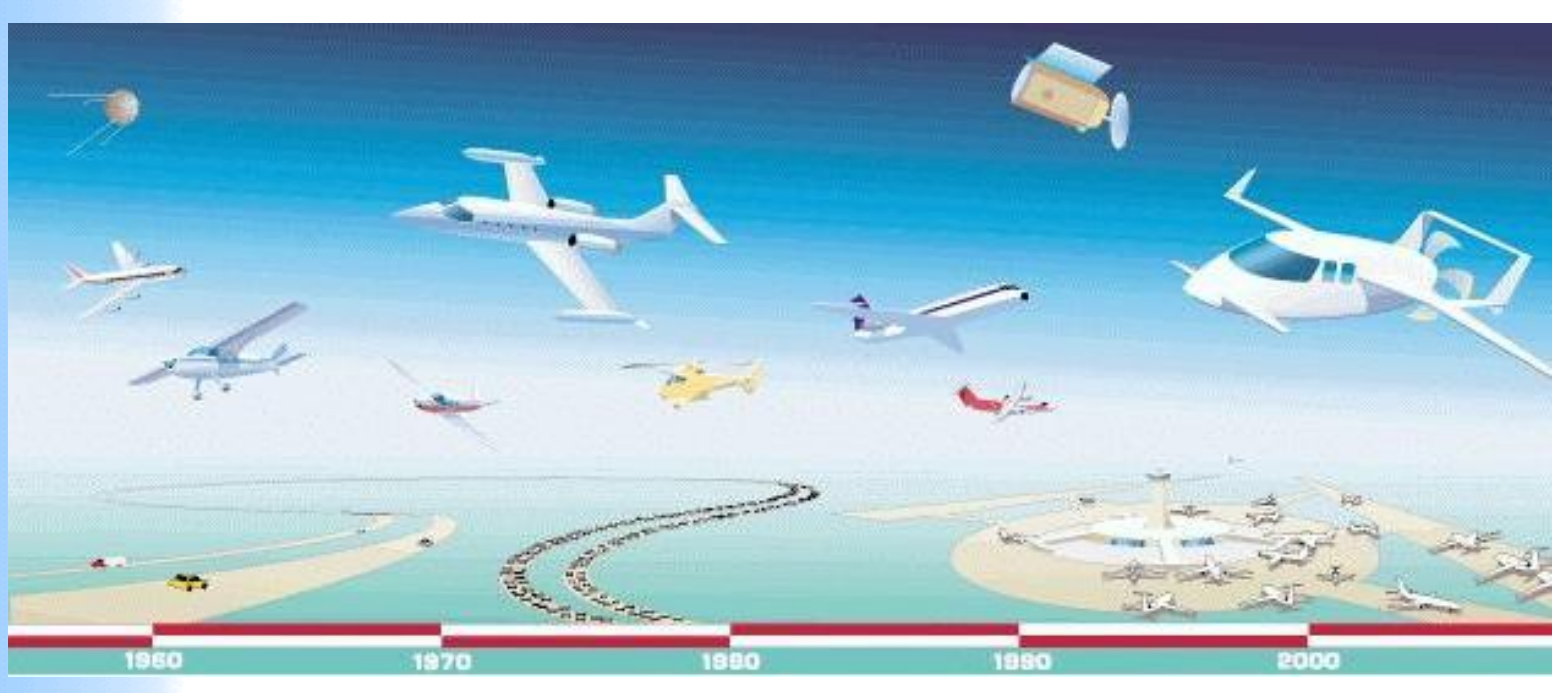
Personal Travel Expense

Average Monthly Expenditure For Personal Travel

1624 Respondents

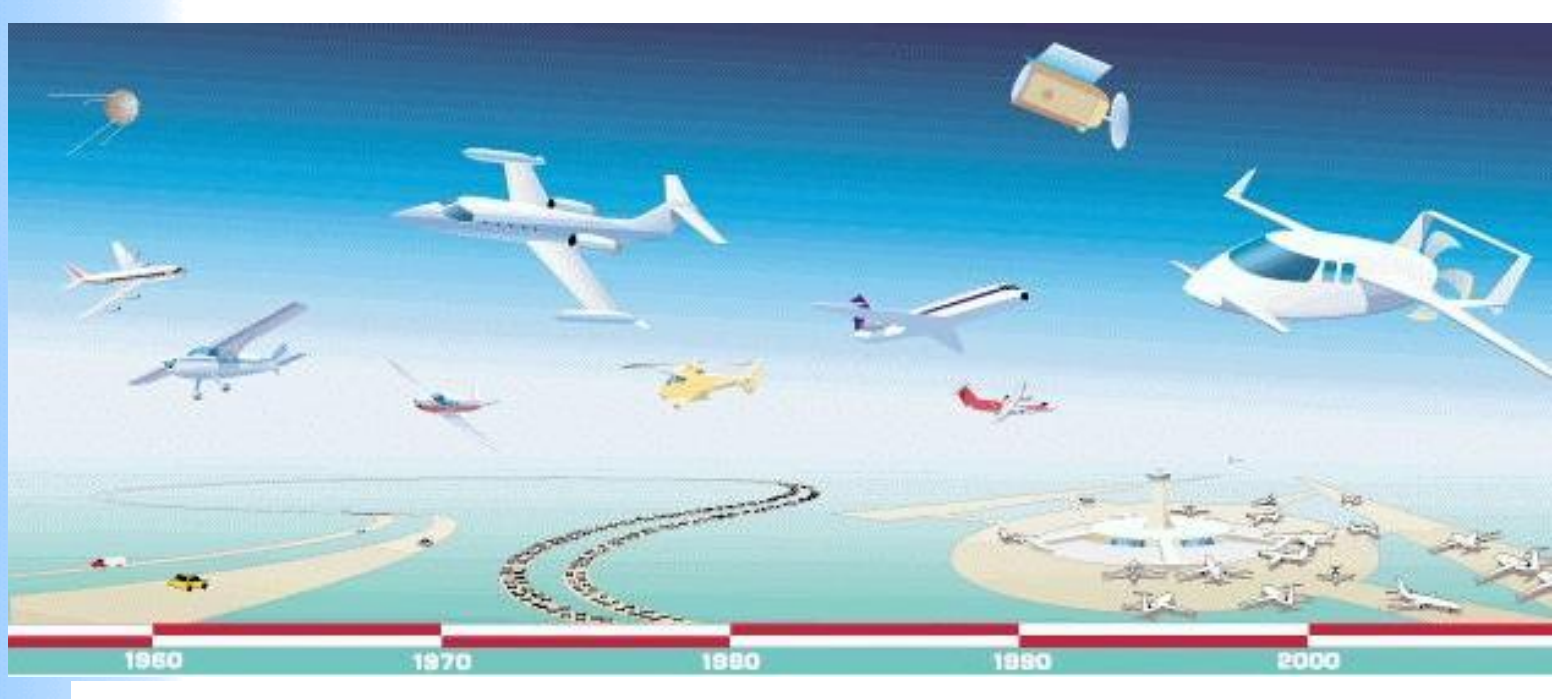
People who travel frequently (Question 1>3) and DON'T travel often on business (Question2<4)





AGATE Survey Results

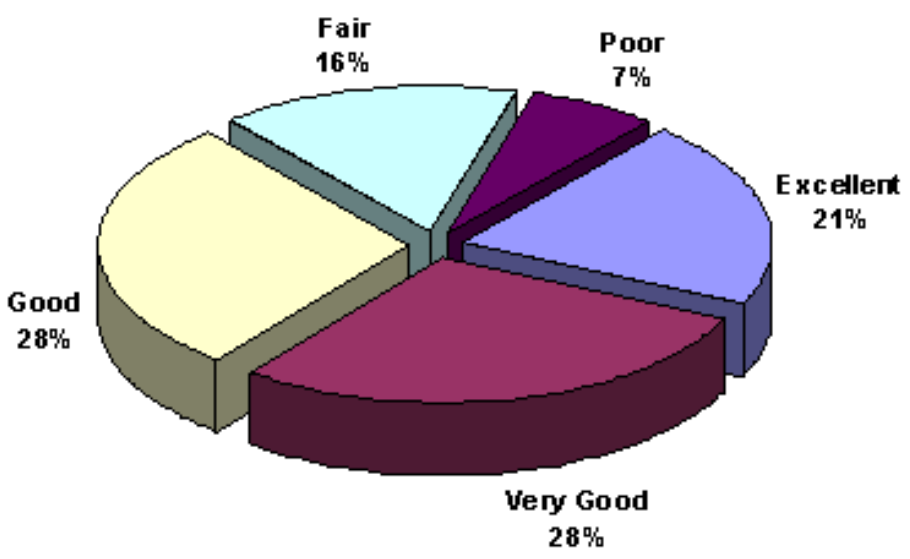
Commercial Air Travel Information

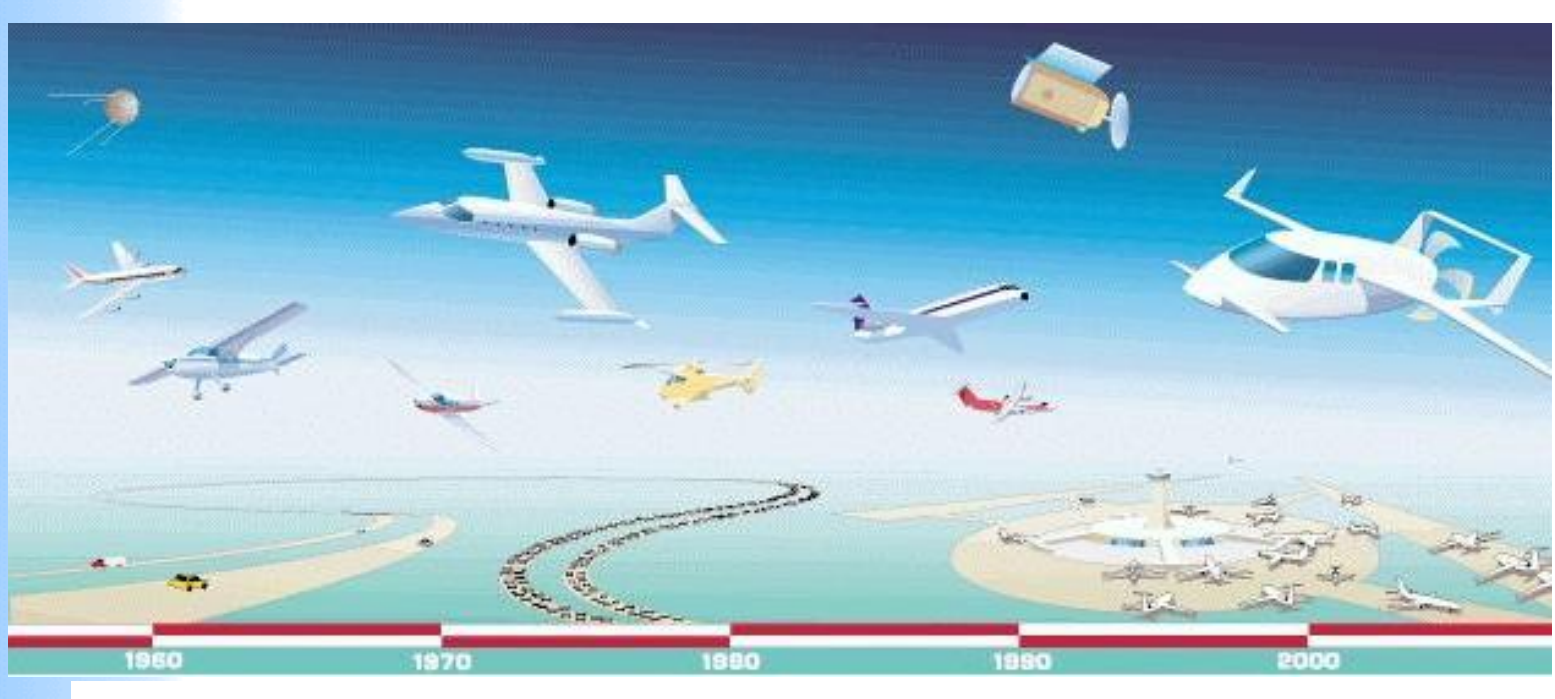


AGATE Survey Results

Service Rating

Rating of Commercial Airline Service



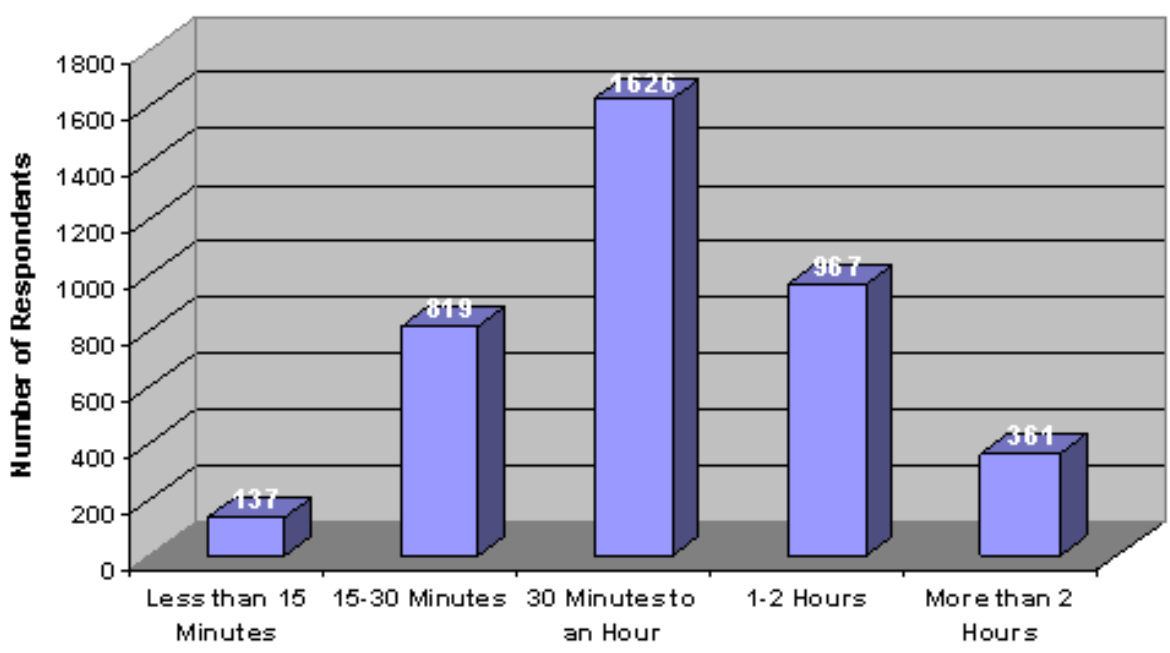


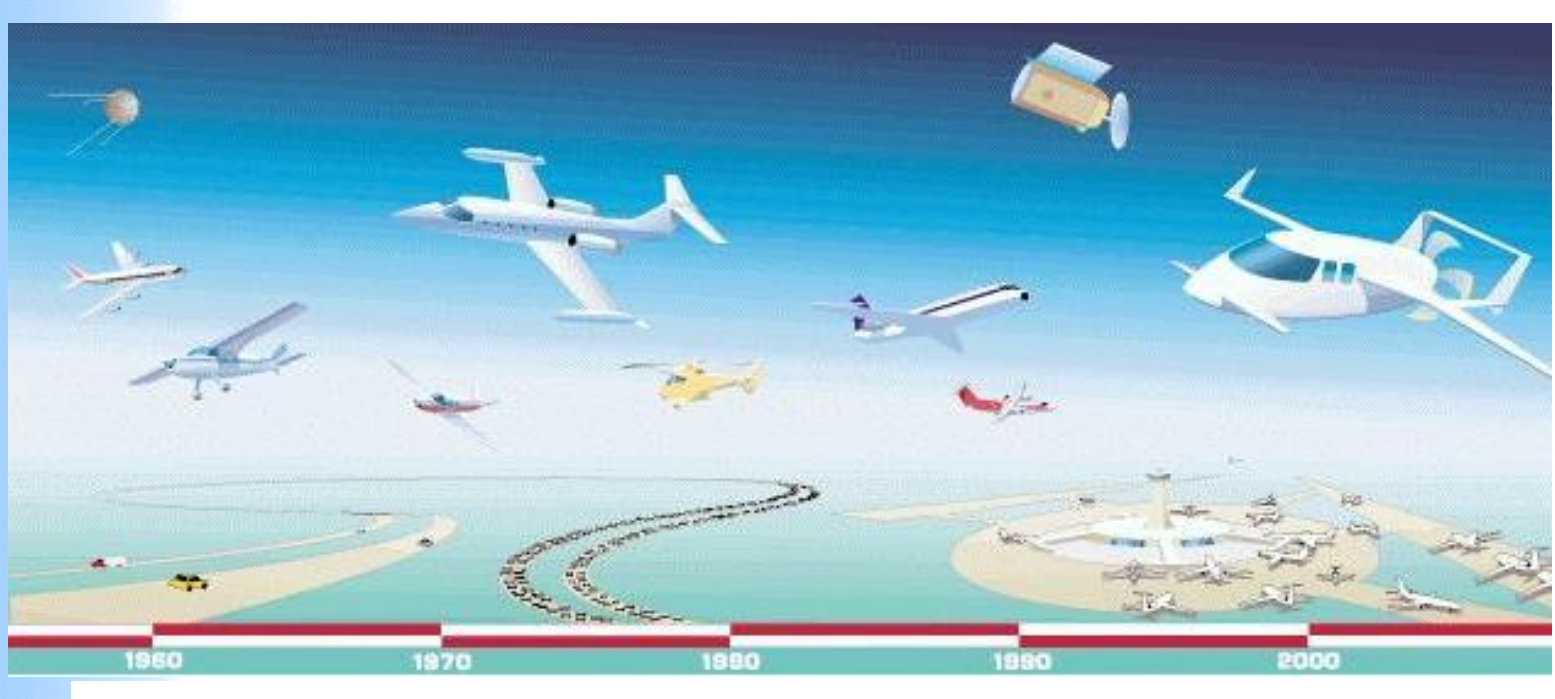
AGATE Survey Results

Travel to Airport

Time to Reach Airport

To Catch a Flight

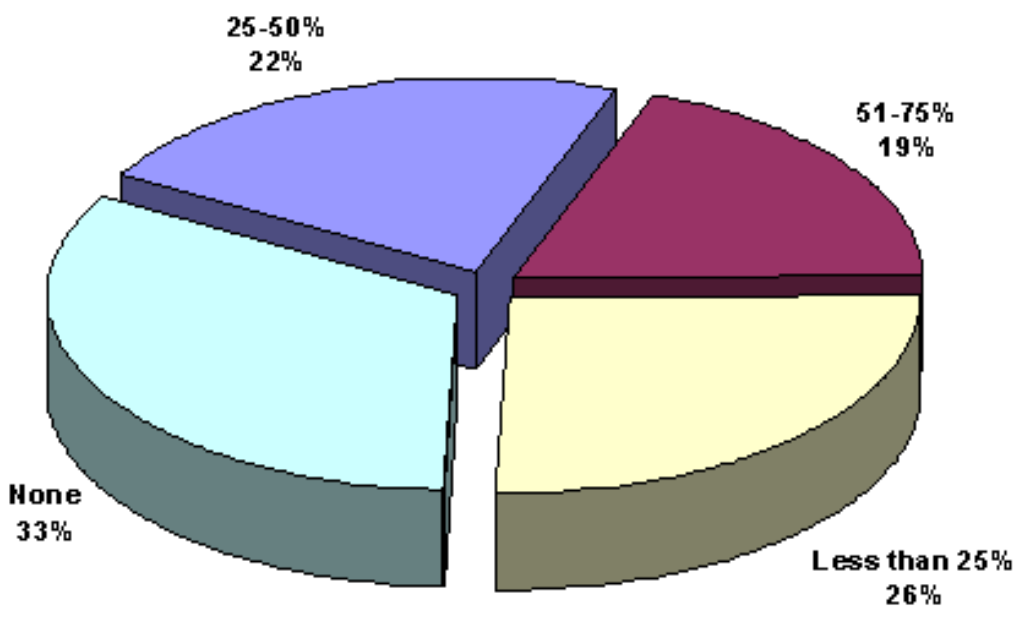


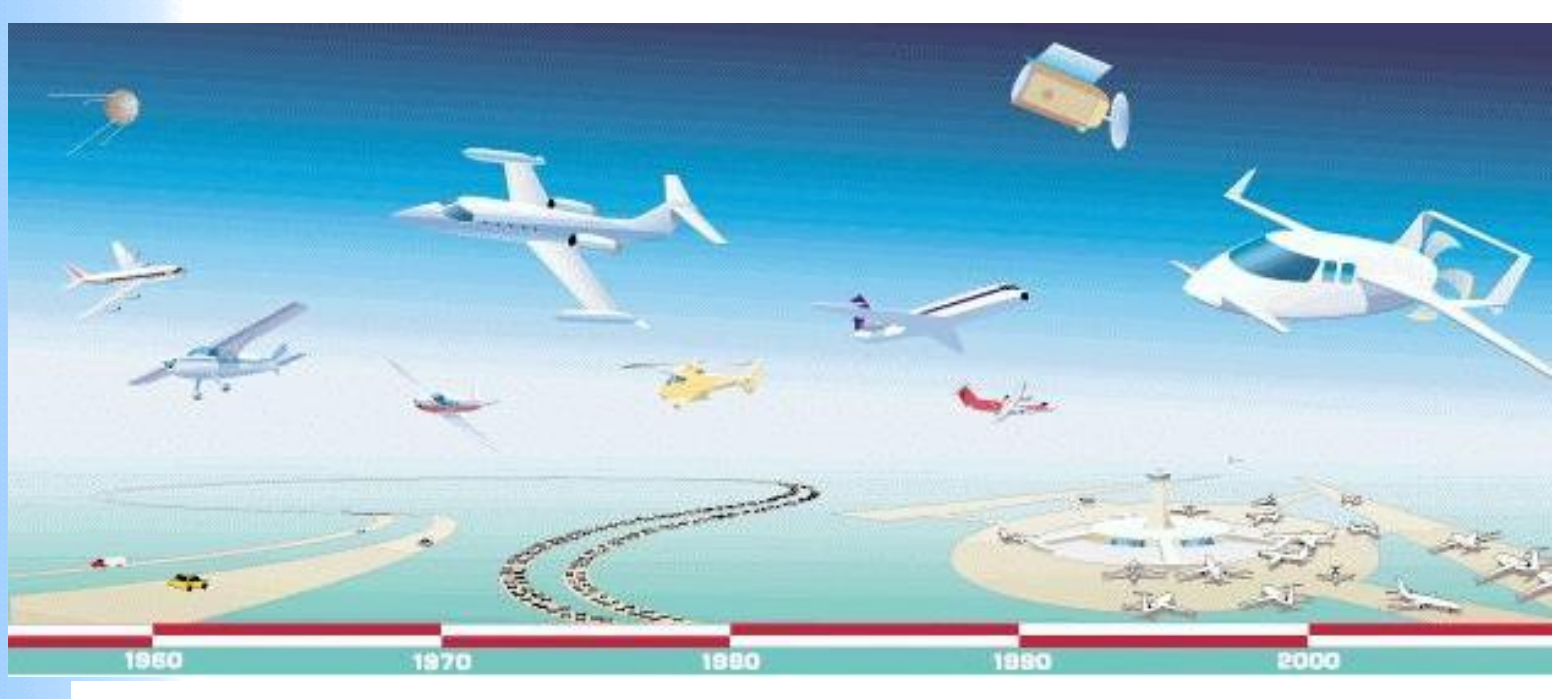


AGATE Survey Results

Commercial Air Destinations

Destinations Served by Commercial Airlines

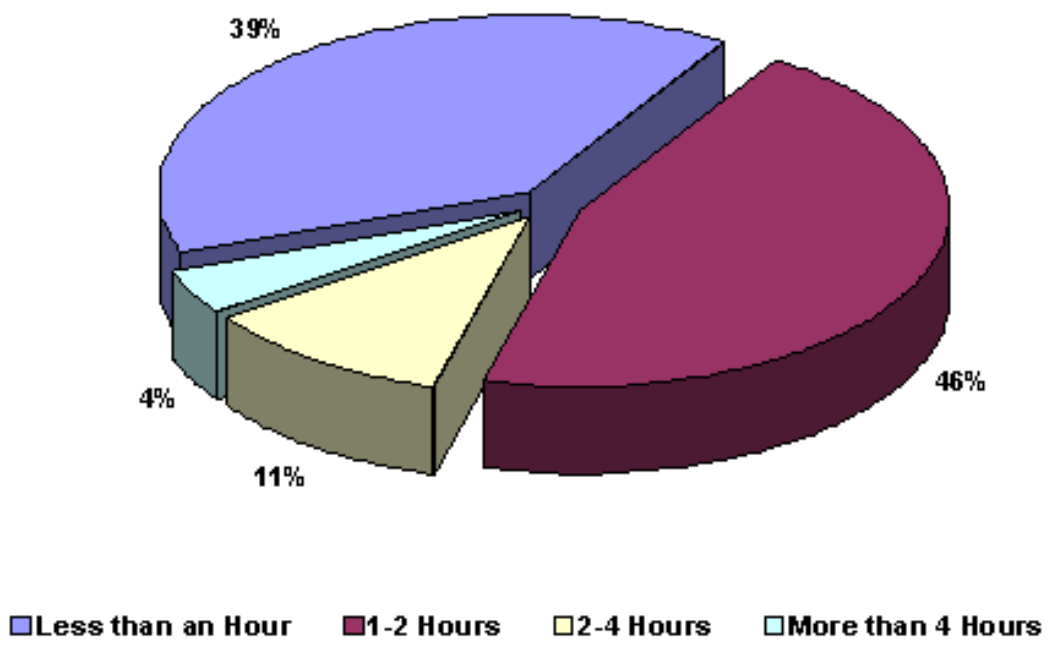


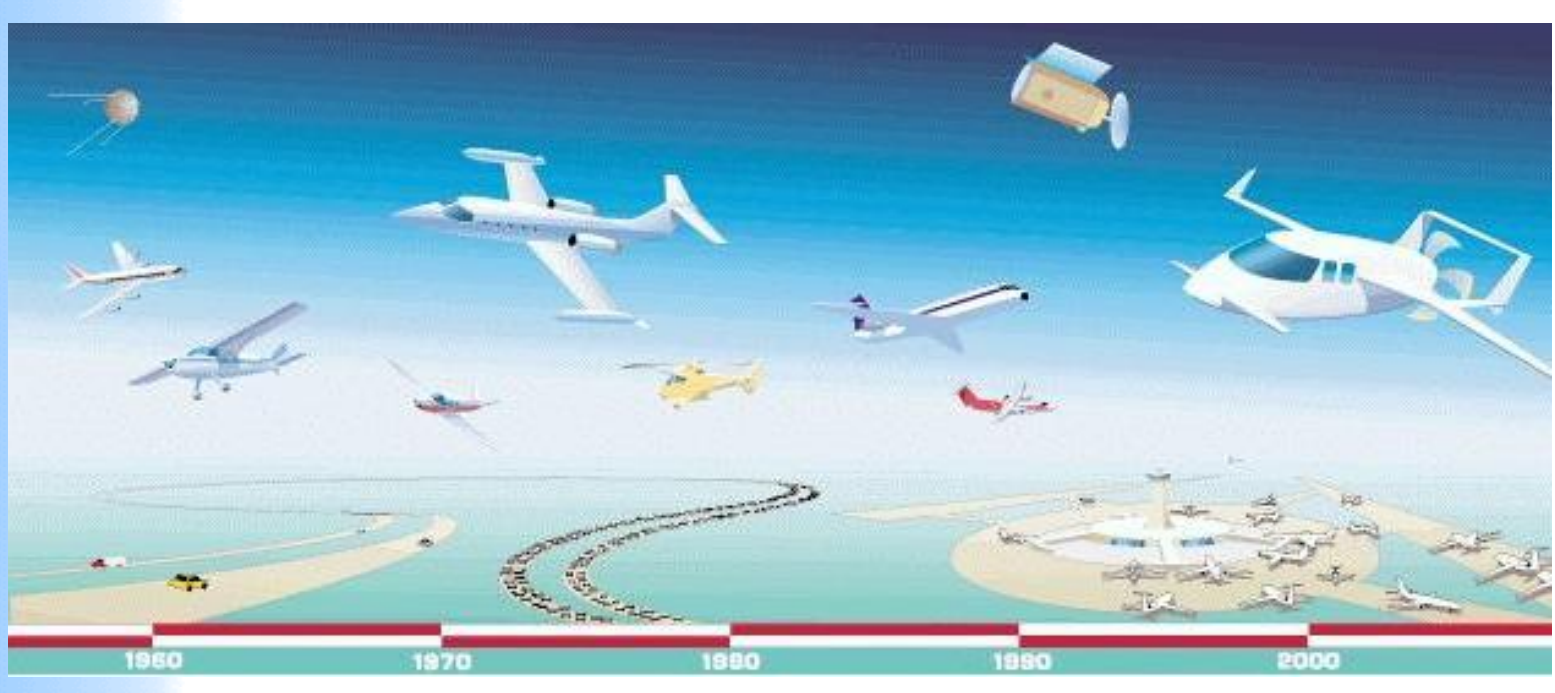


AGATE Survey Results

Time to Final Destination

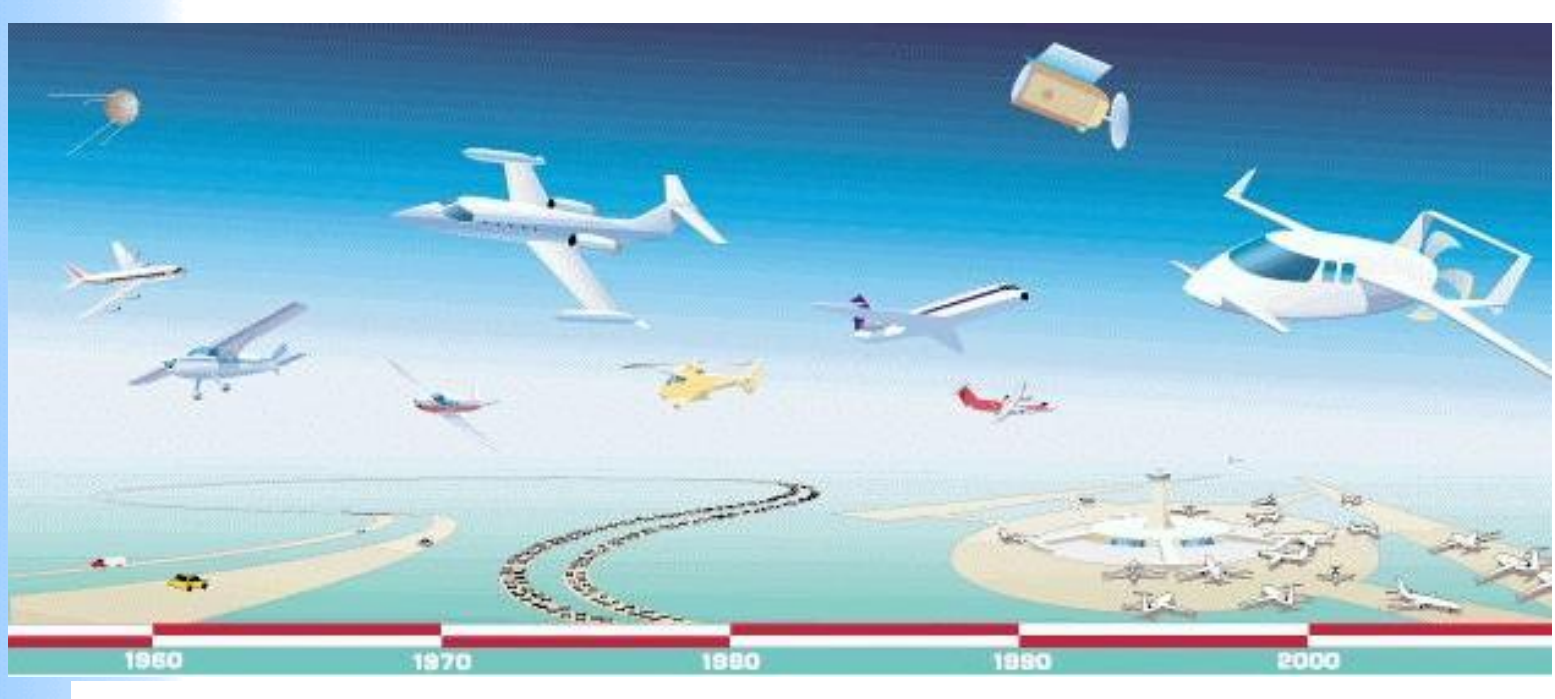
Time From Landing to Final Destination





AGATE Survey Results

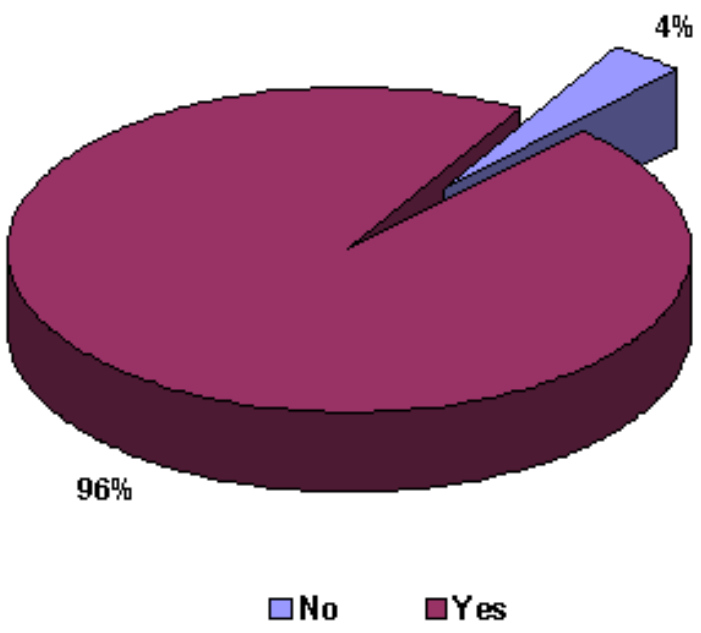
Advanced Light Plane (ALP) Travel Information

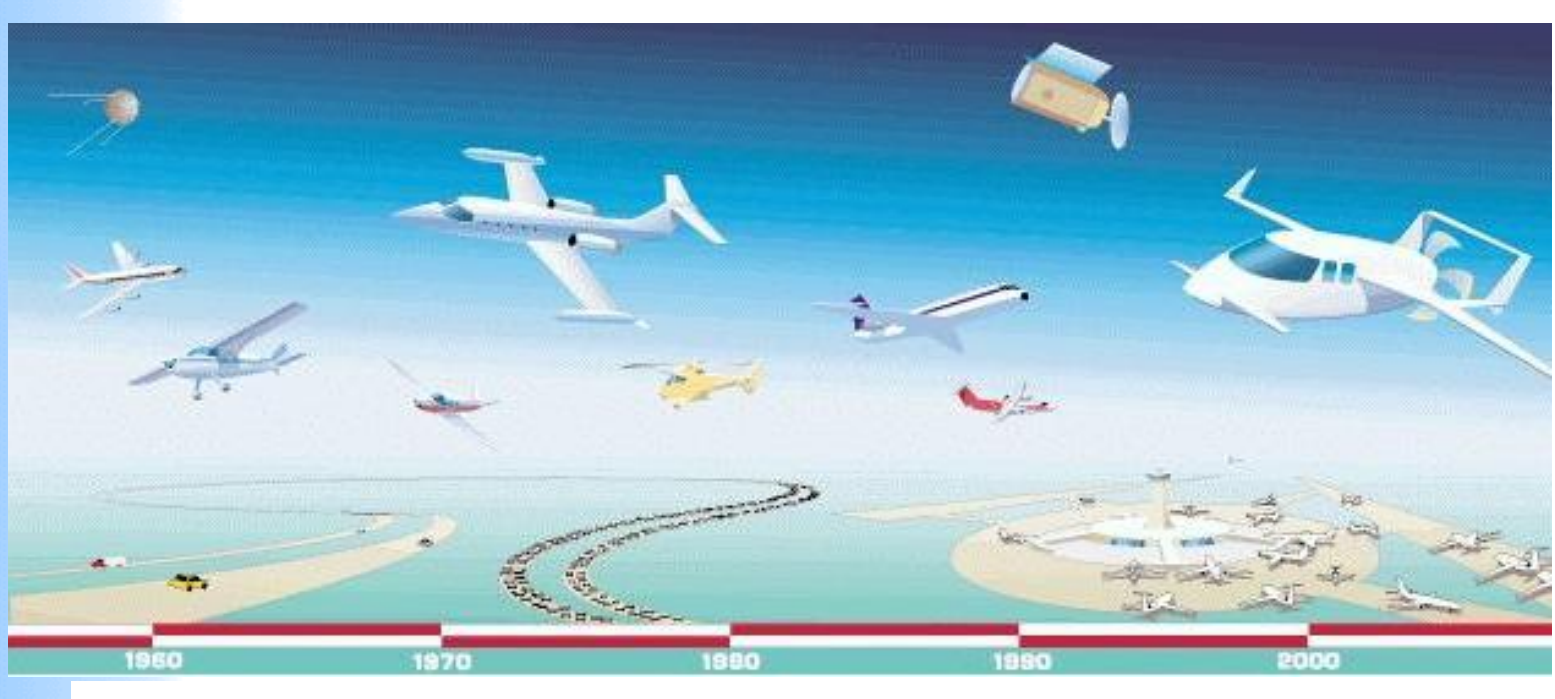


AGATE Survey Results

Interest in ALP

Interested in Traveling in an Advanced Light Aircraft

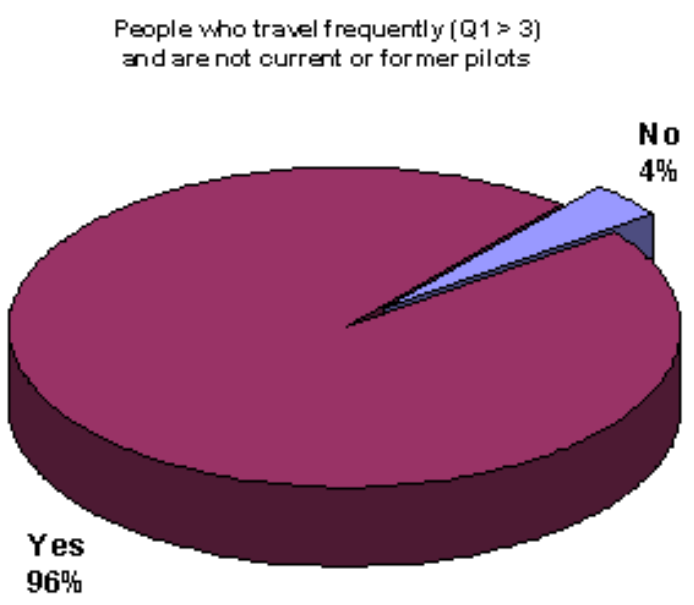


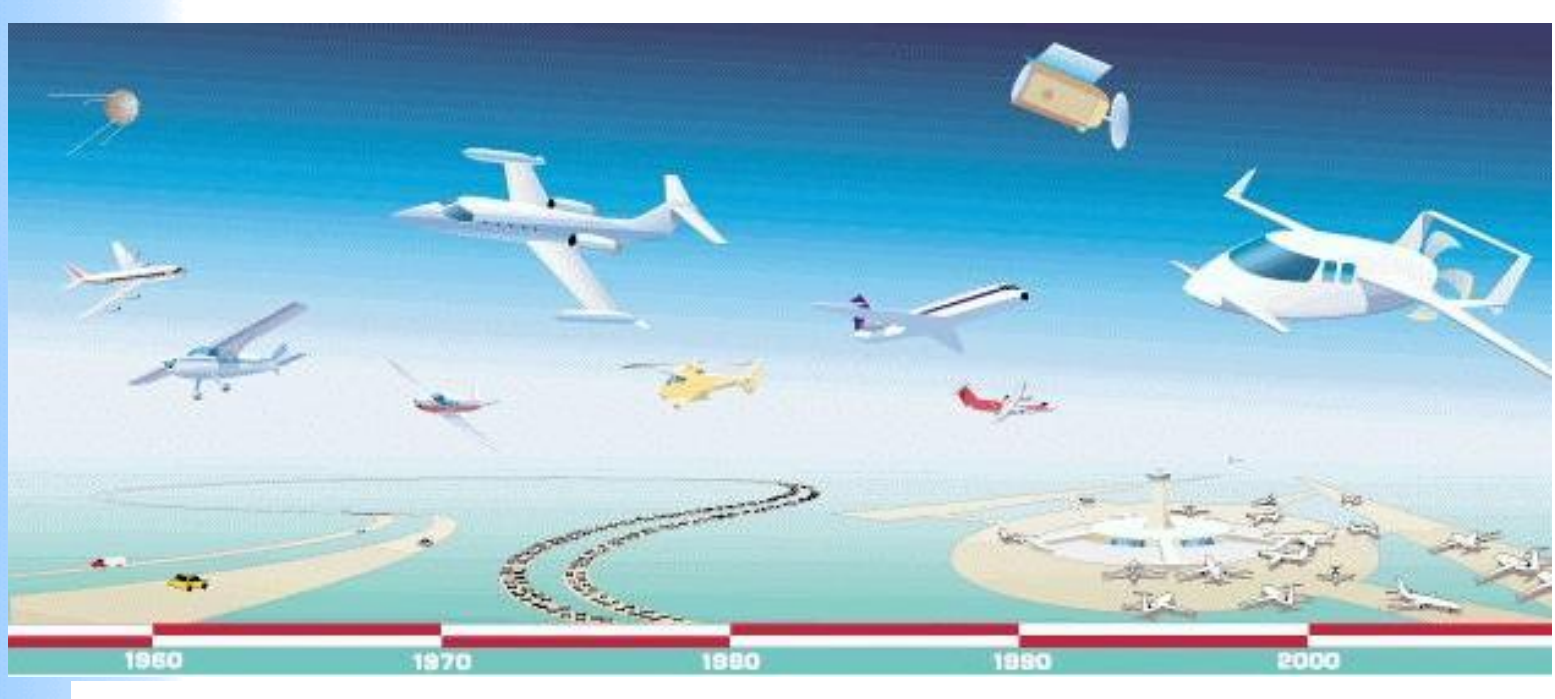


AGATE Survey Results

Willingness to Travel in ALP

Willing To Travel In Advanced Light Aircraft

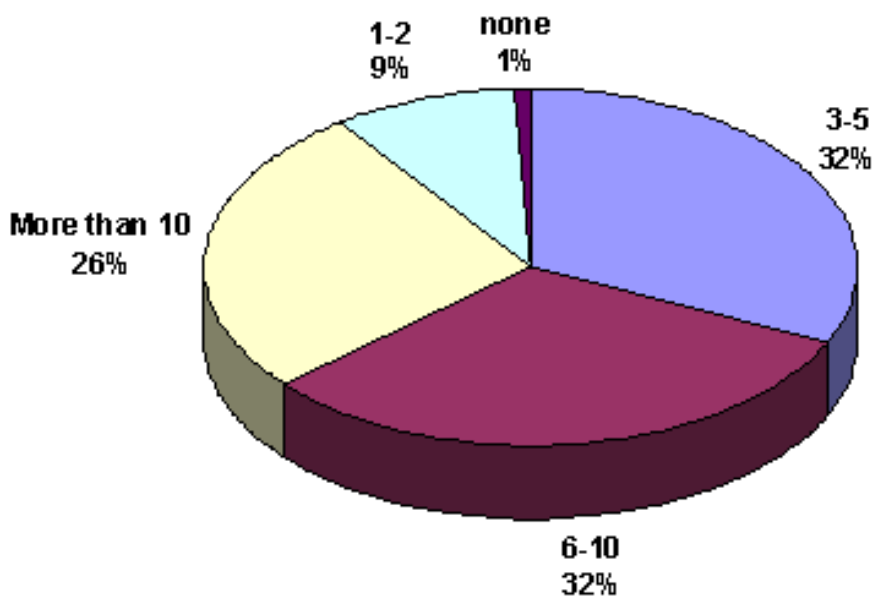


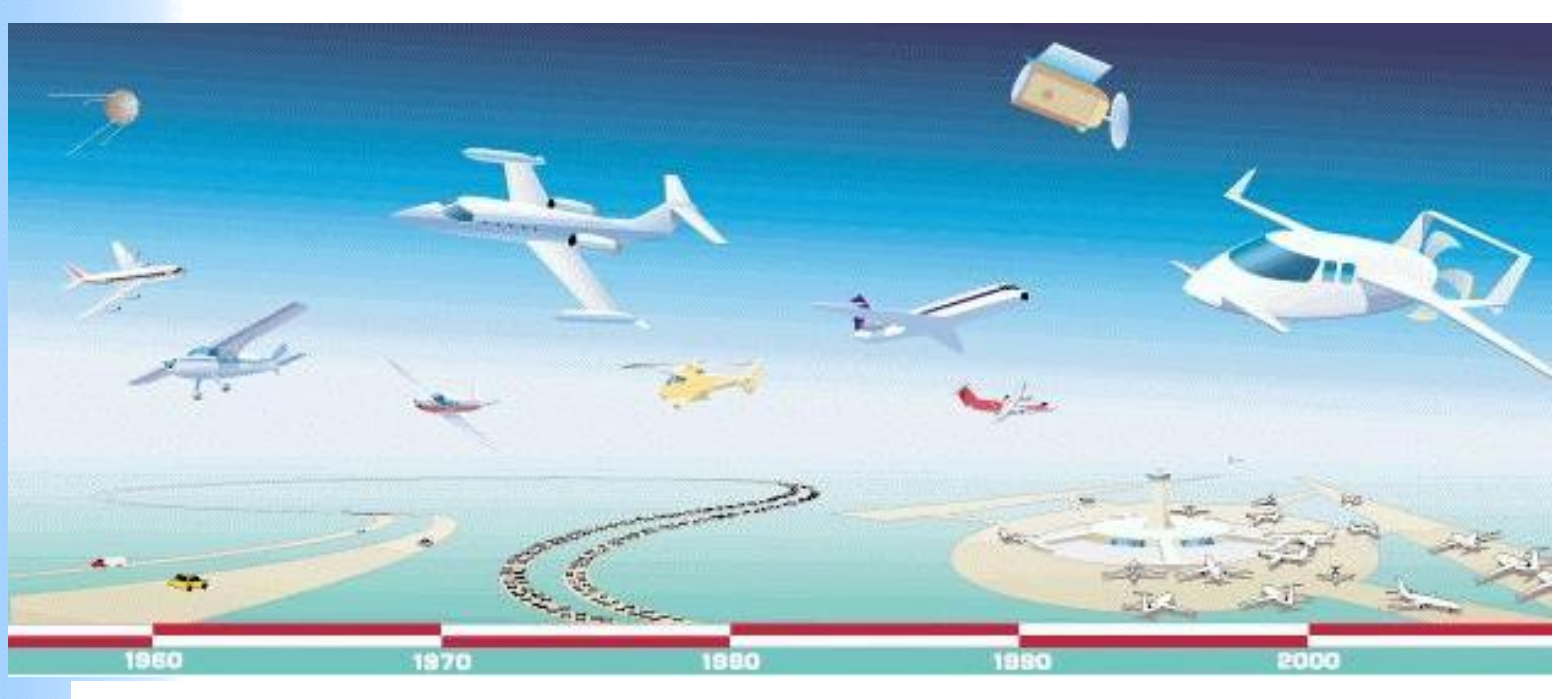


AGATE Survey Results

Extra Trips / Cheaper

Extra Trips if Less Expensive Than Commercial Air Travel
(Trips Exceeding 2 Hours But Less Than 1,000 Miles)



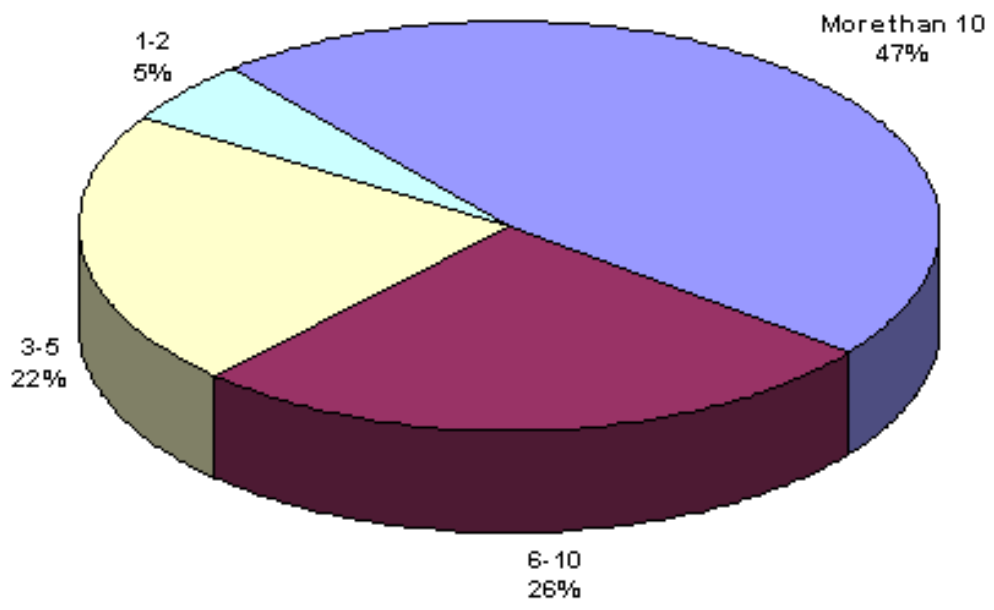


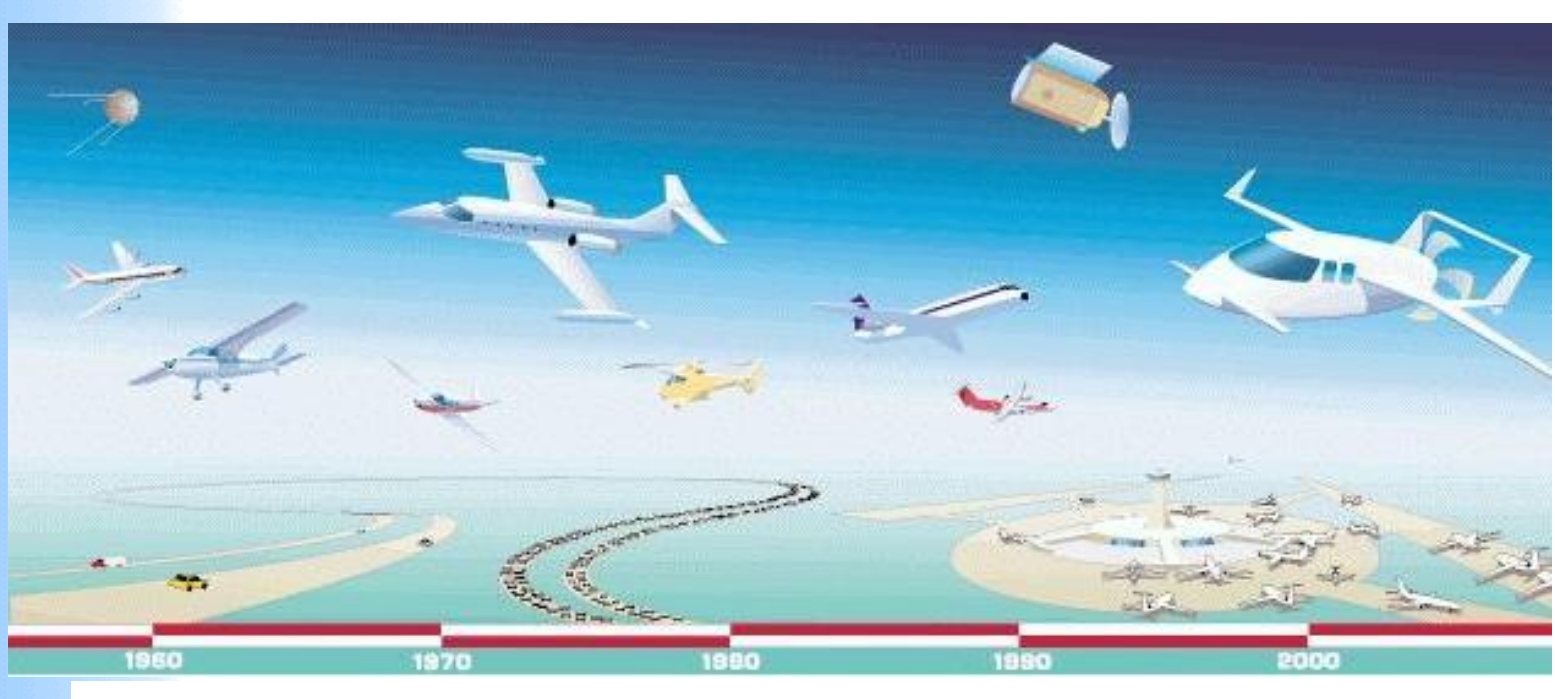
AGATE Survey Results

Extra Trips / Faster

Extra Trips if Travel Three Times Faster

(Trips Exceeding 2 Hours But Less Than 1,000 Miles)



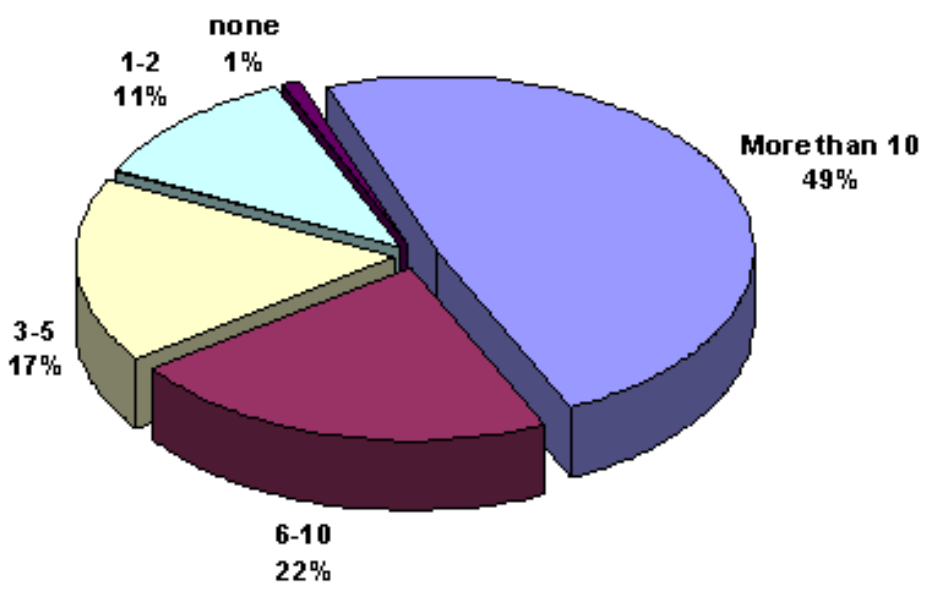


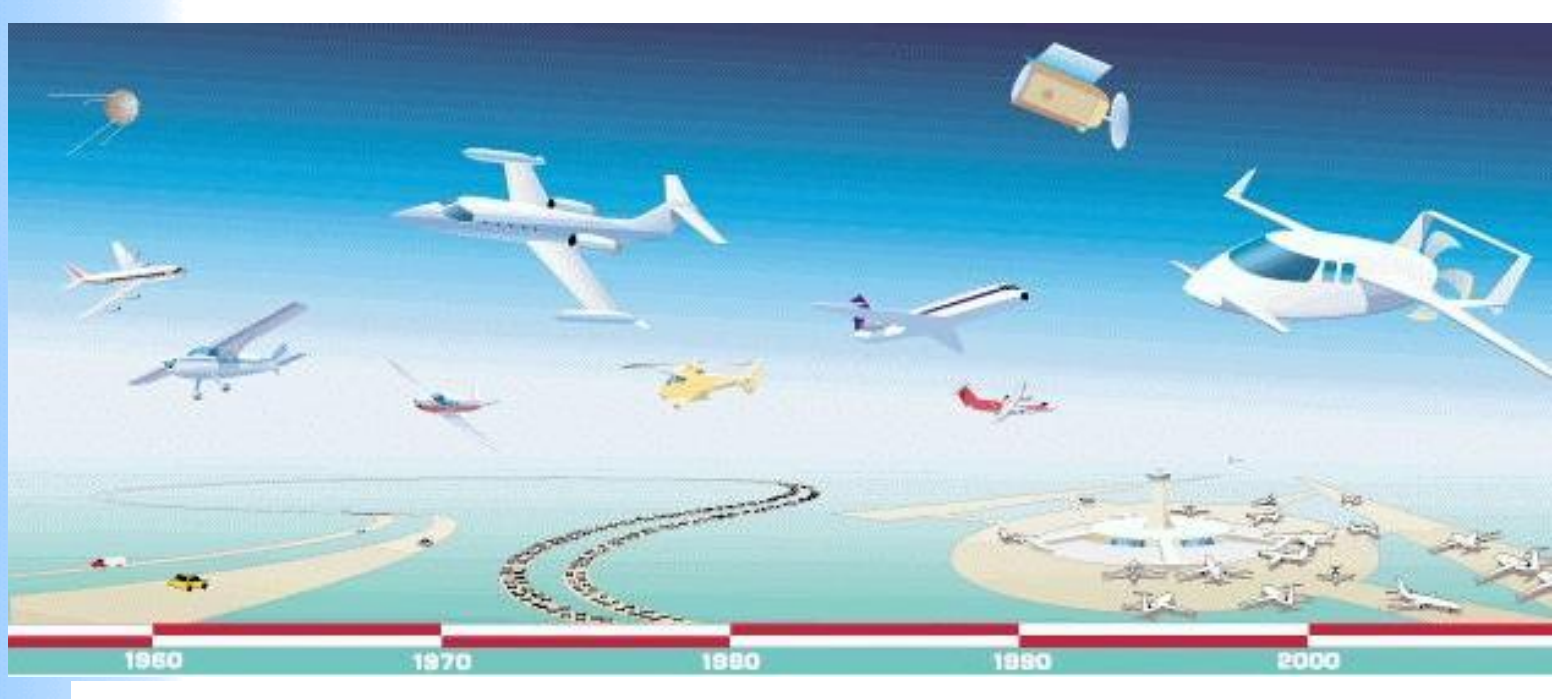
AGATE Survey Results

Extra Trips / Cheaper and Faster

Extra Trips if Less Expensive Than Commercial Air & Three Times Faster Than Automobile

(Trips Exceeding 2 Hours But Less Than 1,000 Miles)

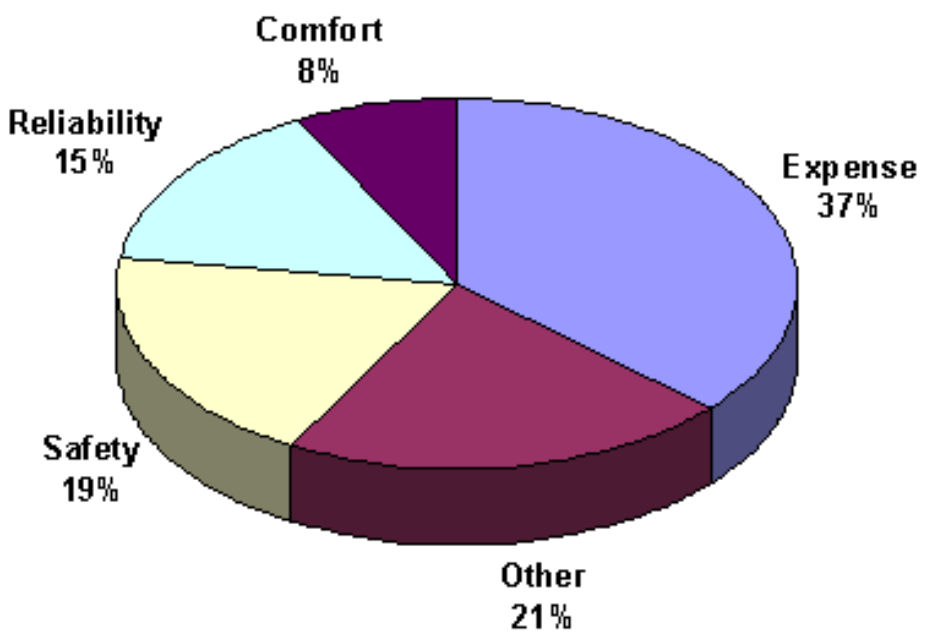


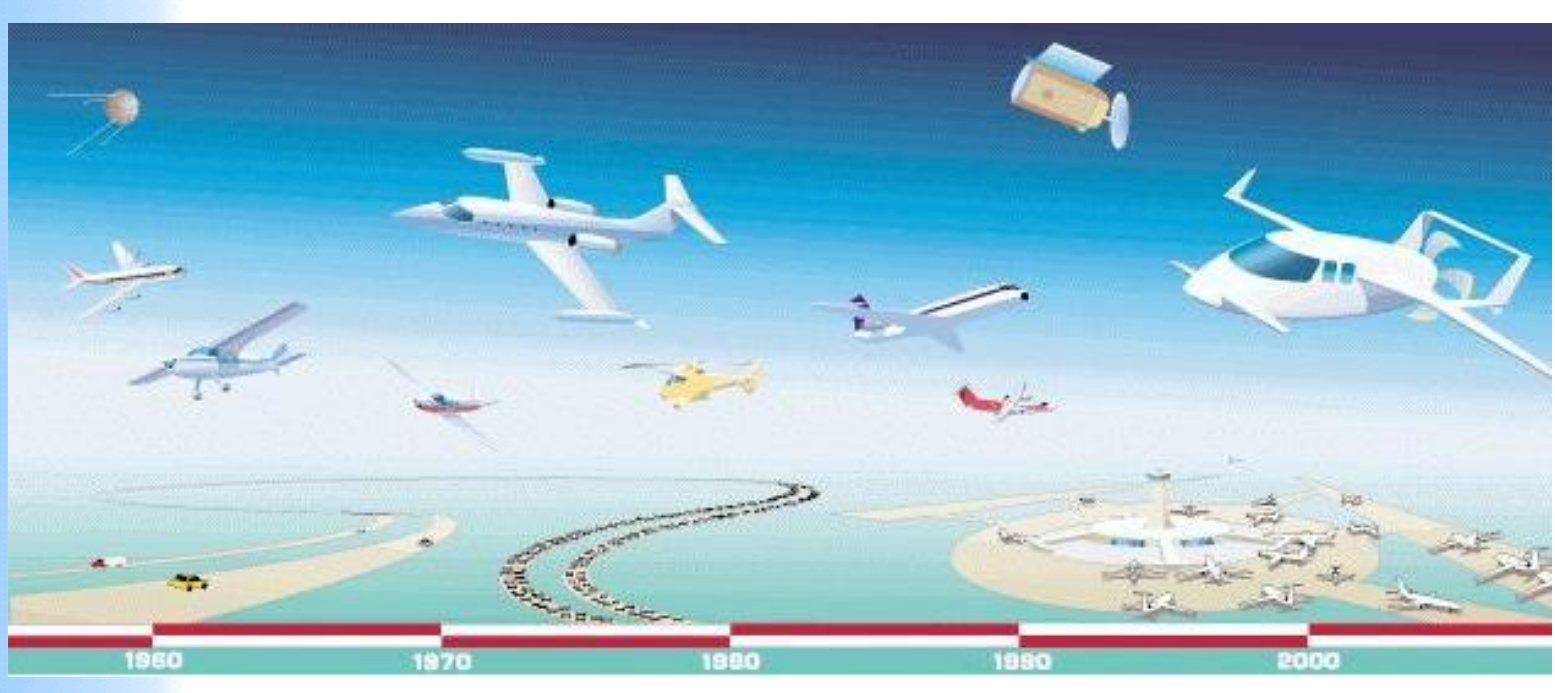


AGATE Survey Results

Reasons not to Travel in ALP

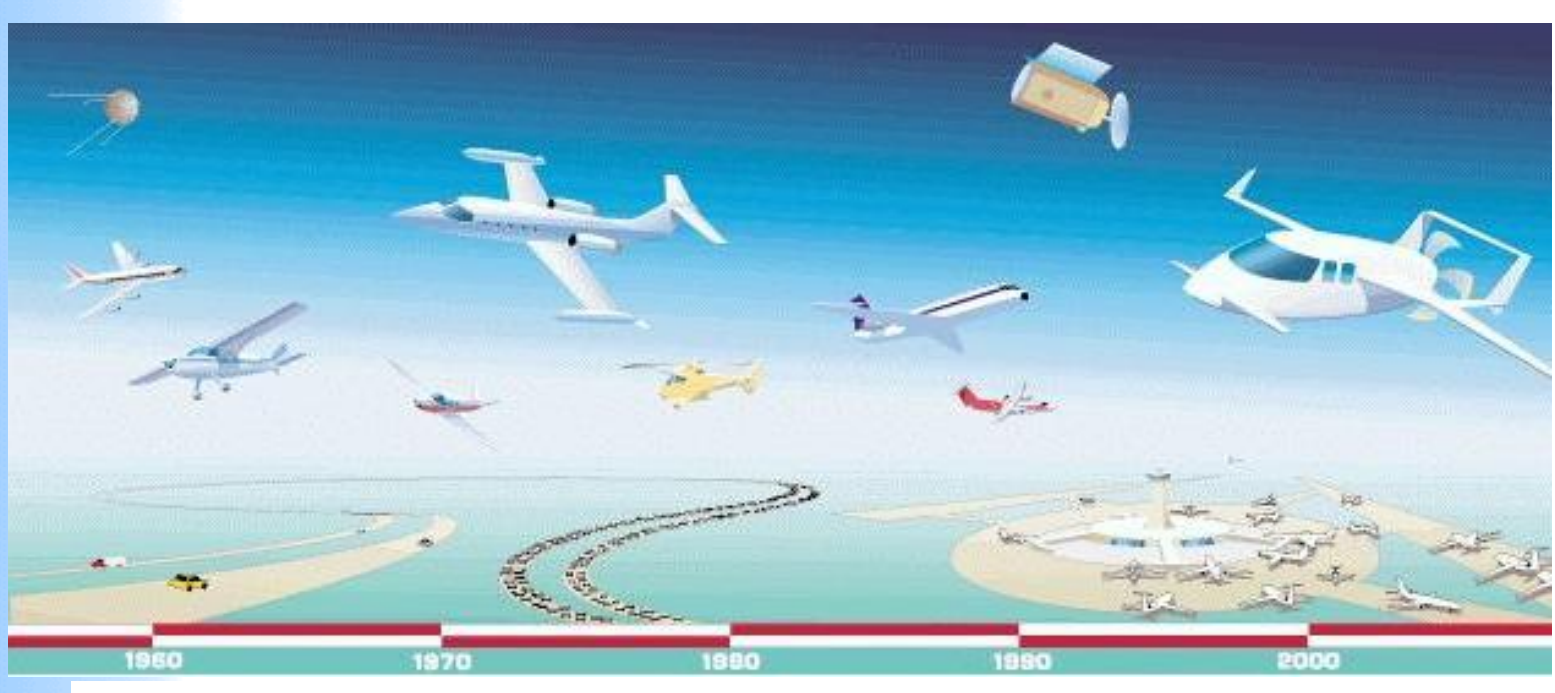
Reasons Unwilling To Travel
in an Advanced Light Aircraft





AGATE Survey Results

Potential Pilot Information

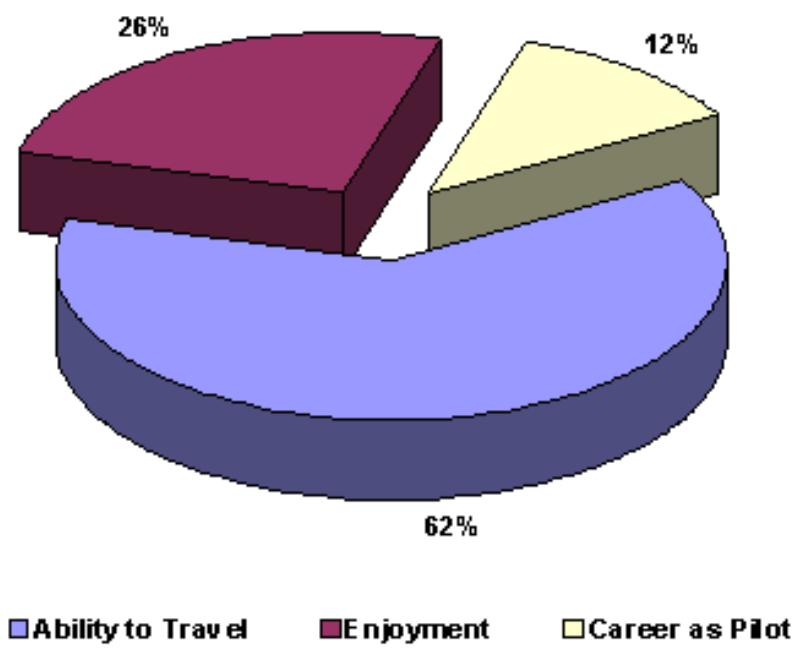


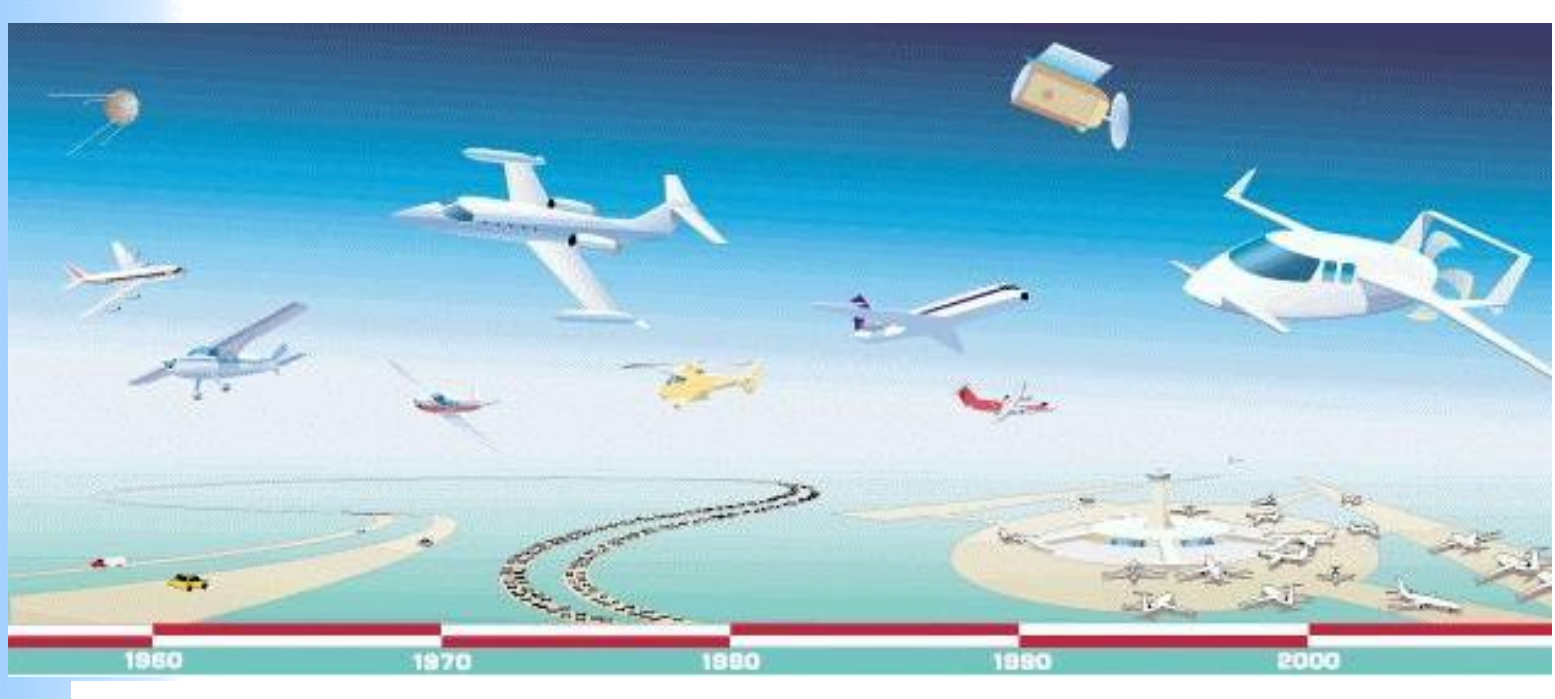
AGATE Survey Results

Benefits

Important Benefit of Flying

Potential Pilots

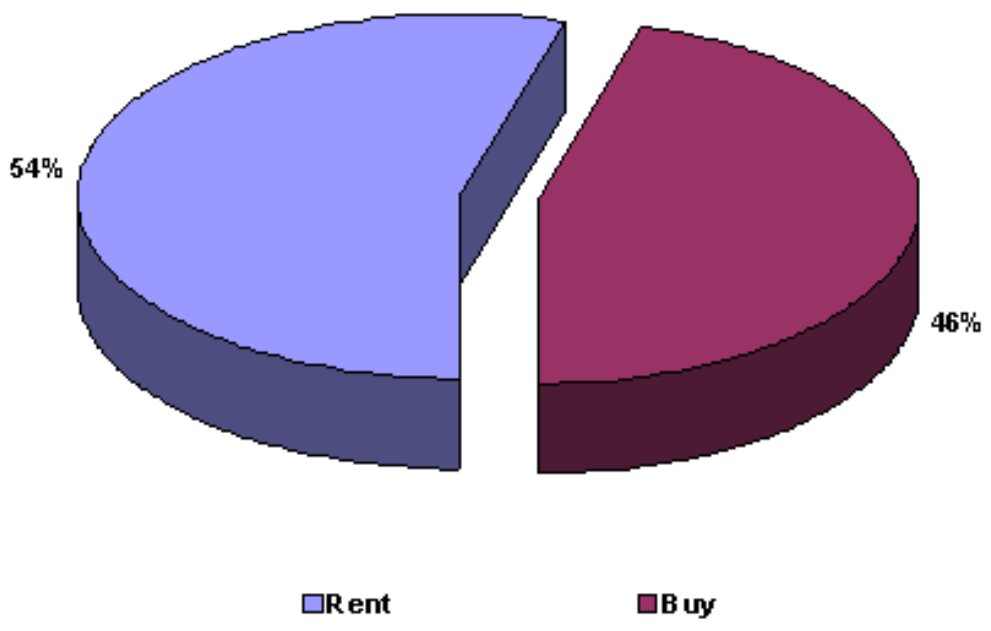


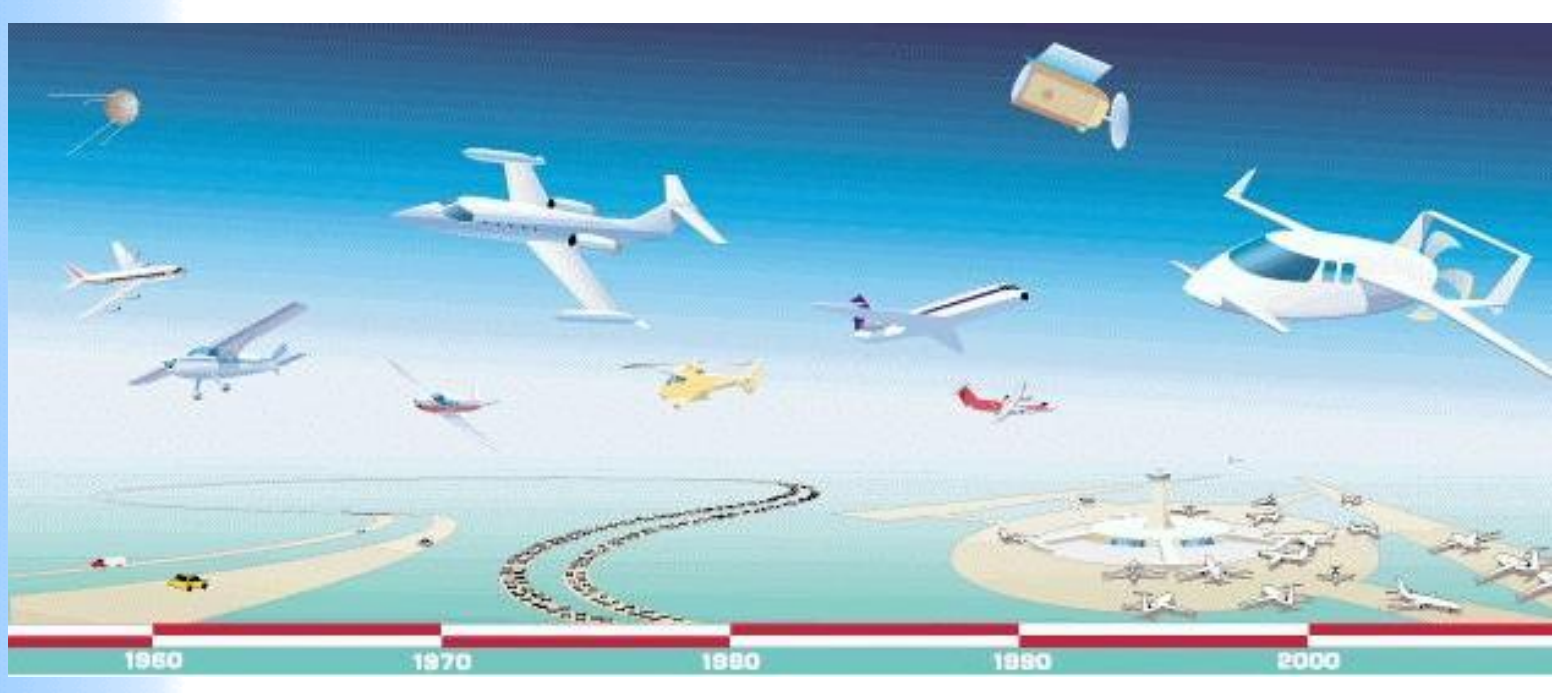


AGATE Survey Results

Purchase Plans

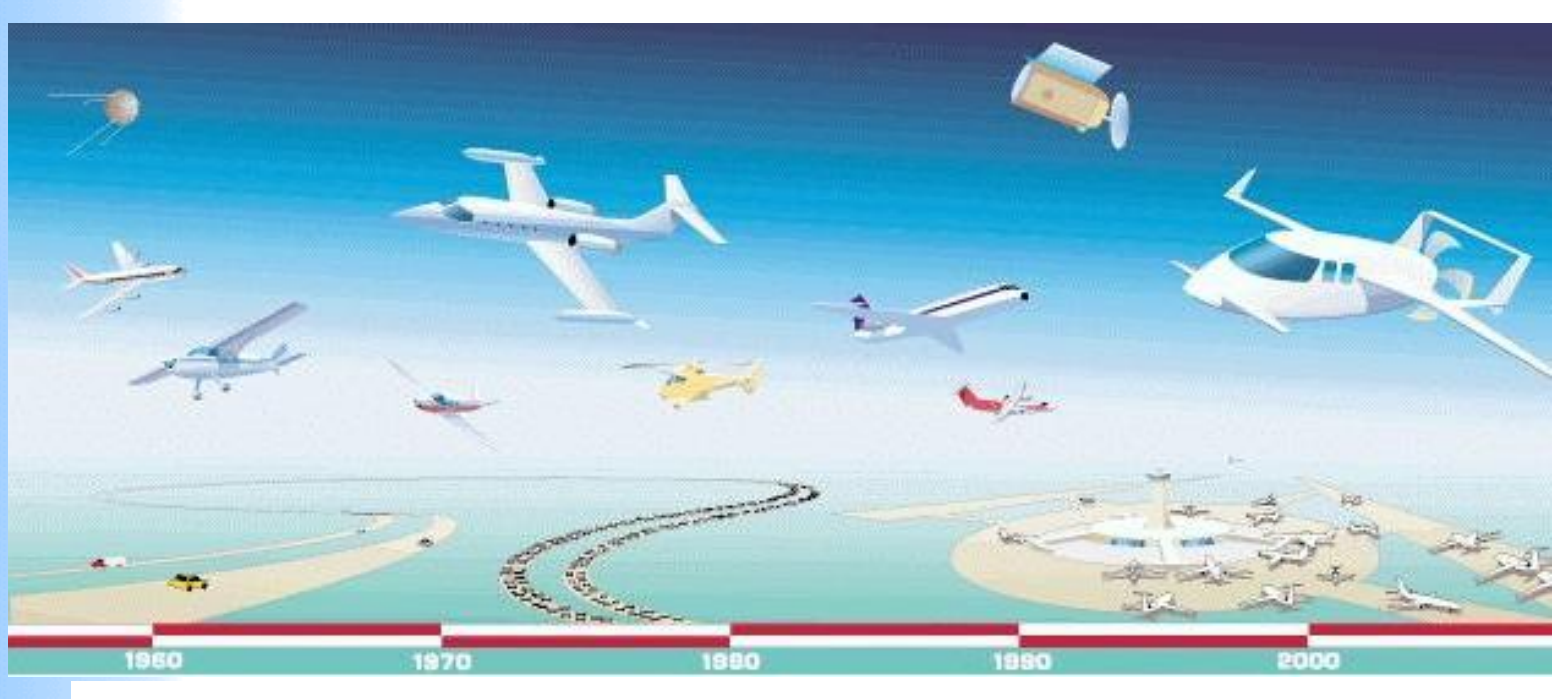
Potential Pilots 5 Year Plan for Airplane





AGATE Survey Results

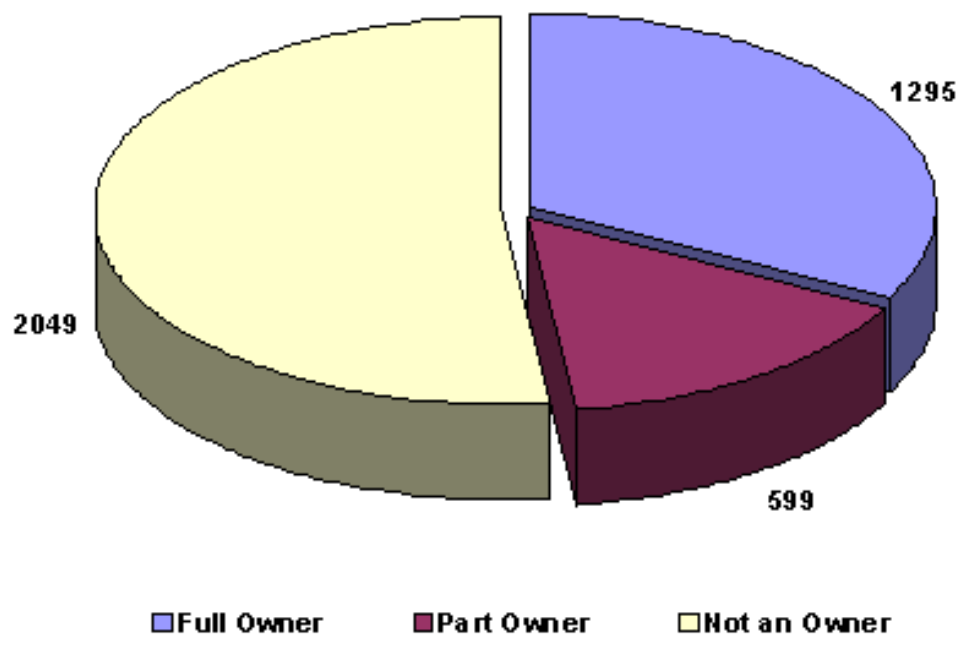
Pilot and Owner Information

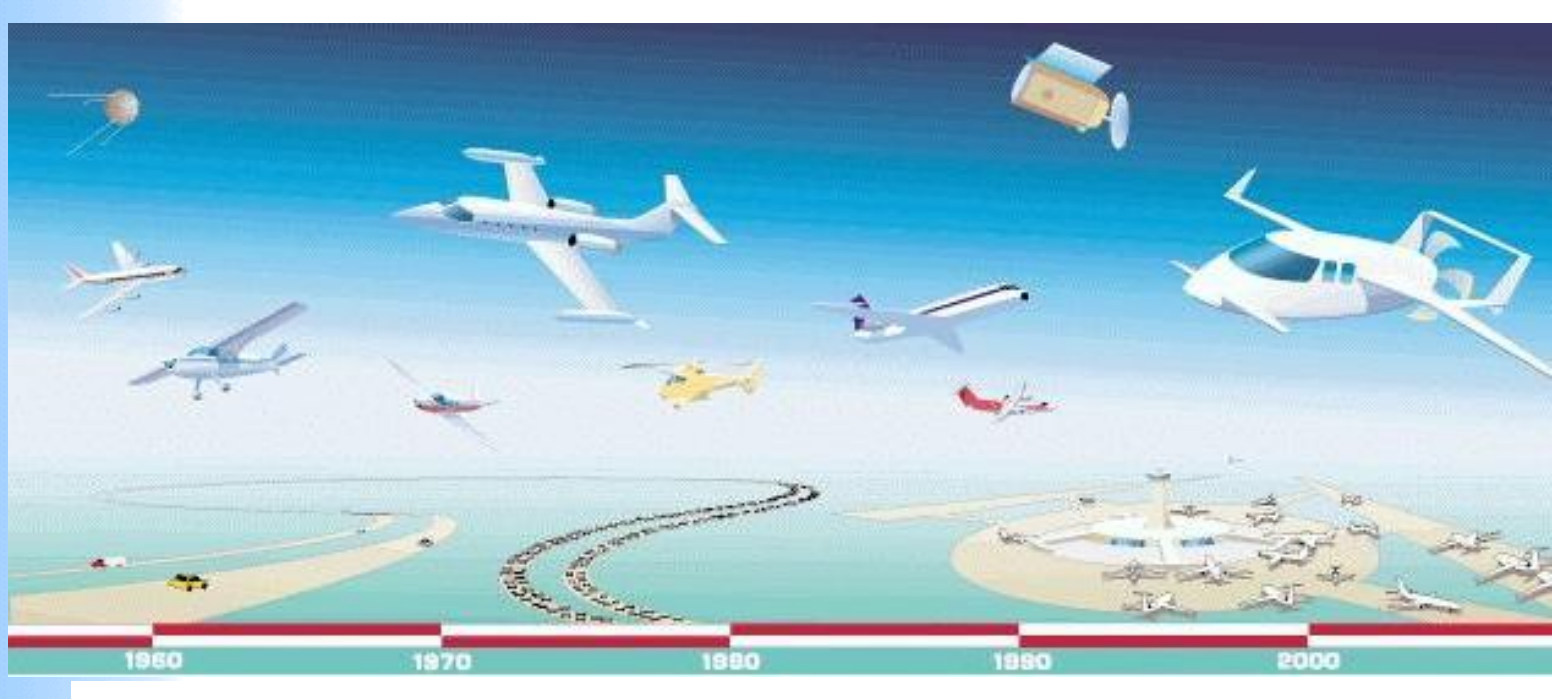


AGATE Survey Results

Owner Status

Ownership of an Airplane



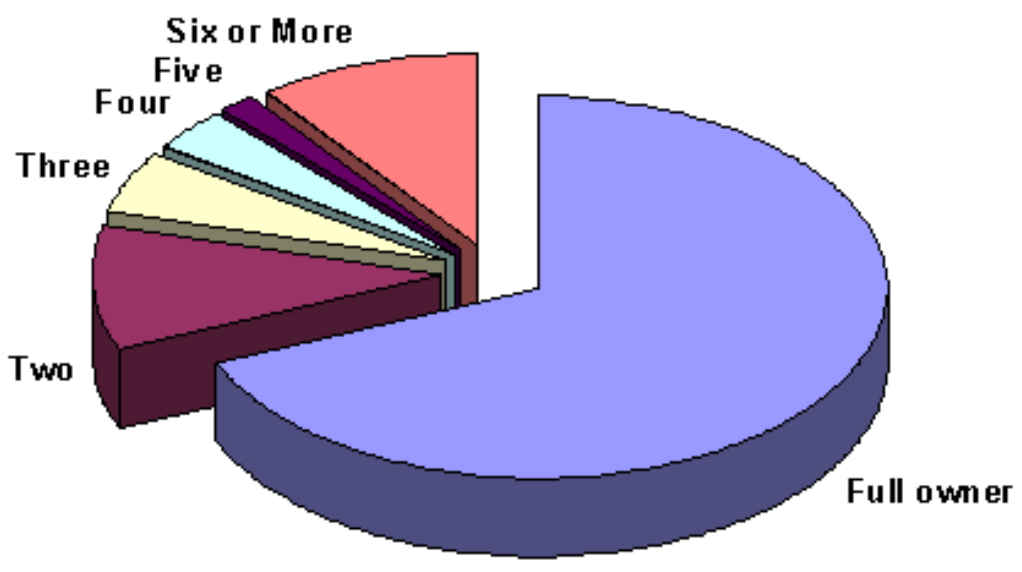


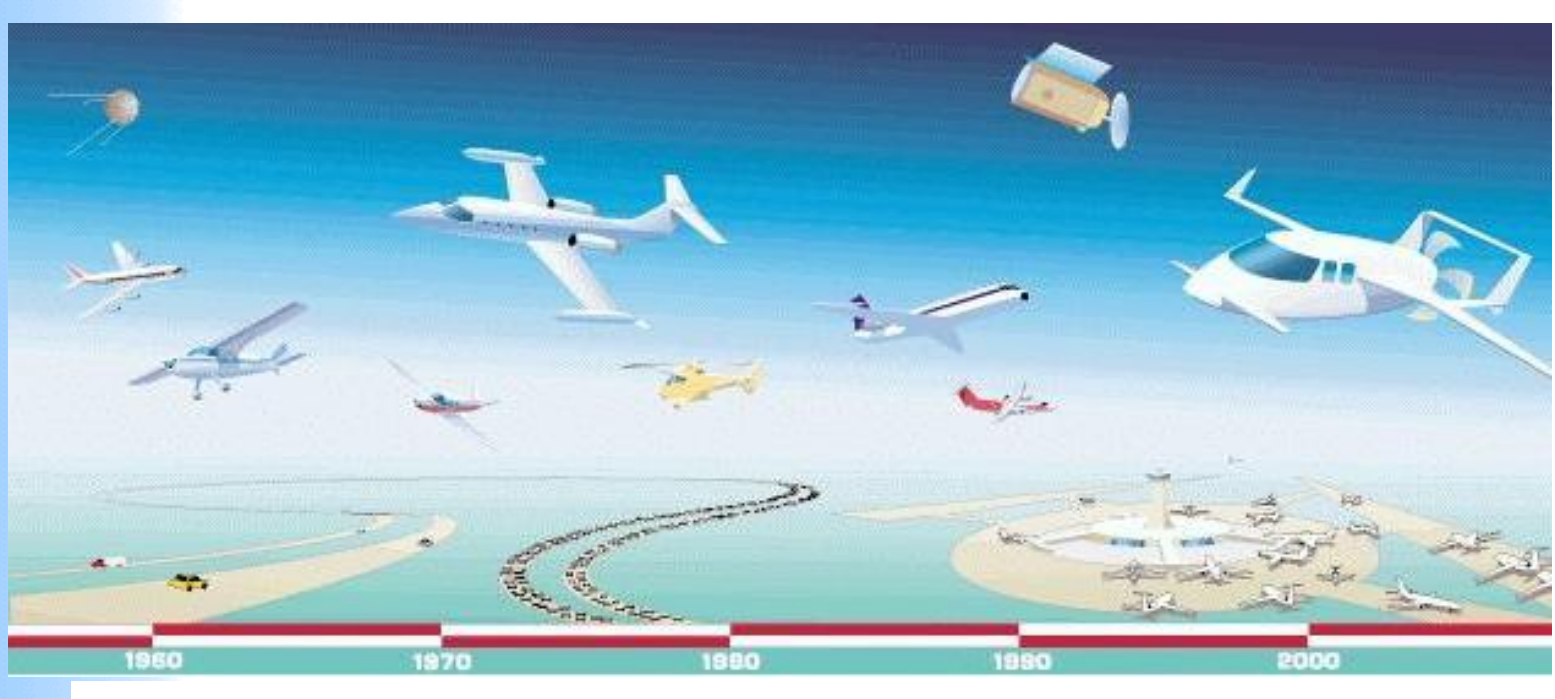
AGATE Survey Results

Number of Owners

Plane Ownership

(Number of Owners)

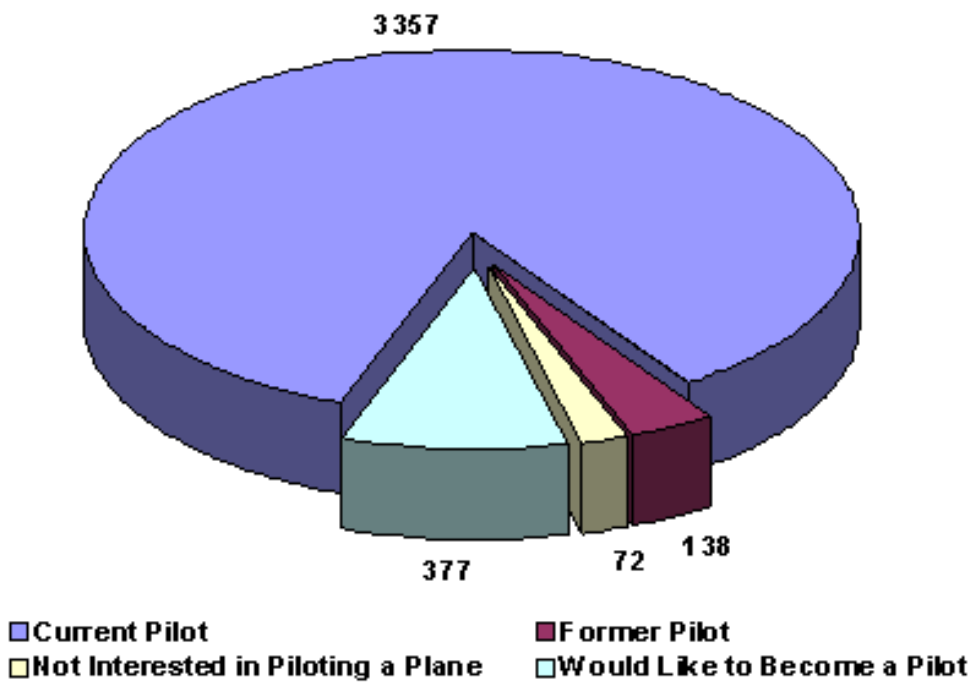


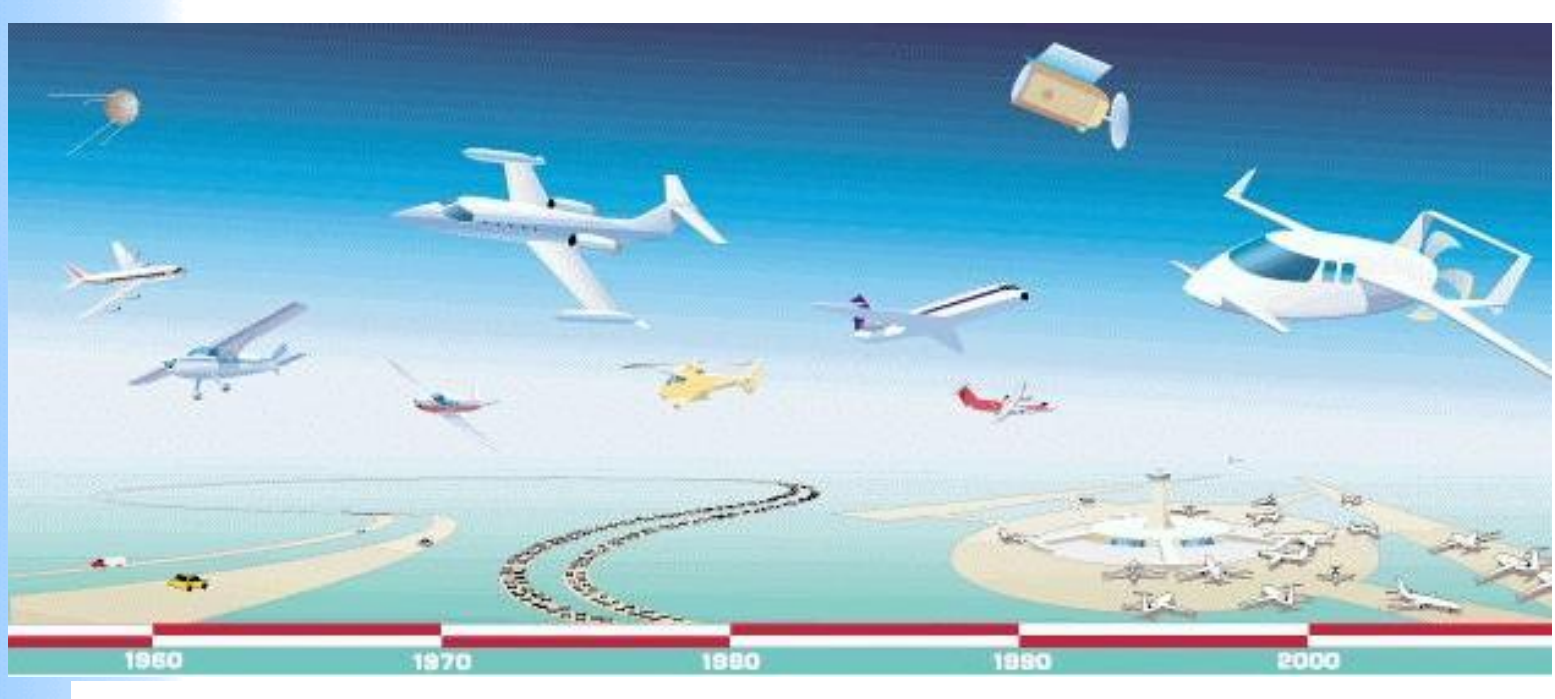


AGATE Survey Results

Pilot Demographics

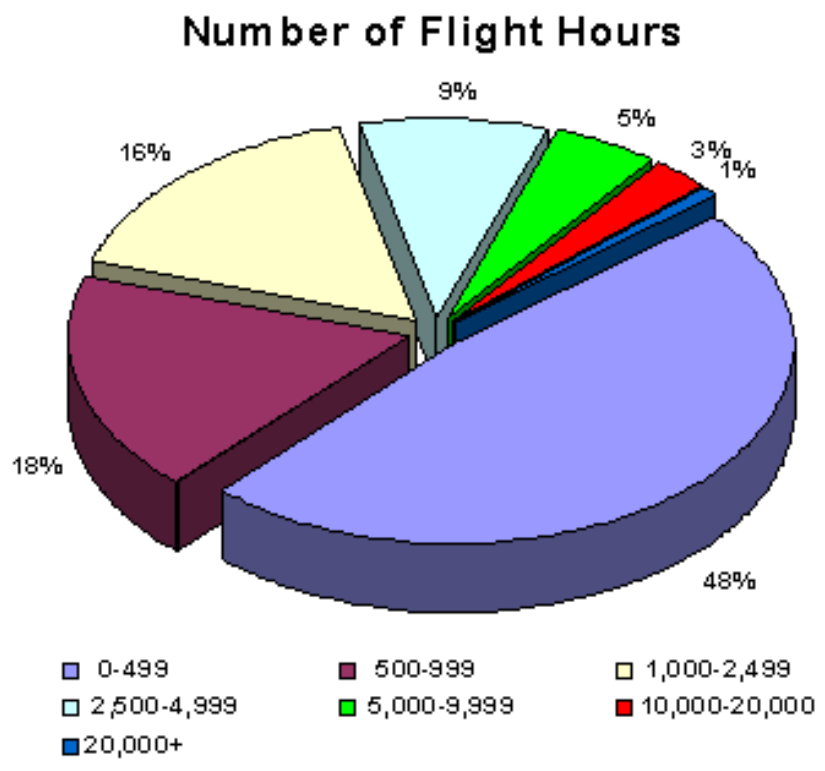
Pilot Status

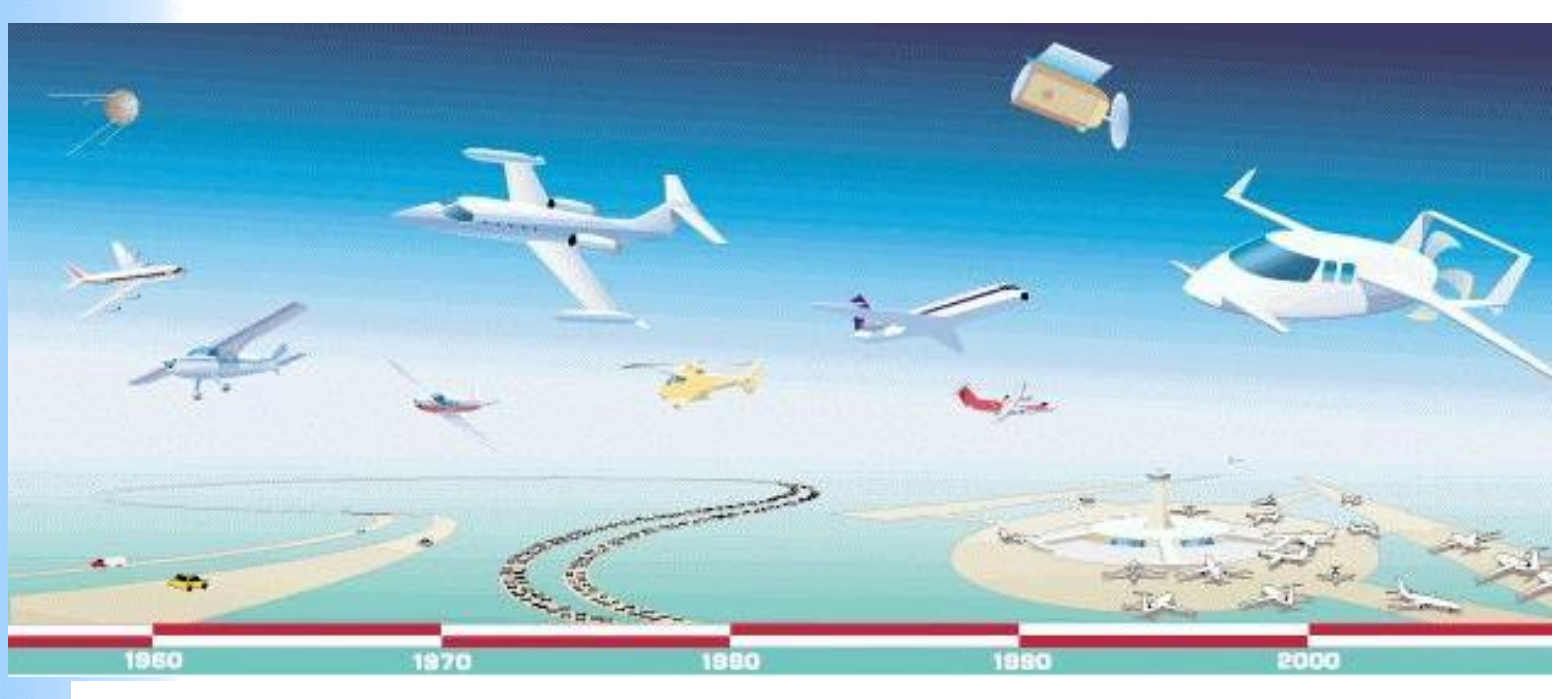




AGATE Survey Results

Flight Hours

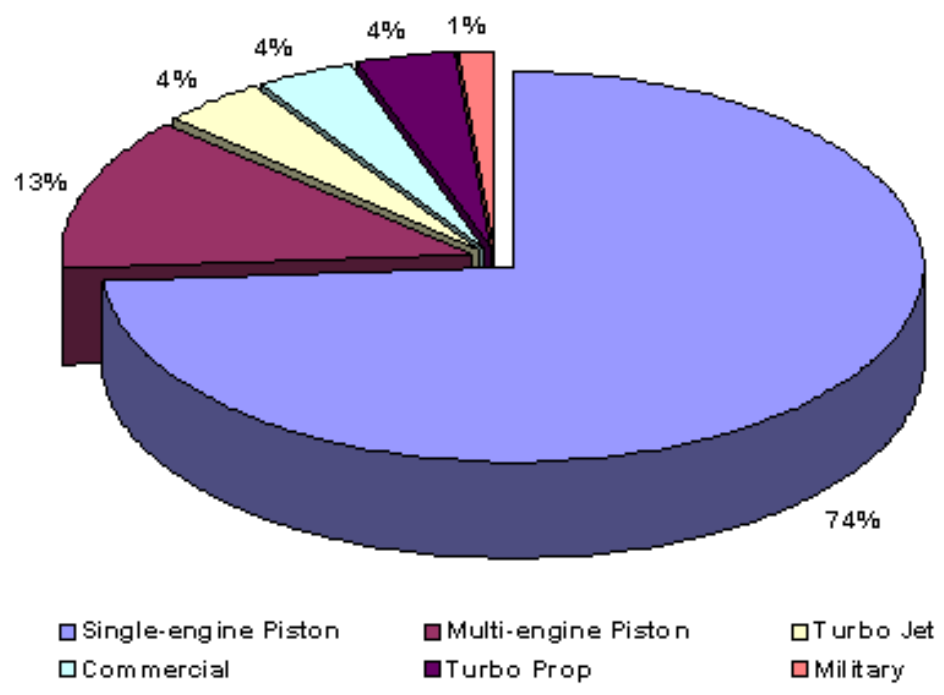


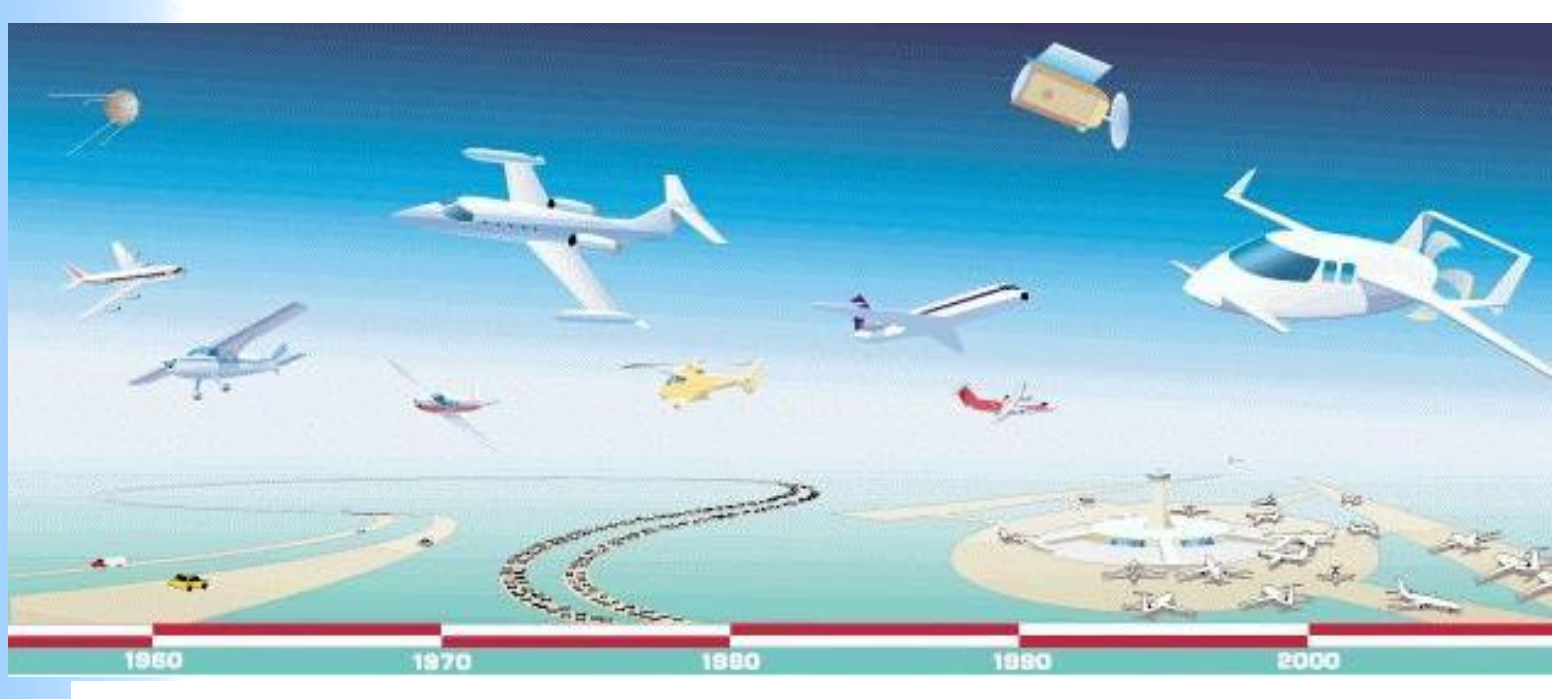


AGATE Survey Results

Planes Flown

Types of Planes Flown

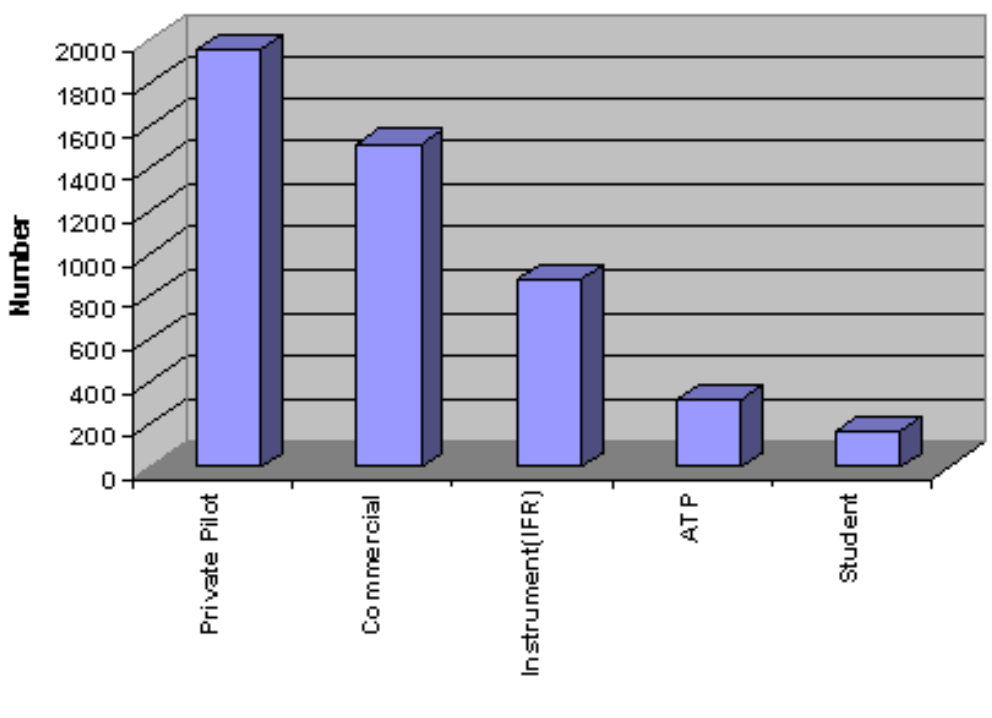


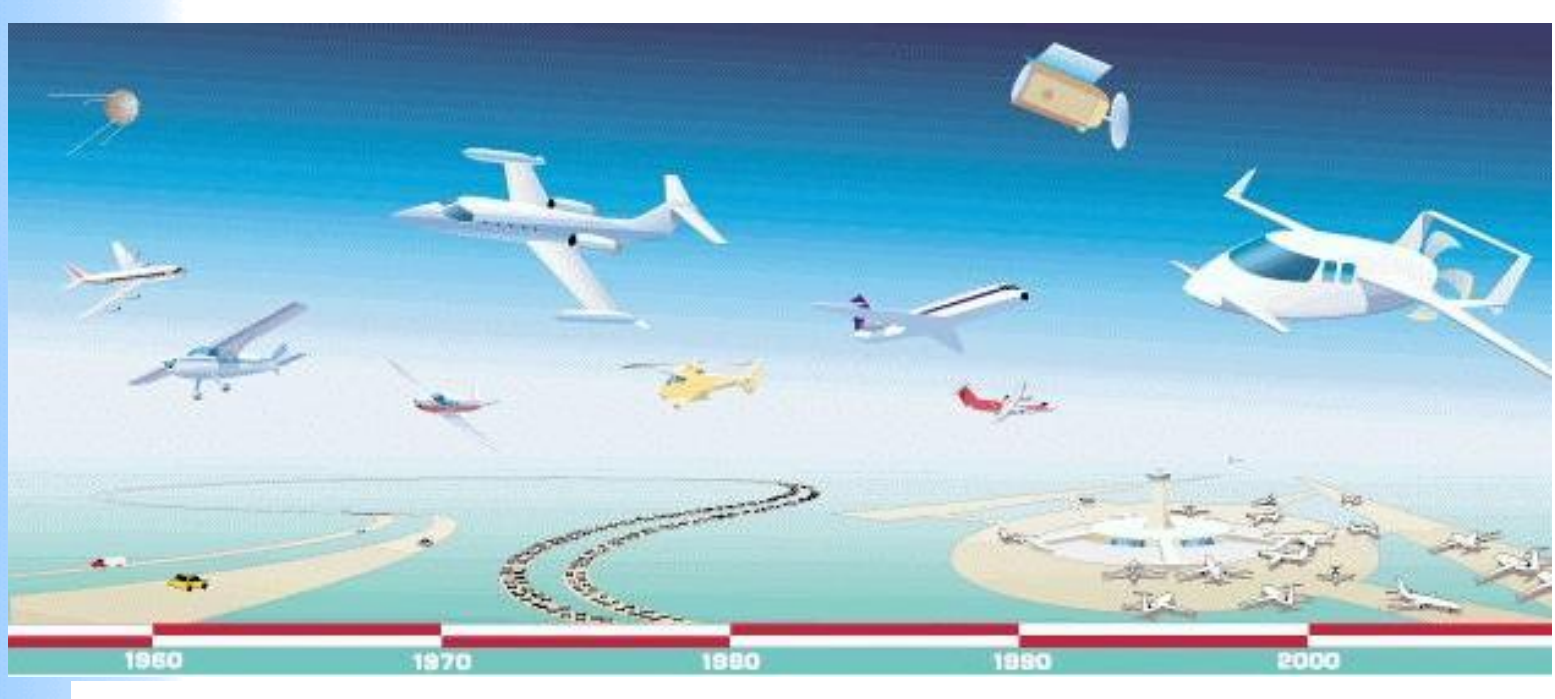


AGATE Survey Results

Rating Distribution

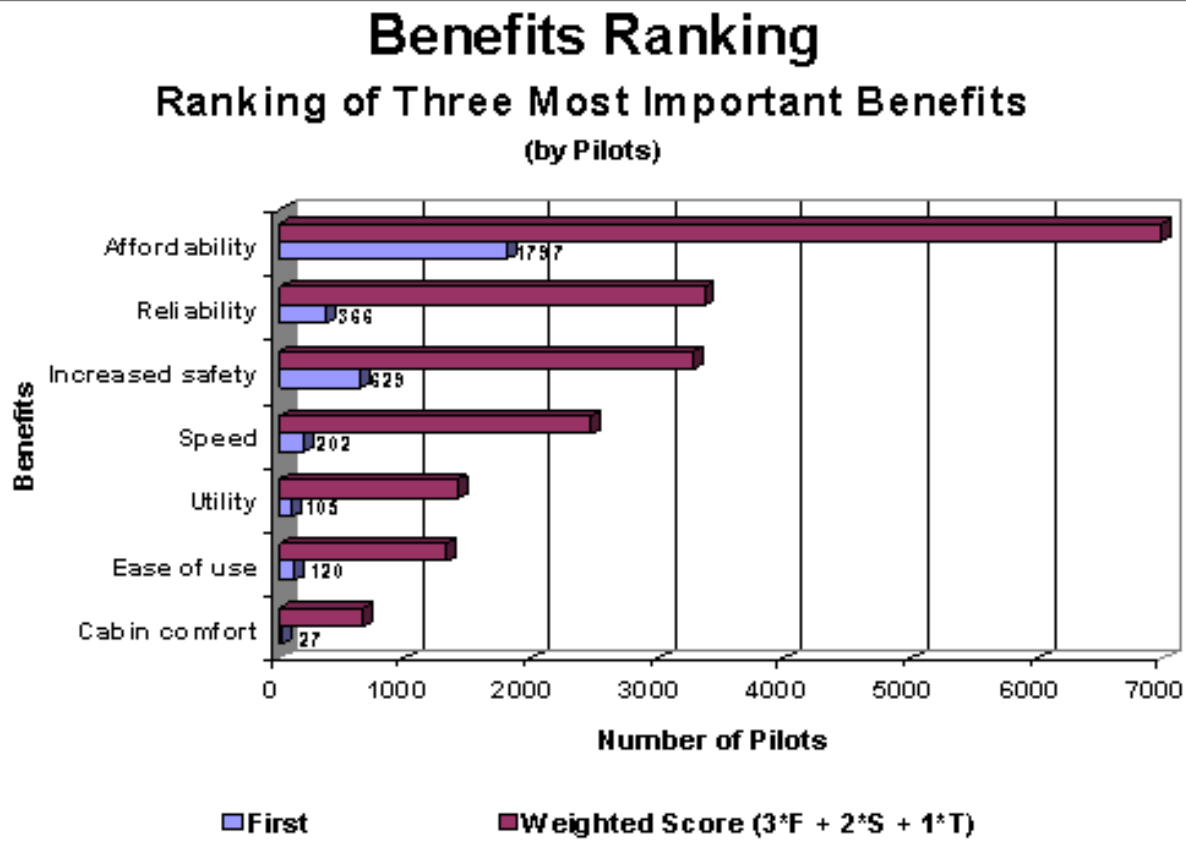
Distribution of Pilot Ratings

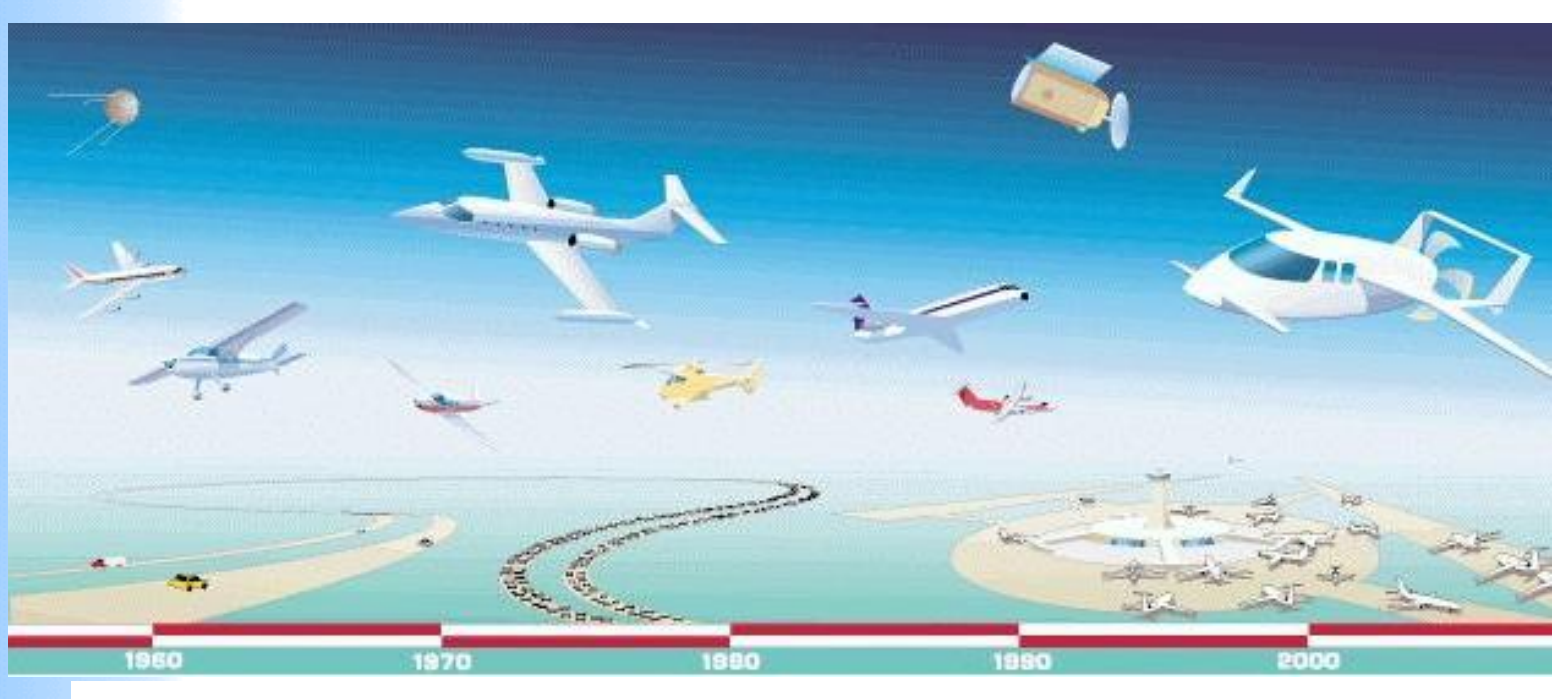




AGATE Survey Results

Benefits Ranking

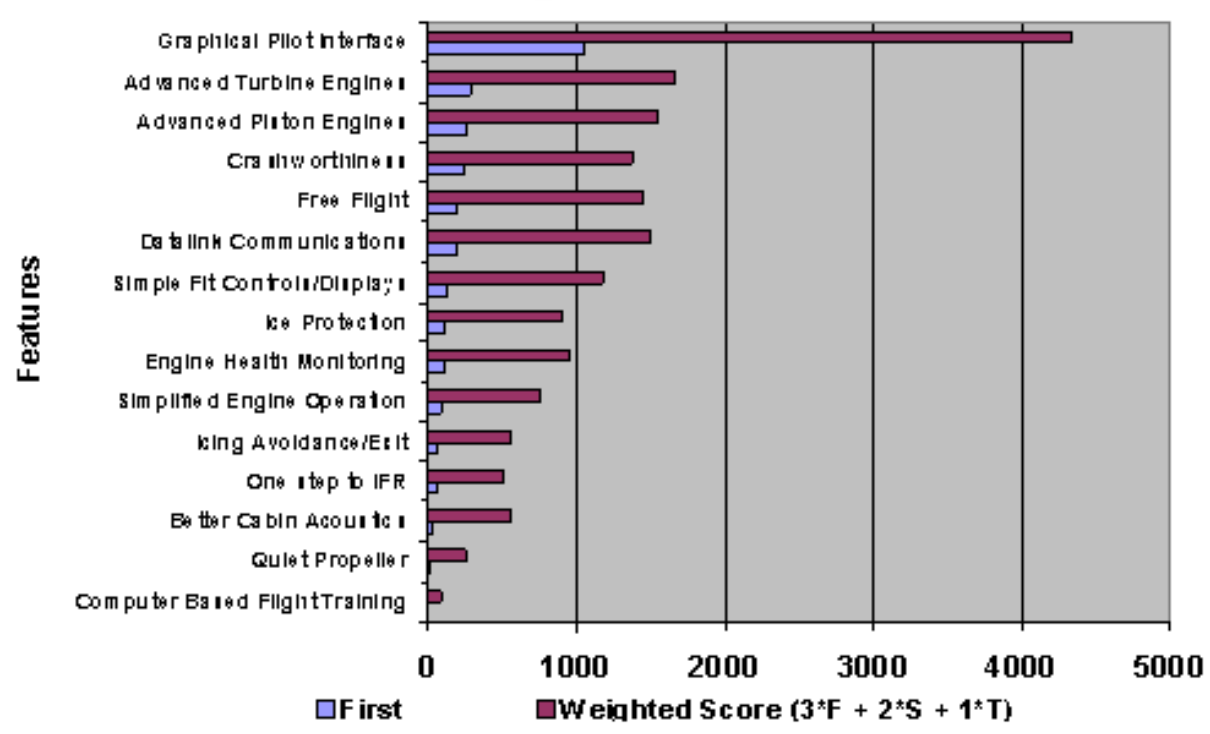


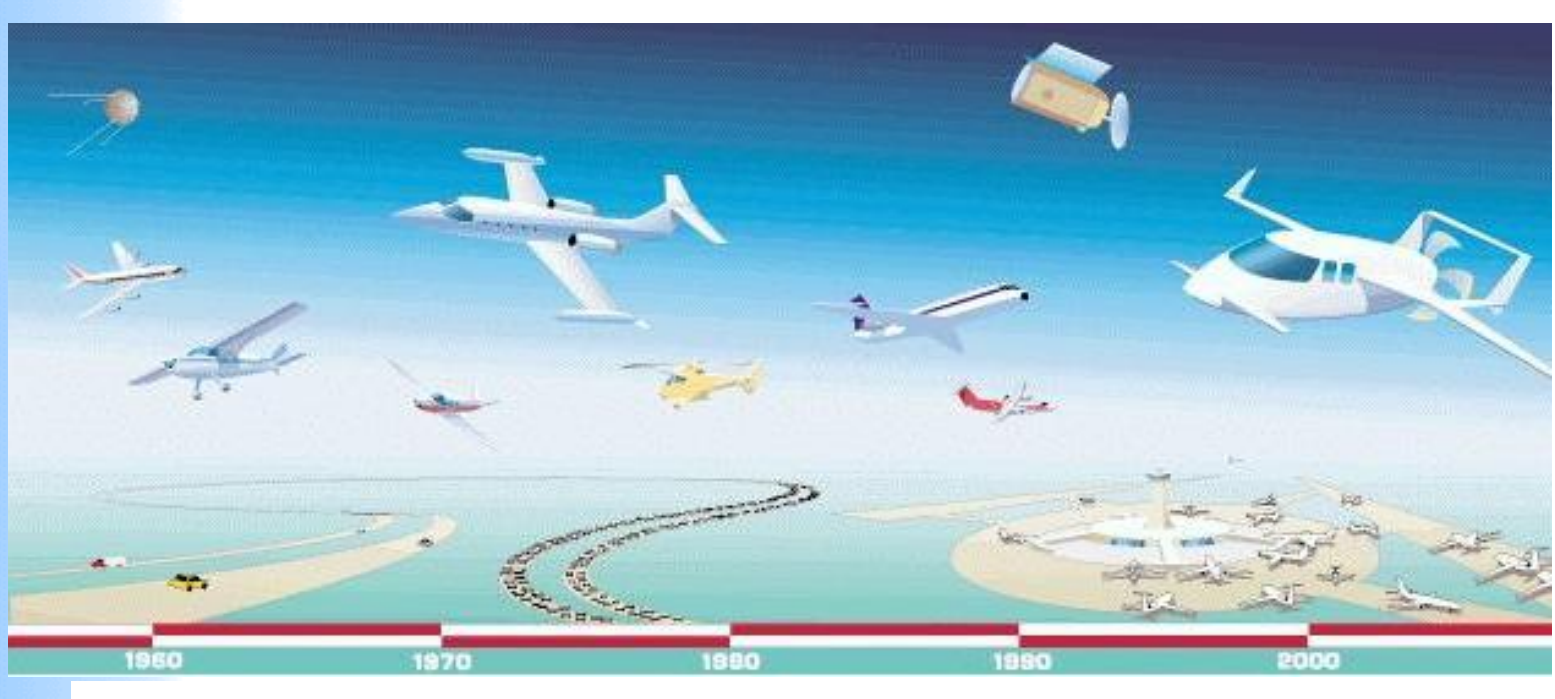


AGATE Survey Results

Features Ranking

Pilot Ranking of AGATE Features



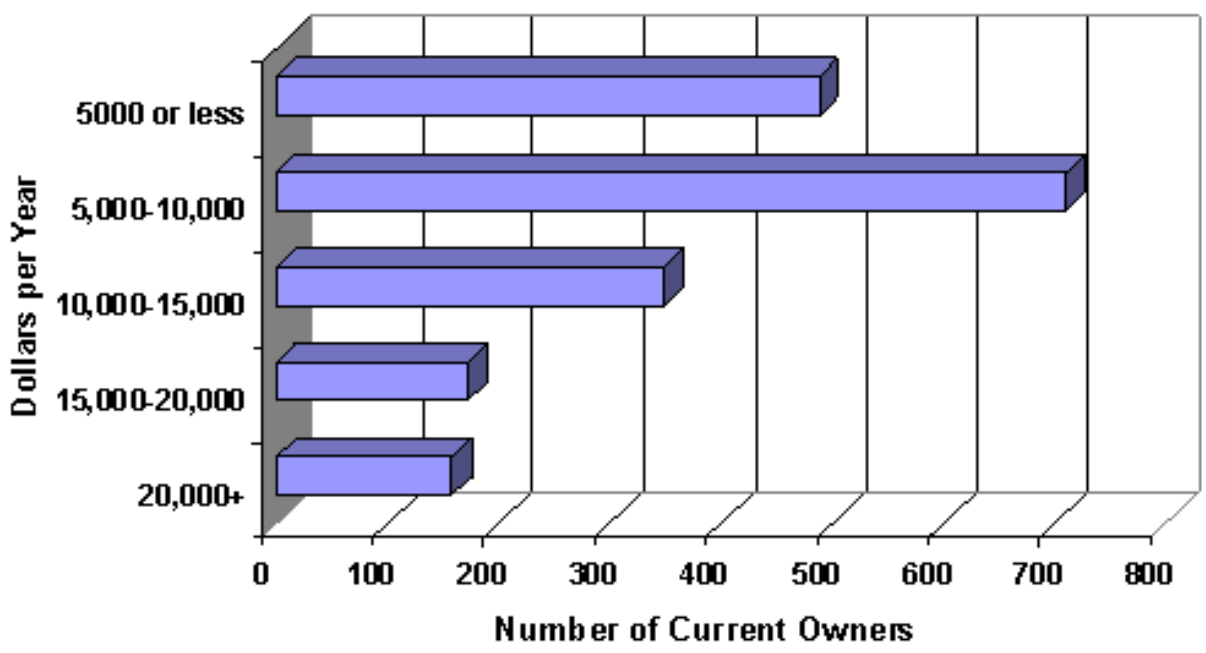


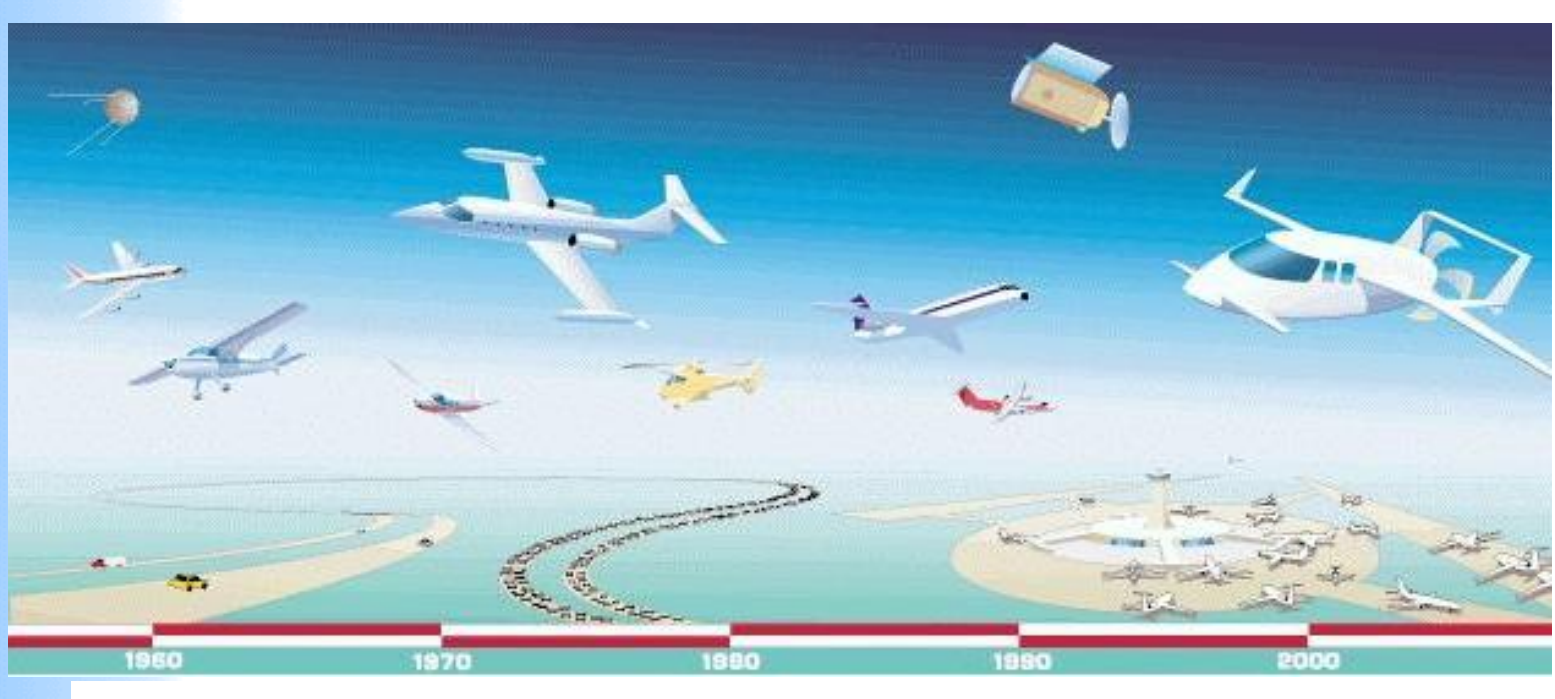
AGATE Survey Results

Ownership Cost

Annual Plane Ownership Cost

(includes flying, maintenance, storage, fuel, repairs, insurance, etc.)



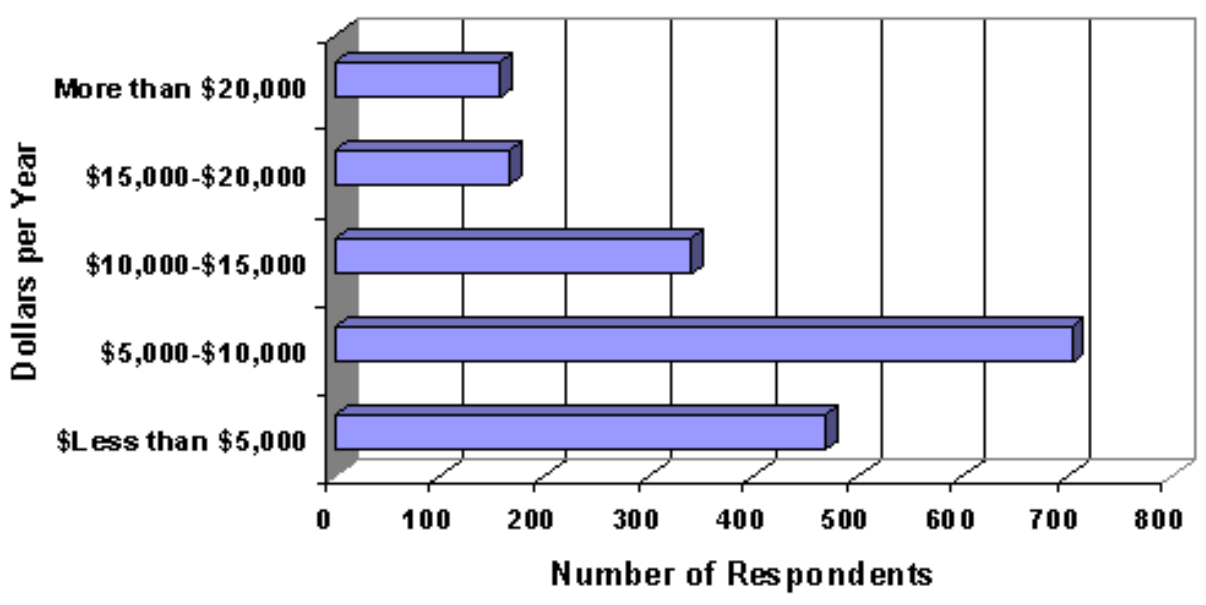


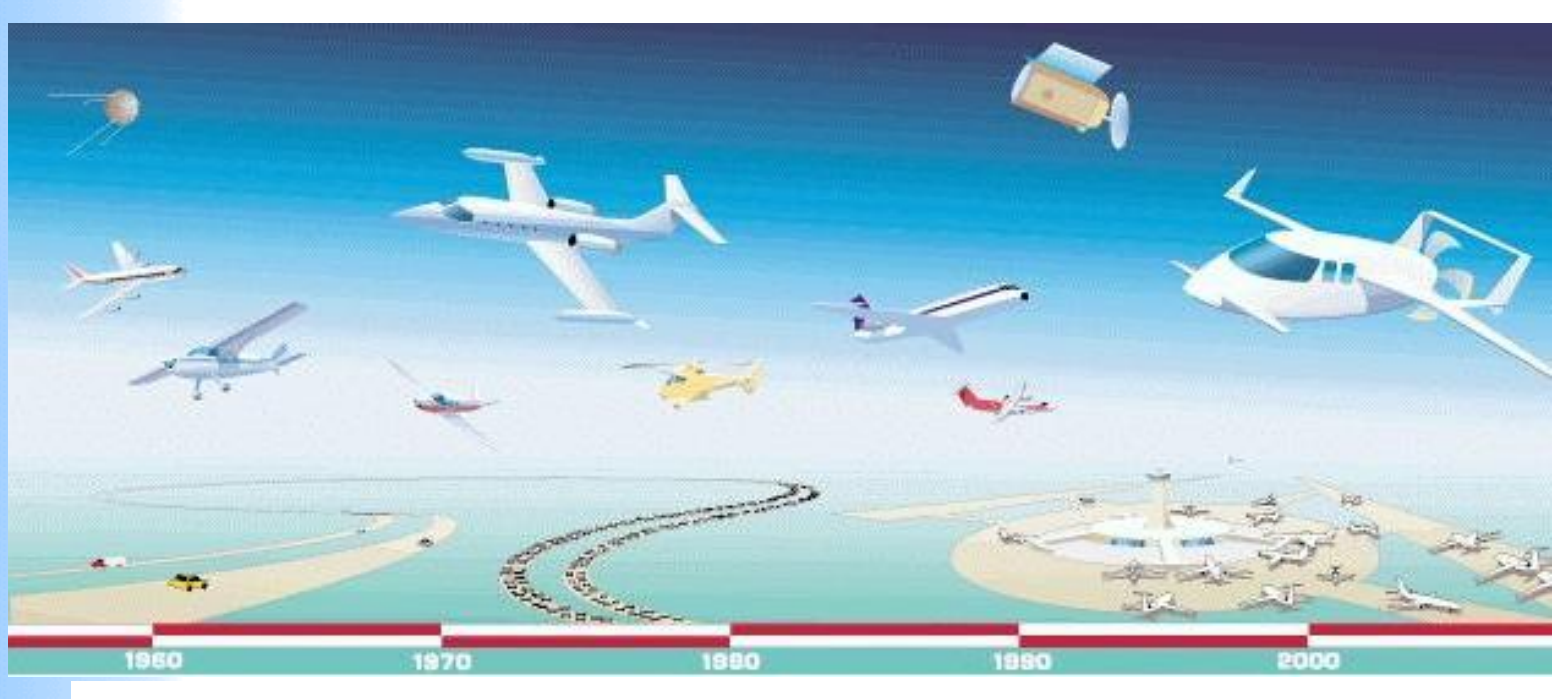
AGATE Survey Results

Pilot Costs

Annual Cost for Pilots who are not Owners

(Maintain License, Rent Planes, Etc.)





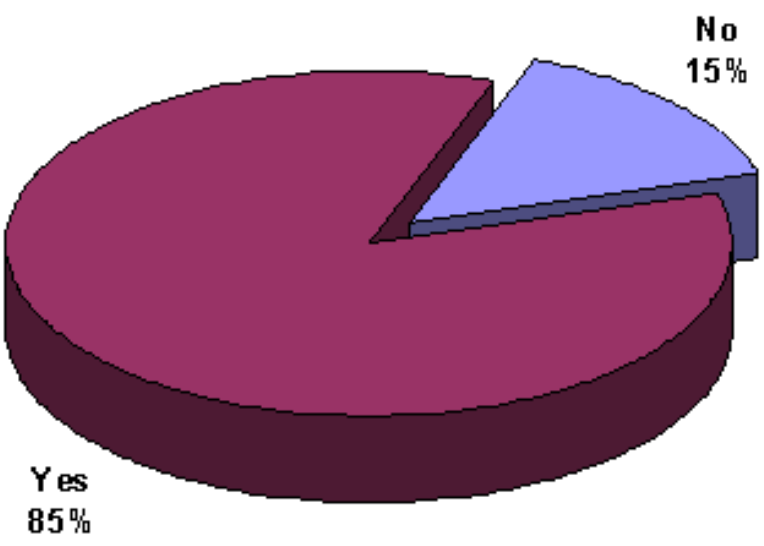
AGATE Survey Results

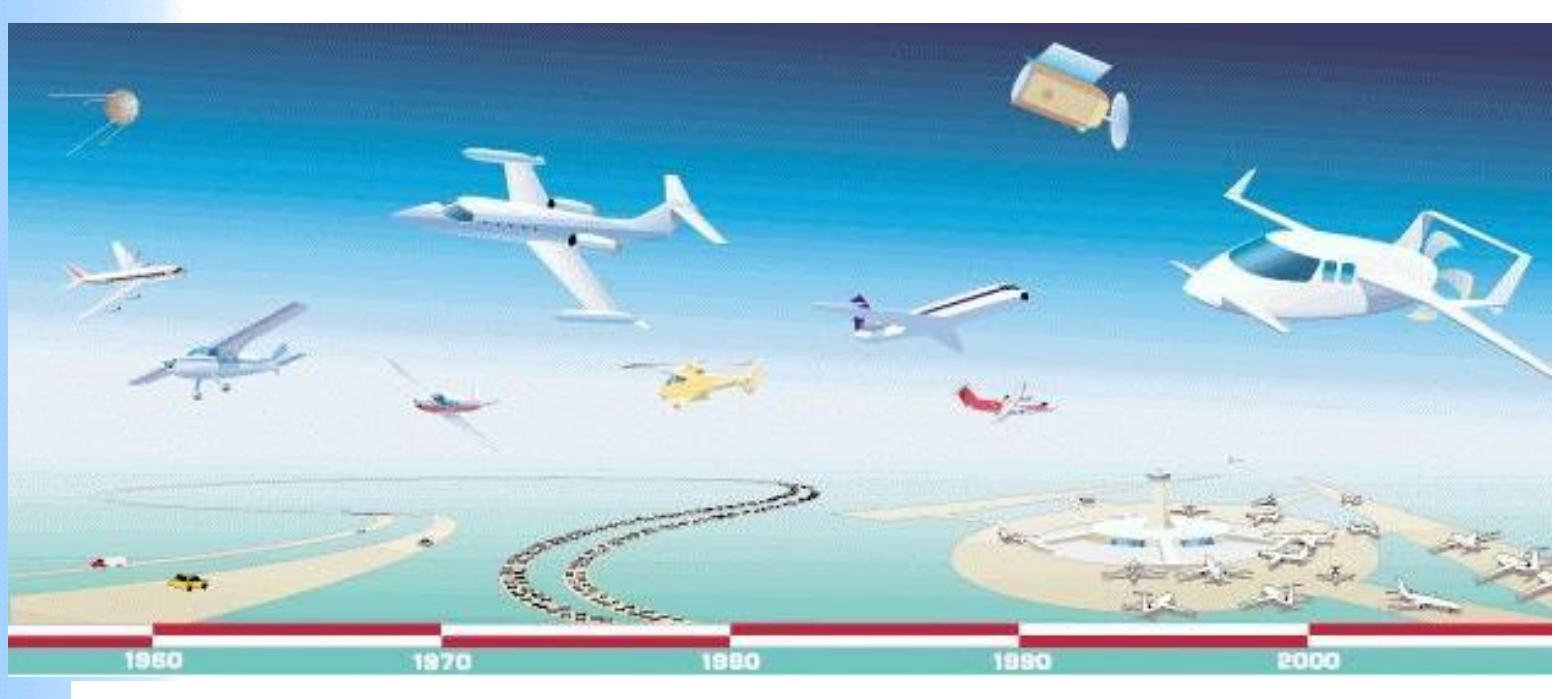
Purchase Information

Consider Purchasing a Share of an Aircraft

People who travel frequently (Q 1>3)
and are a Pilot but not an Owner

1241 Respondents



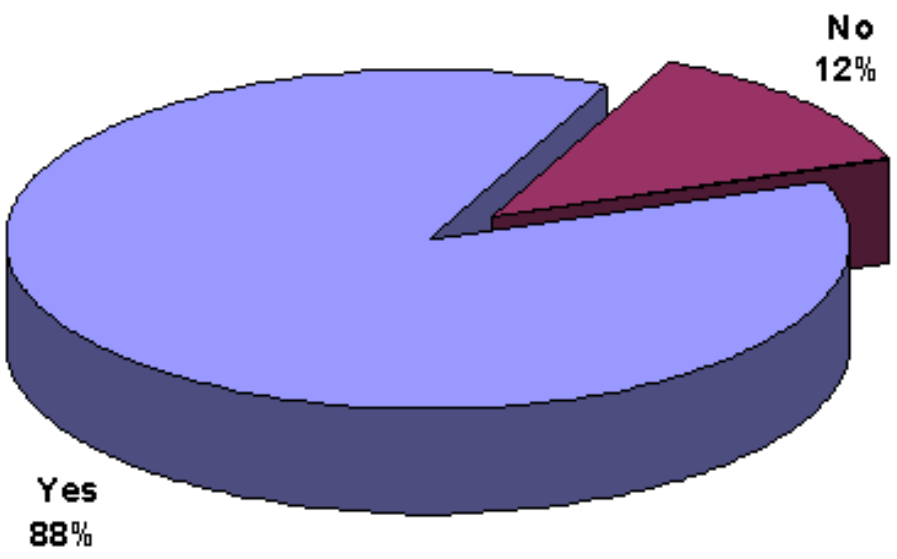


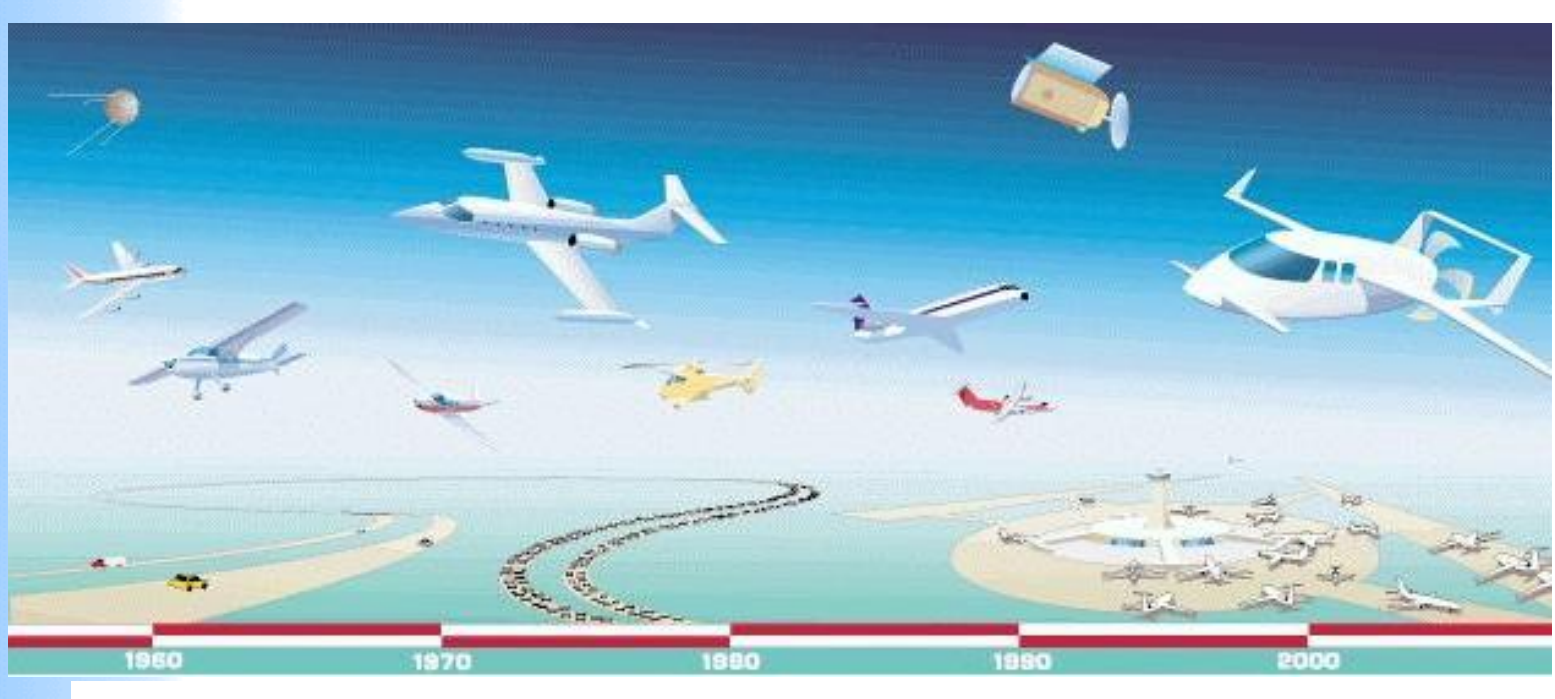
AGATE Survey Results

Retrofit Response

Willingness to Retrofit AGATE Derived Products

(Current Plane Owners)



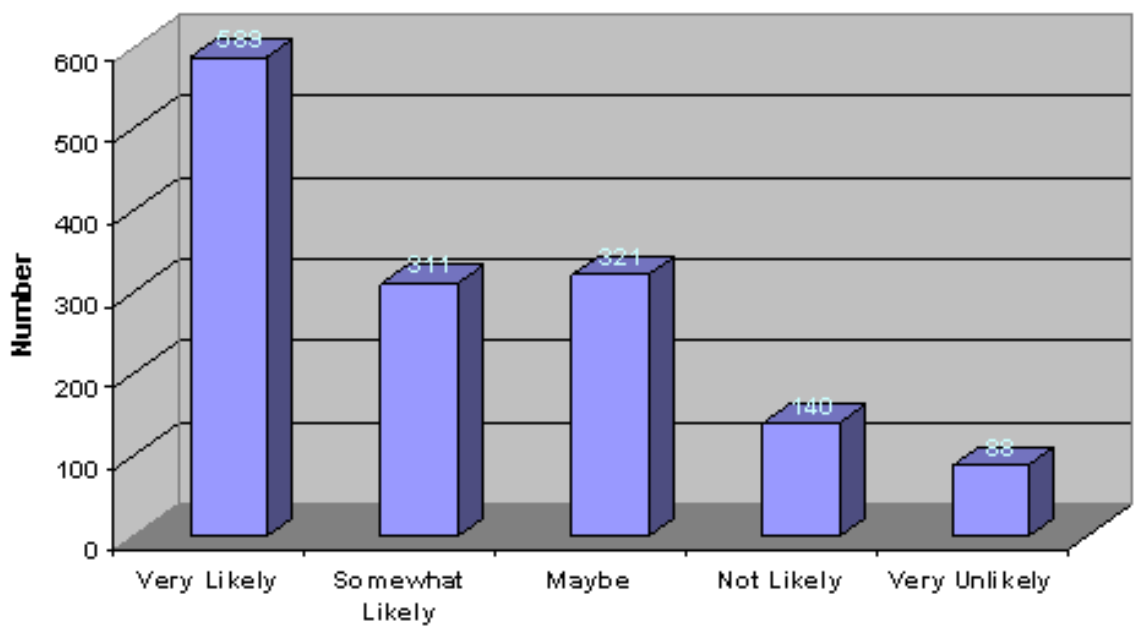


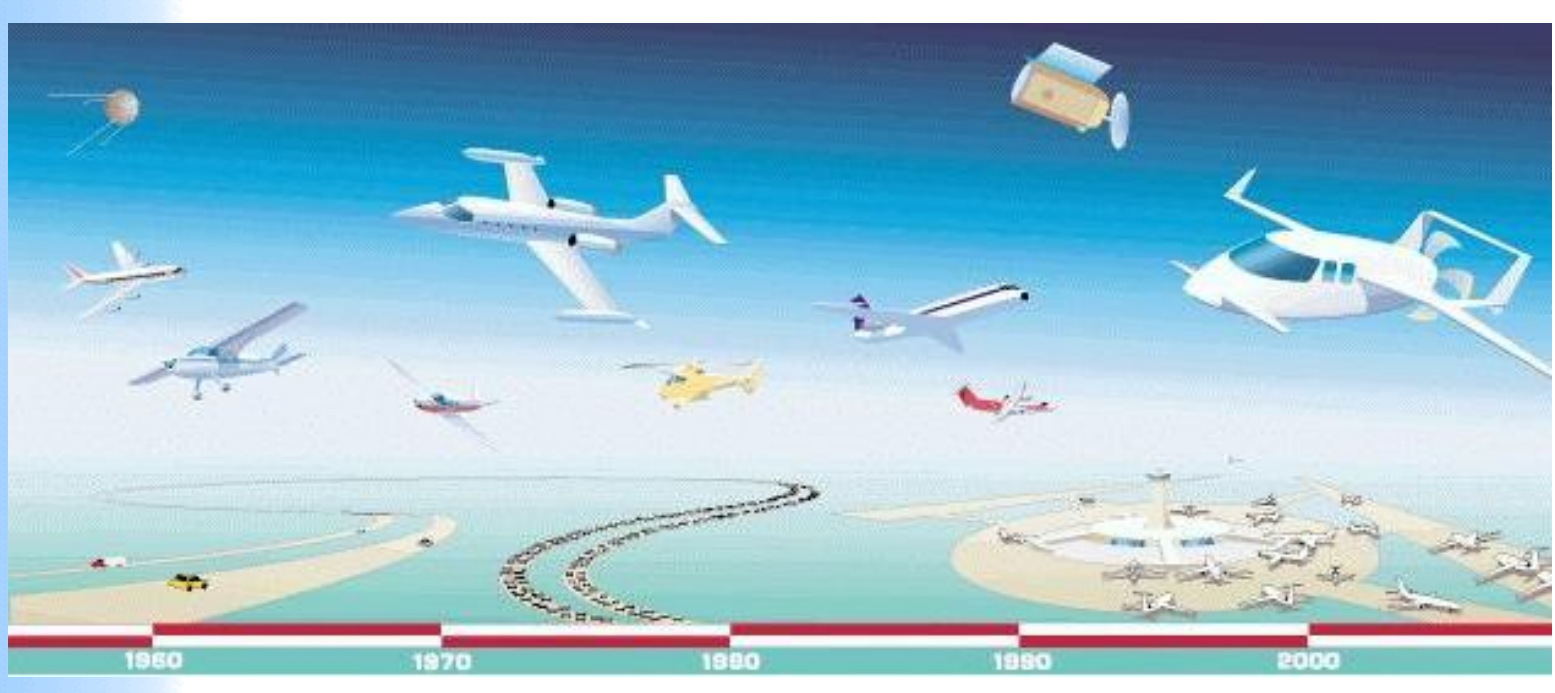
AGATE Survey Results

Purchase Probability

Pilots' Likelihood of Purchase

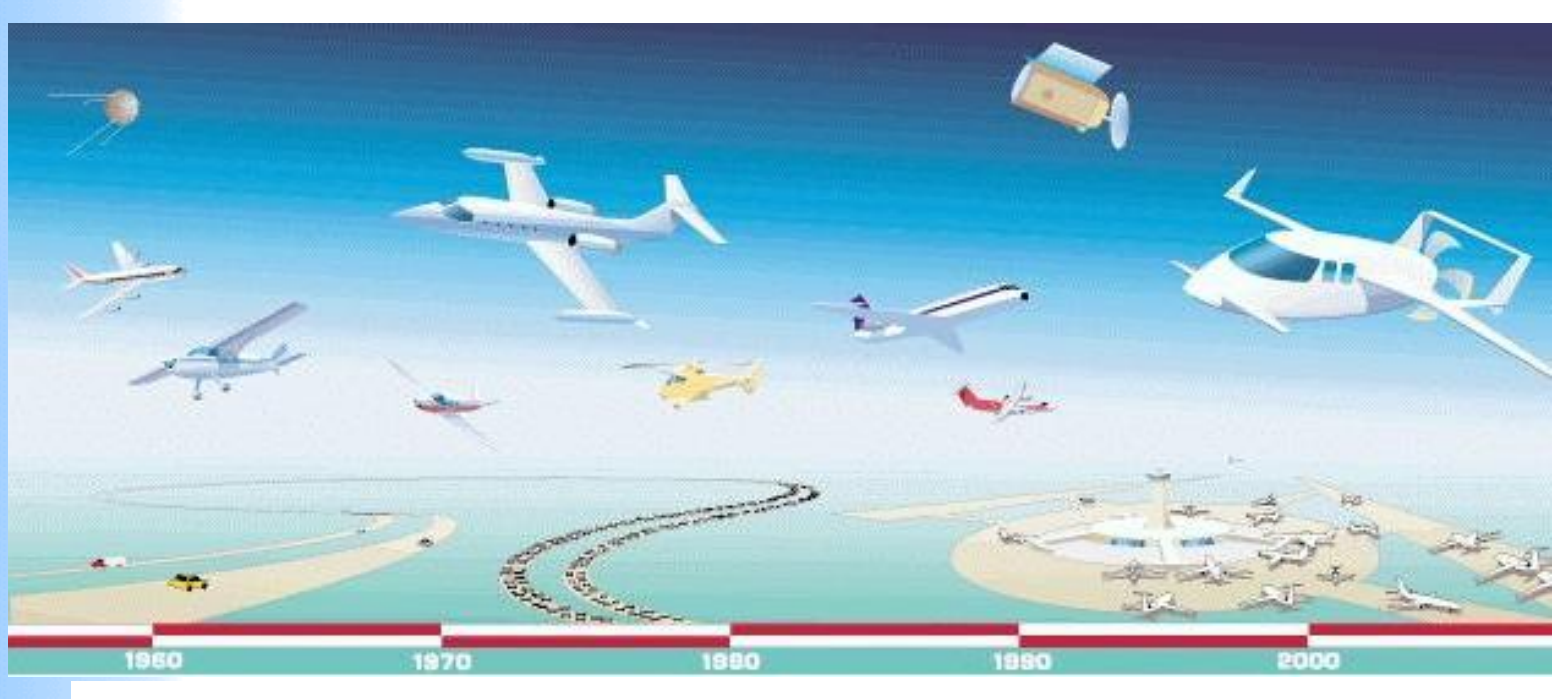
an Aircraft or Share in an Aircraft in Next 5 Years





AGATE Survey Results

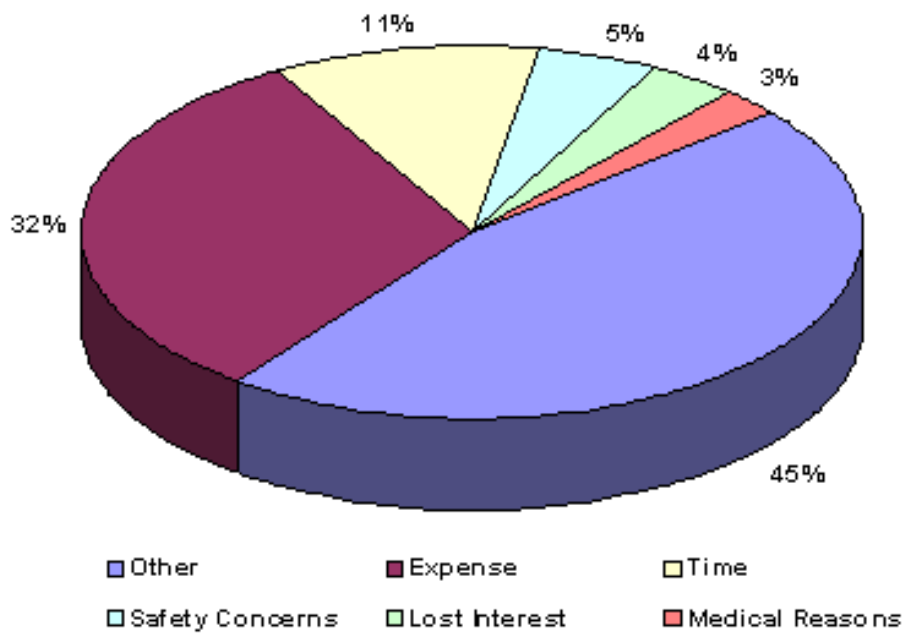
Former Pilot Information

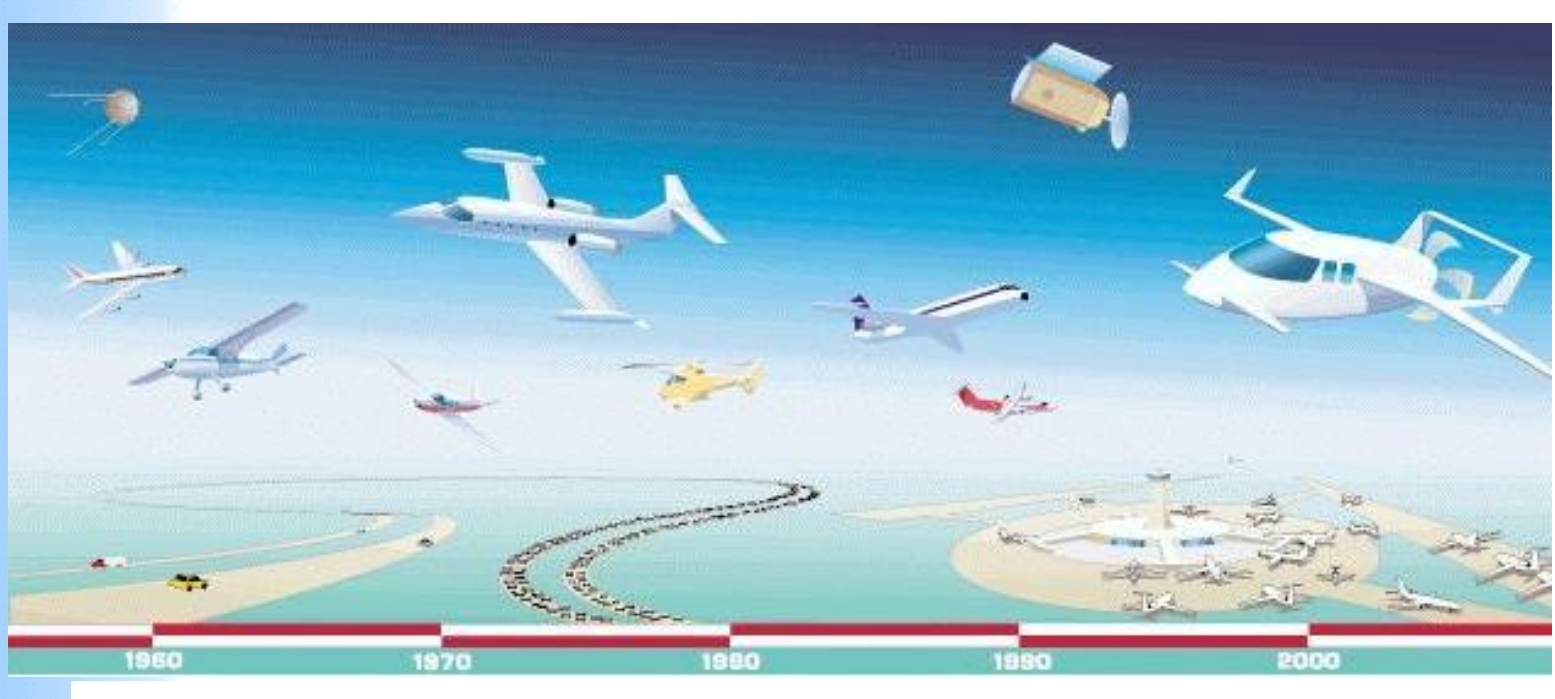


AGATE Survey Results

Rational

Reason for Quiting Flying

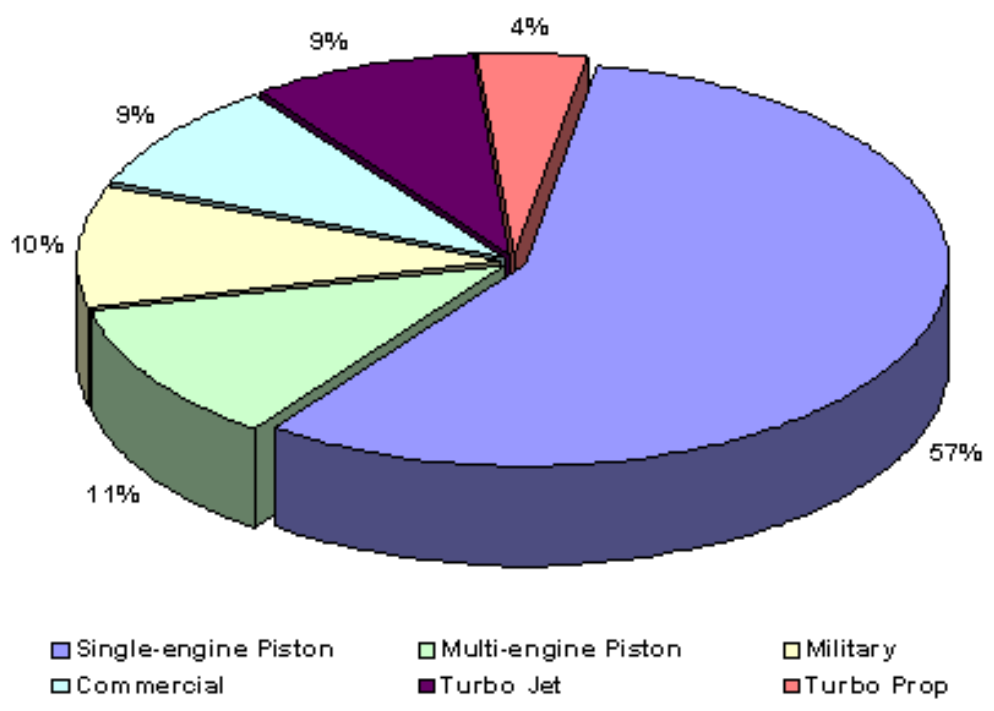


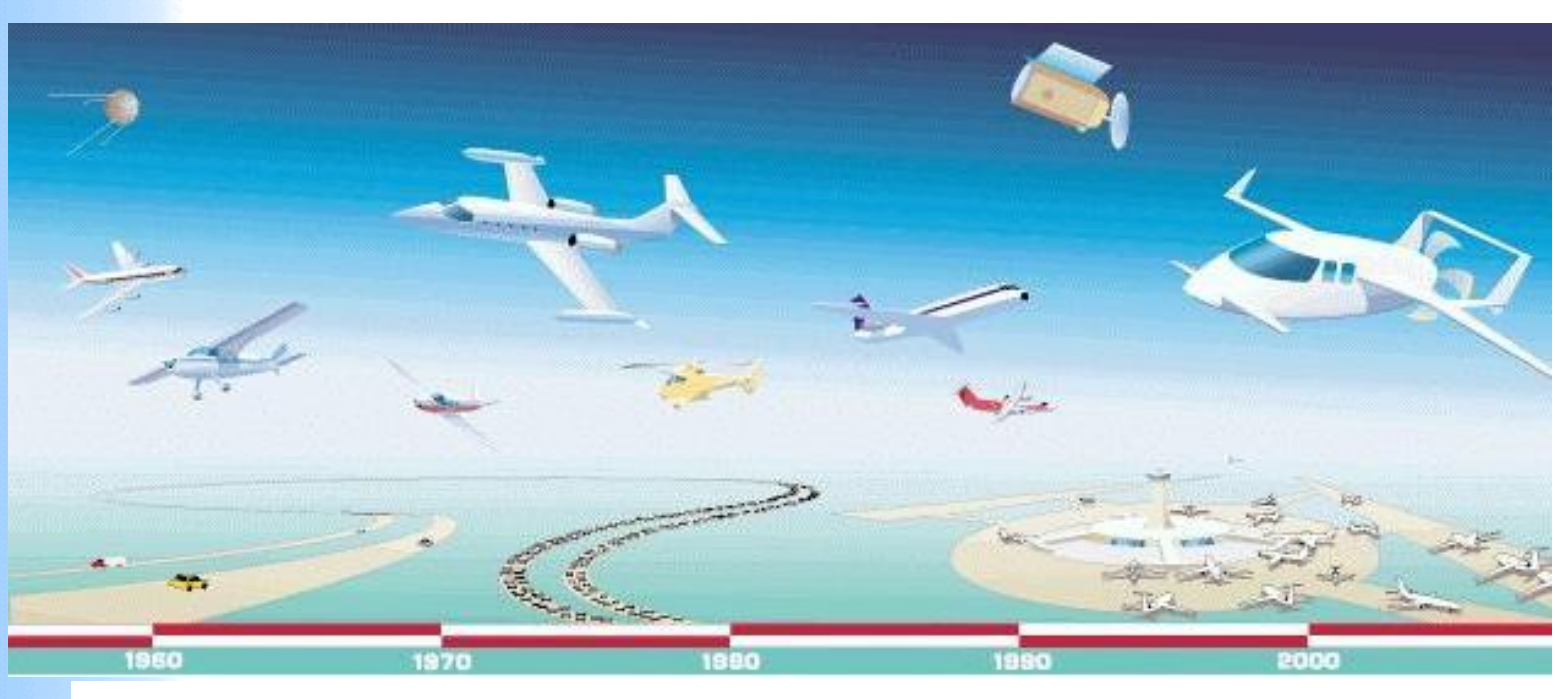


AGATE Survey Results

Former Pilot Aircraft

Former Pilots Flew

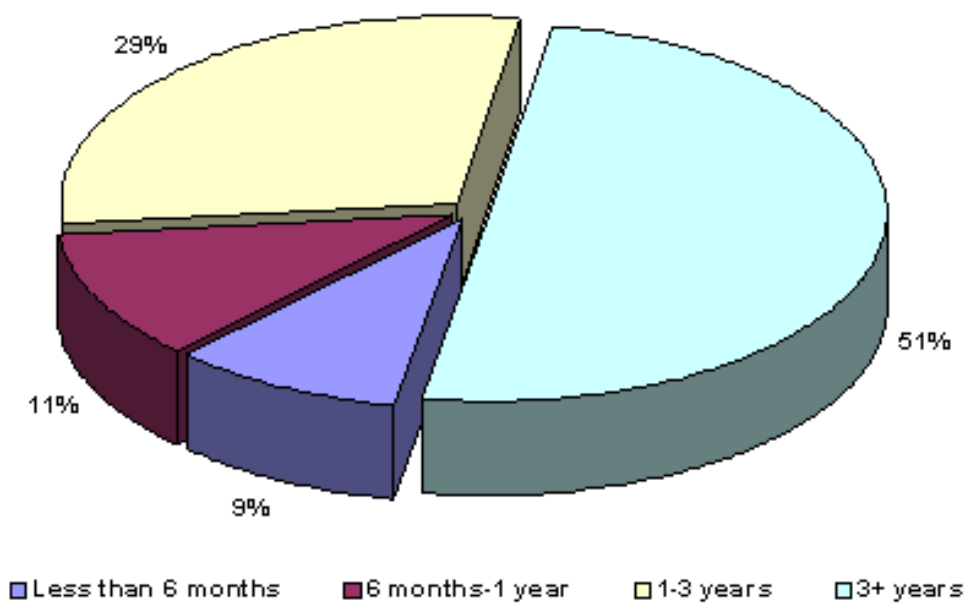


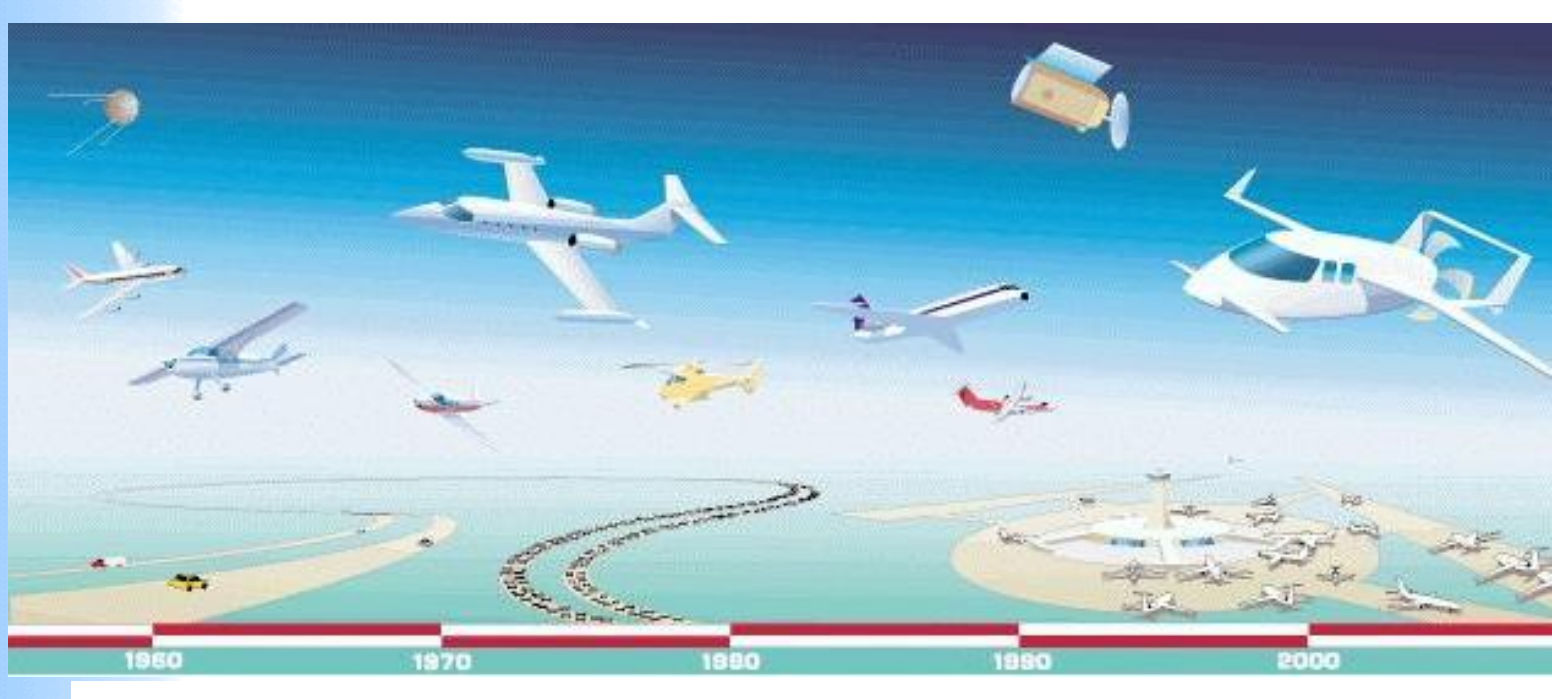


AGATE Survey Results

Last Flown

Former Pilots Last Piloted a Plane

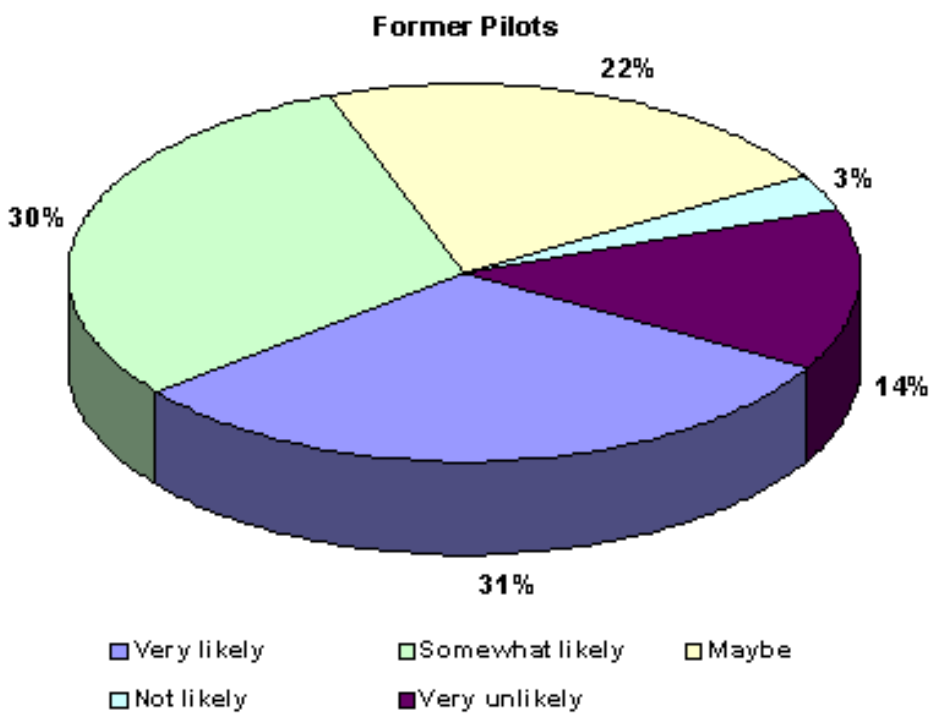


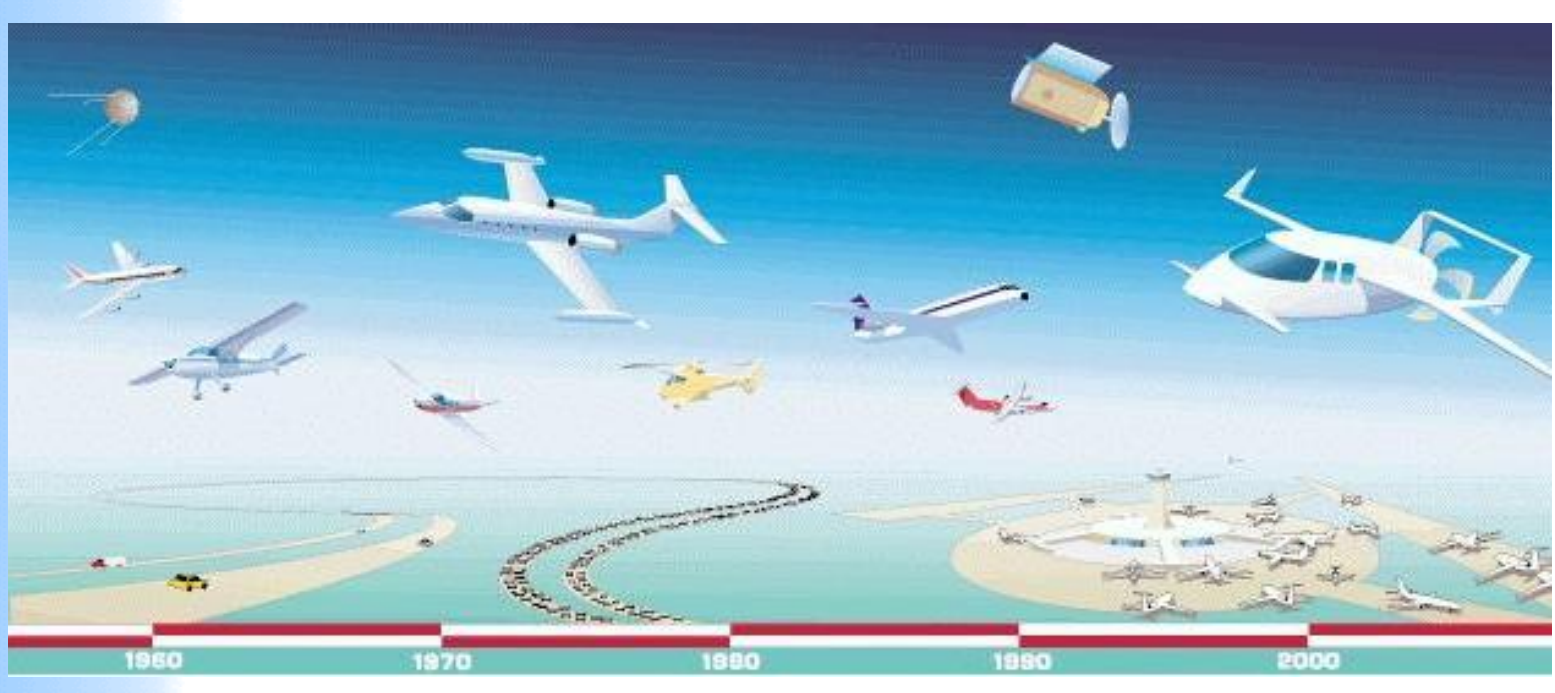


AGATE Survey Results

Likelihood of Resuming

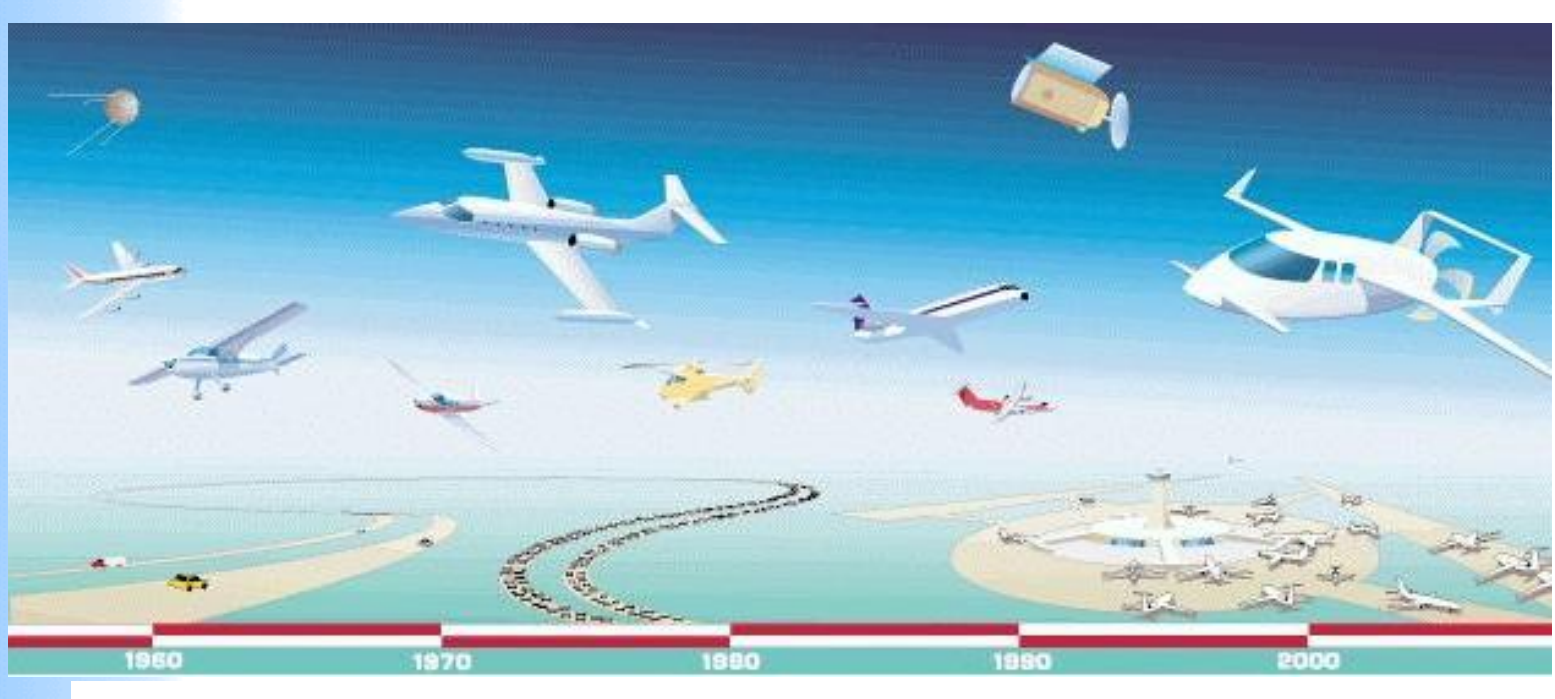
Return to Flying in Next 5 Years





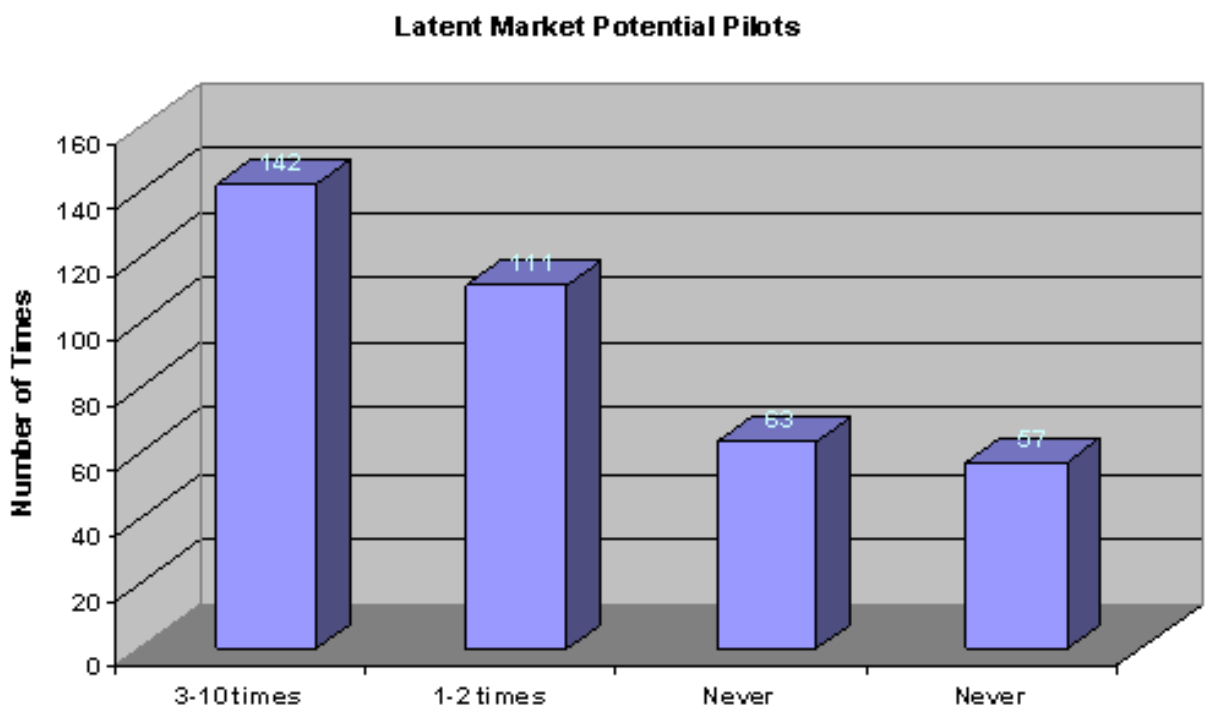
AGATE Survey Results

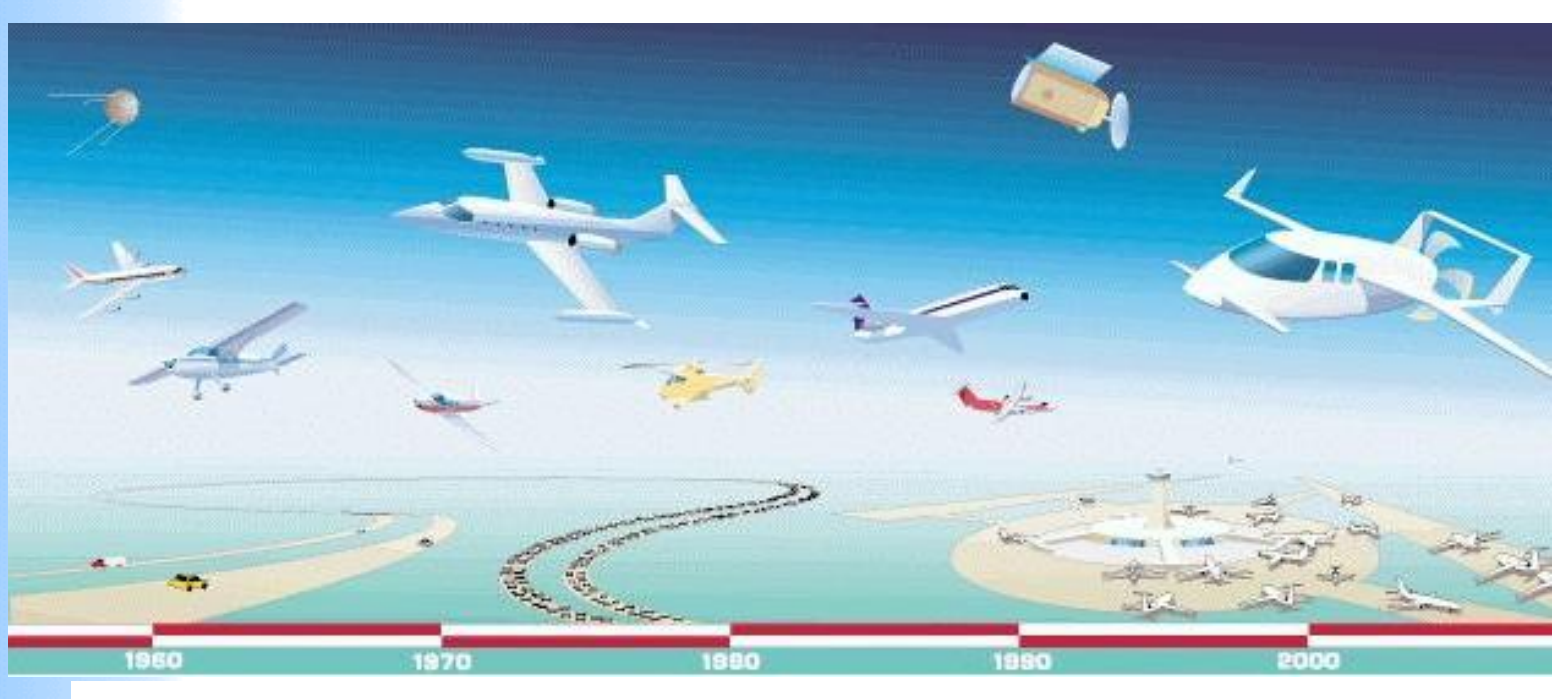
Potential Pilot Information



AGATE Survey Results

Number of Times
Flown with Private Pilot
Latent Market Potential Pilots



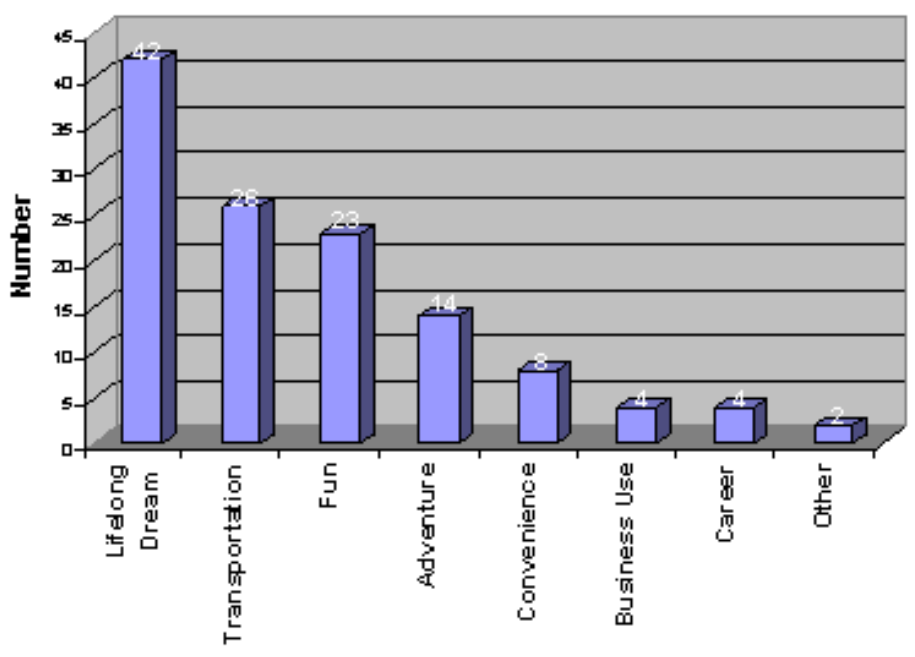


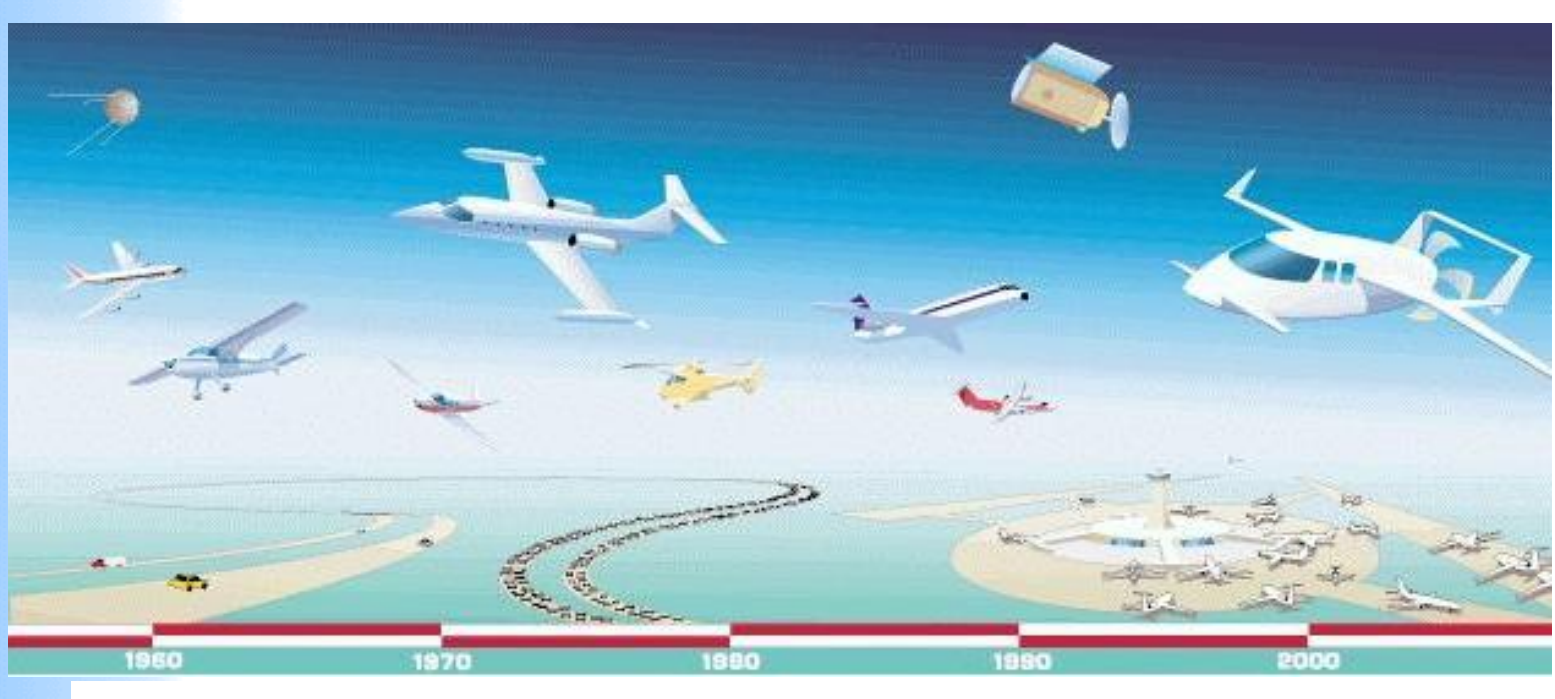
AGATE Survey Results

Reasons

Reasons to Fly

Latent Market



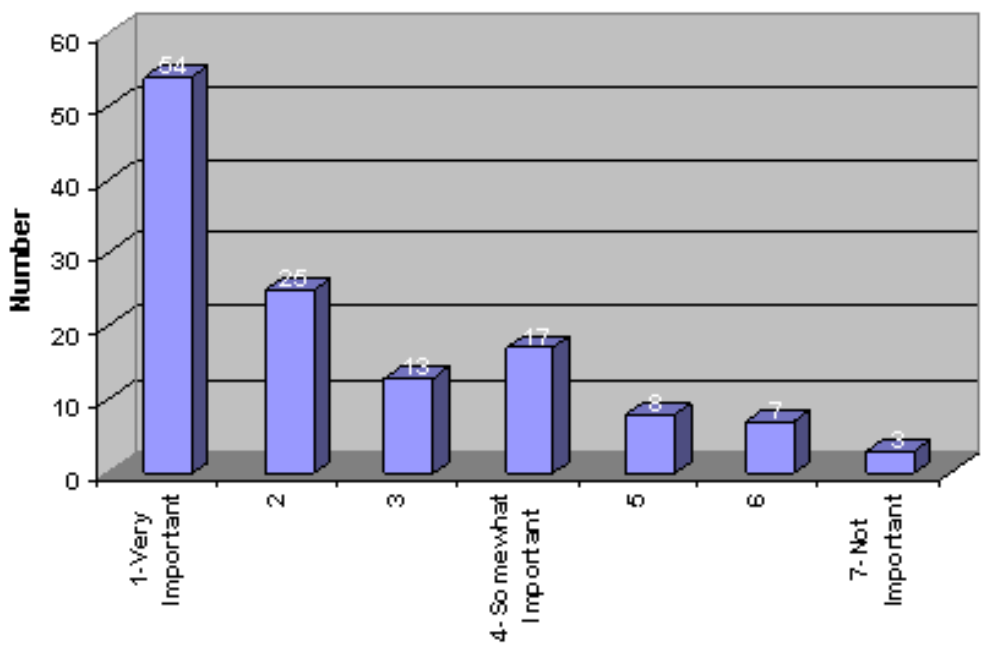


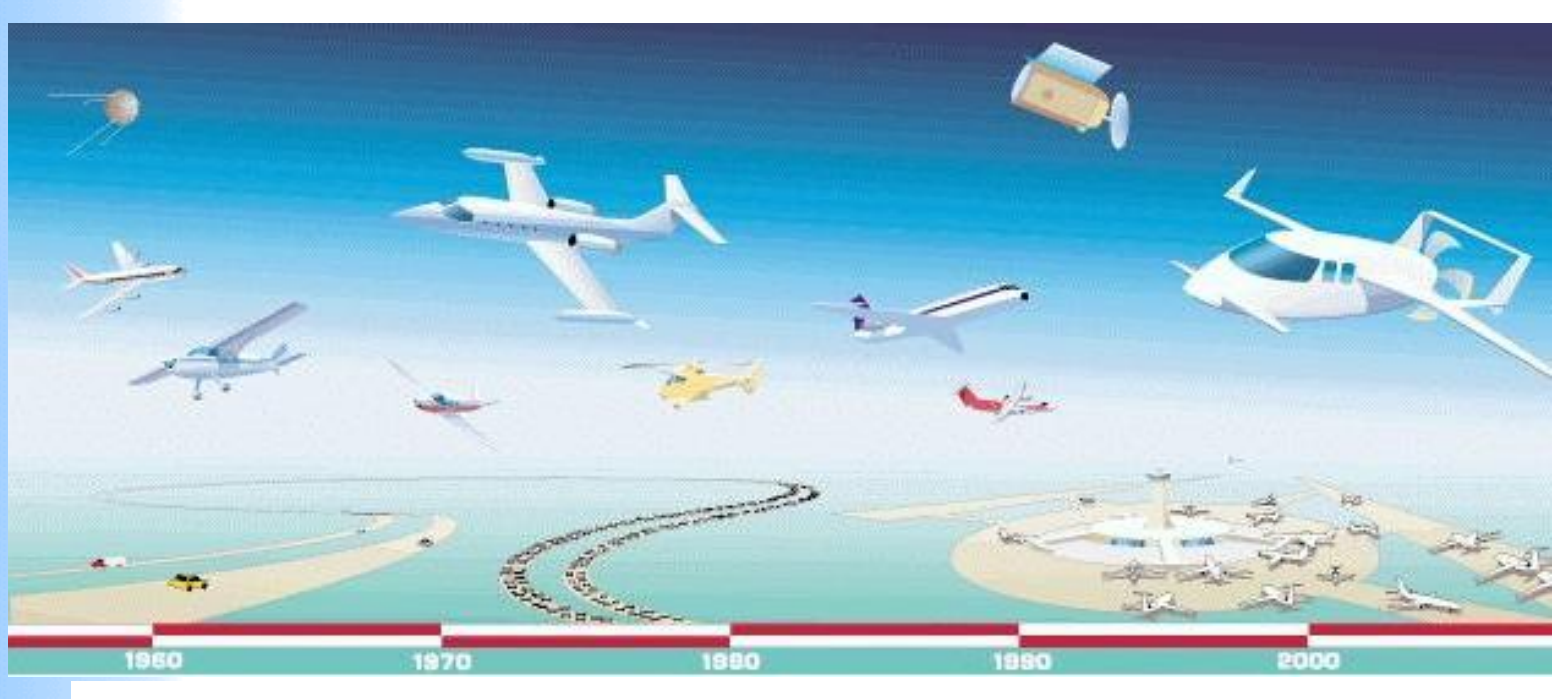
AGATE Survey Results

Learning Importance

How Important is Learning How to Fly

Latent Market Potential Pilots



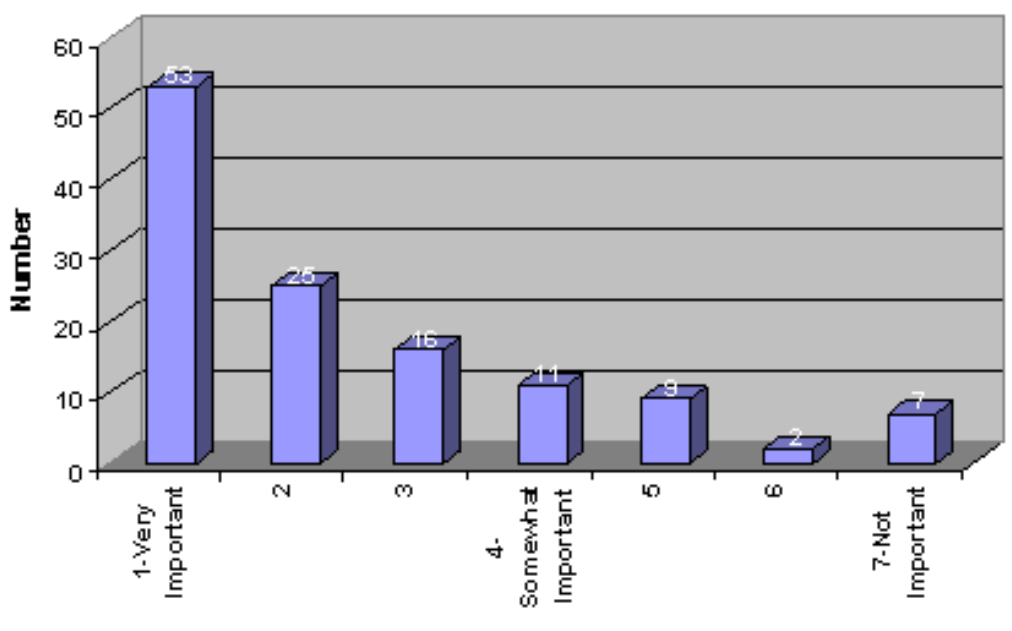


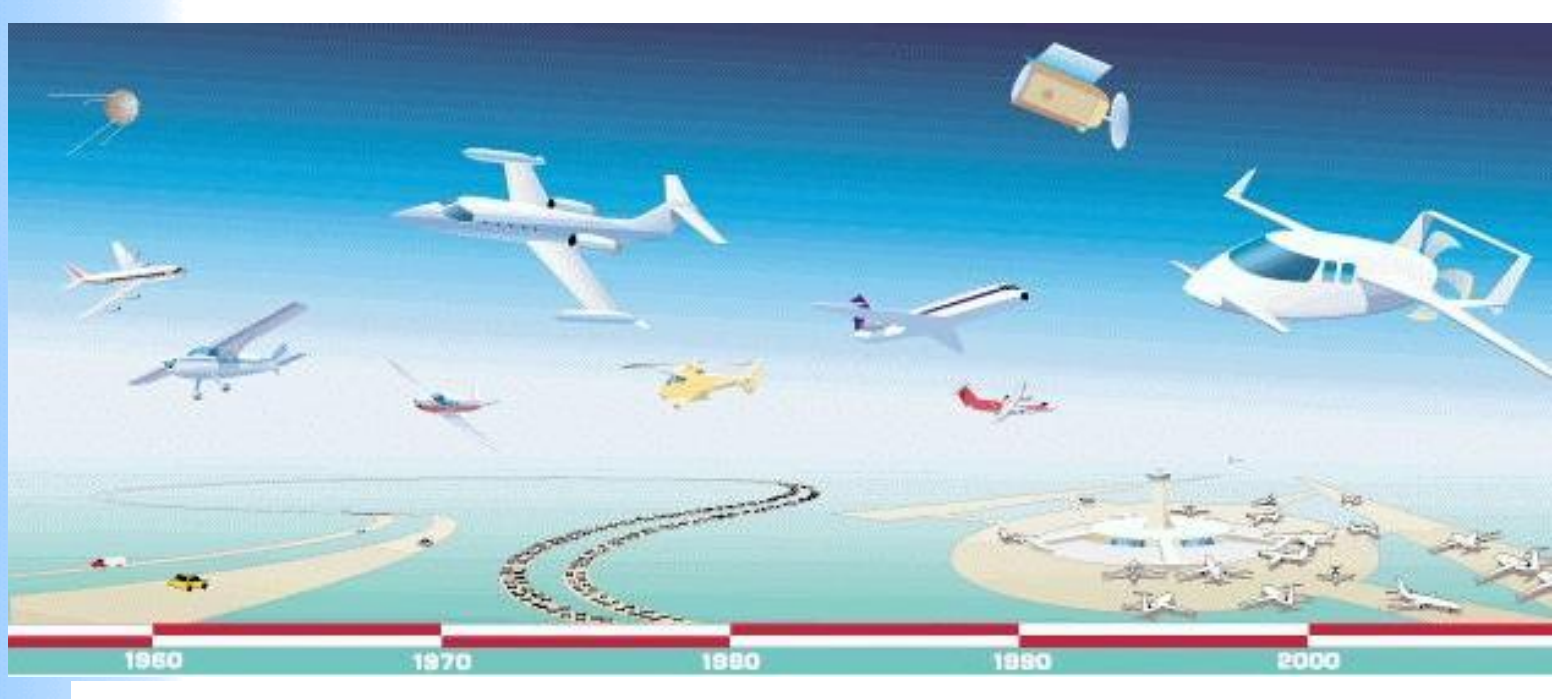
AGATE Survey Results

Personal Aspects

Importance of Personal Aspects of Flying

The freedom, personal achievement, self-reliance, the challenge, and the beauty of it by Latent Market Potential Pilots



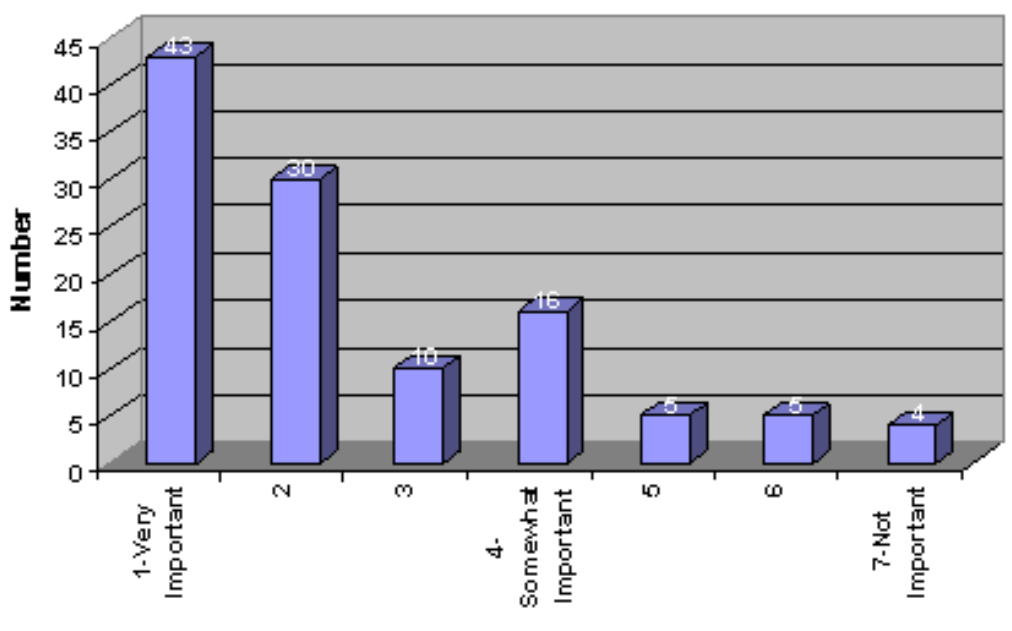


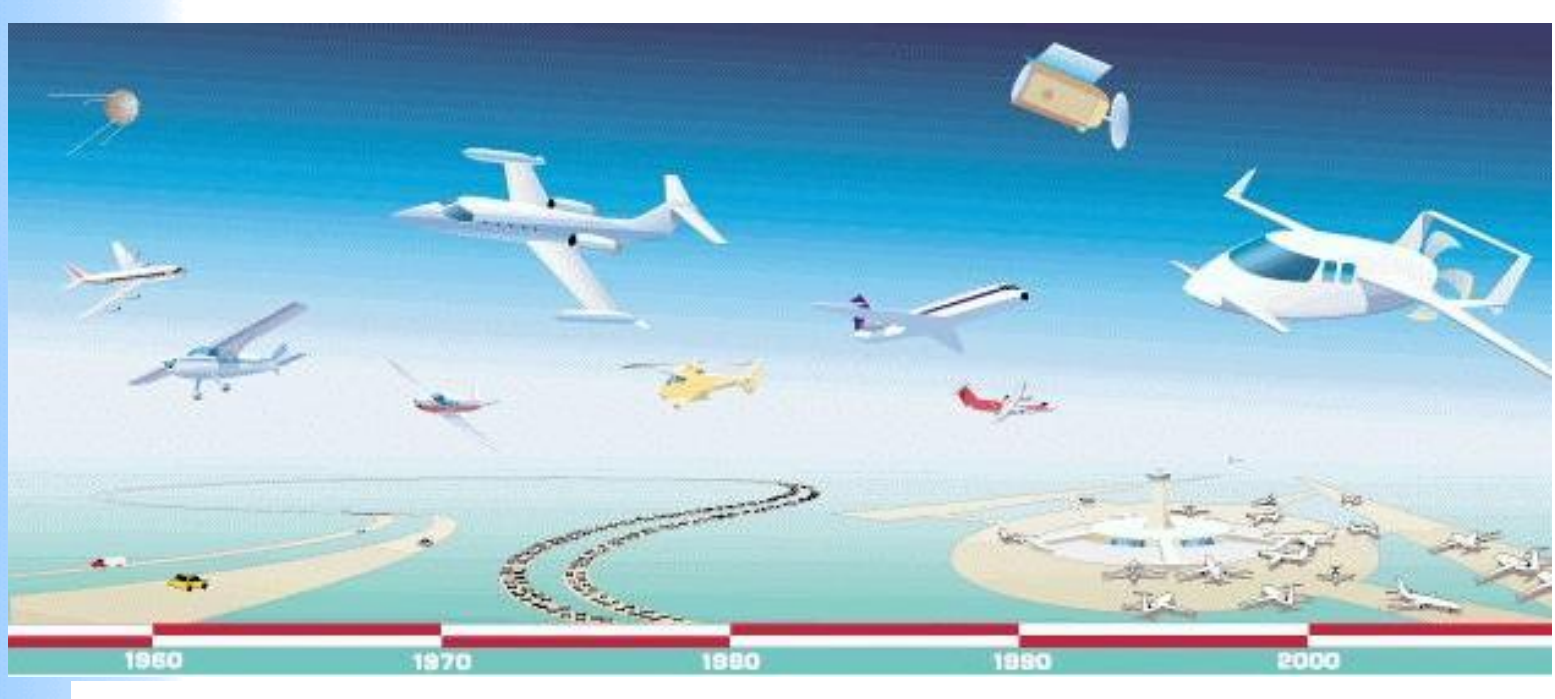
AGATE Survey Results

Practical Aspects

Importance of the Practical Aspects of Flying

The ability to get yourself and others where you want to go quickly and on your own schedule by Latent Market Potential Pilots



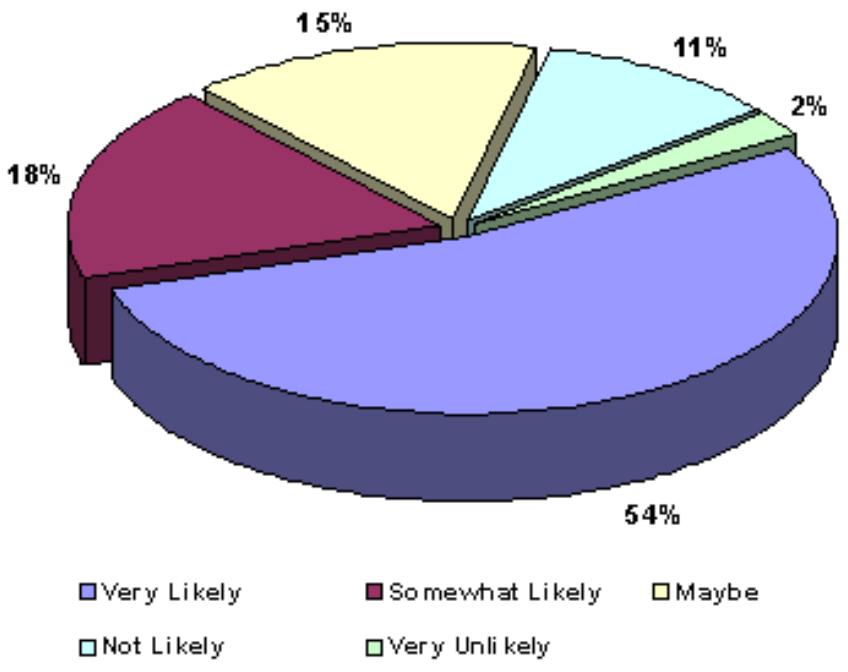


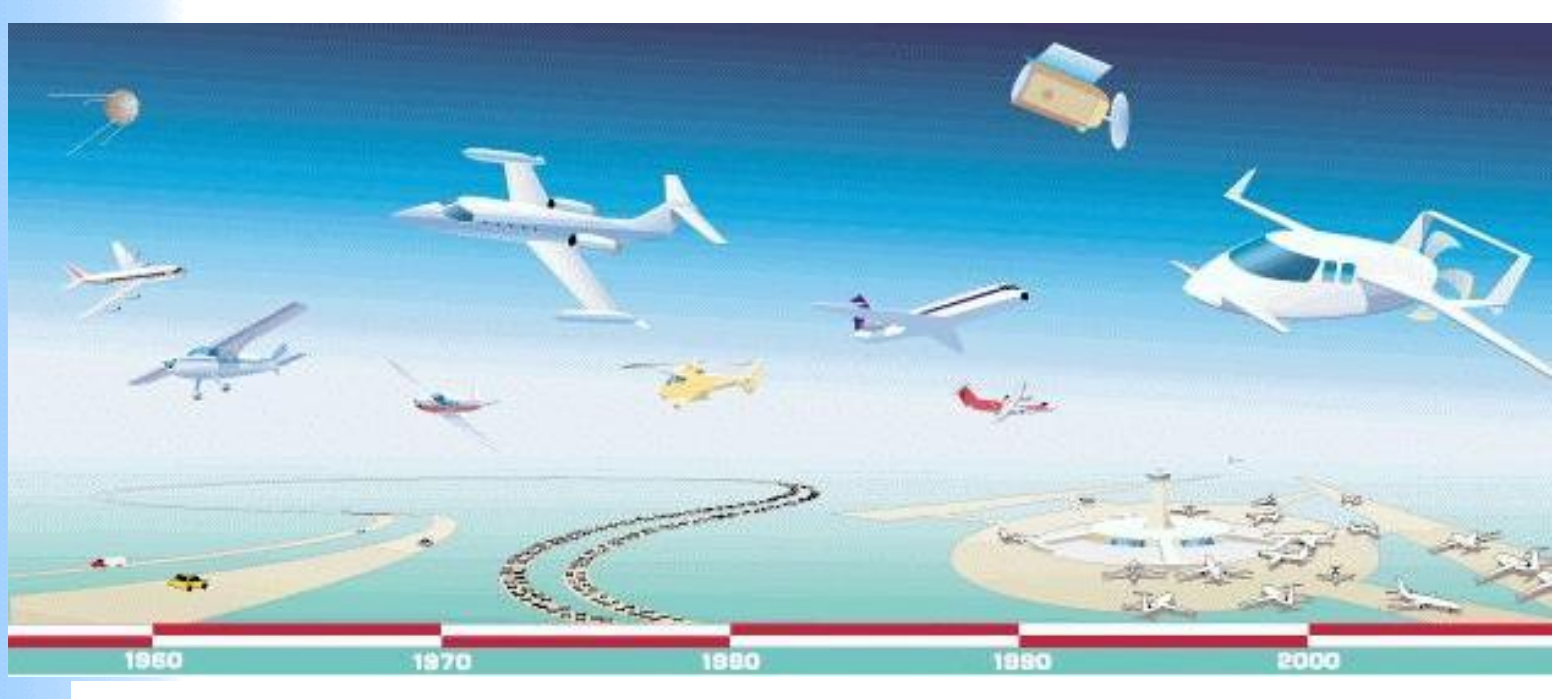
AGATE Survey Results

Learning Likelihood

Likelihood to Start Pilot Training

in Next 5 Years by Latent Market Potential Pilots

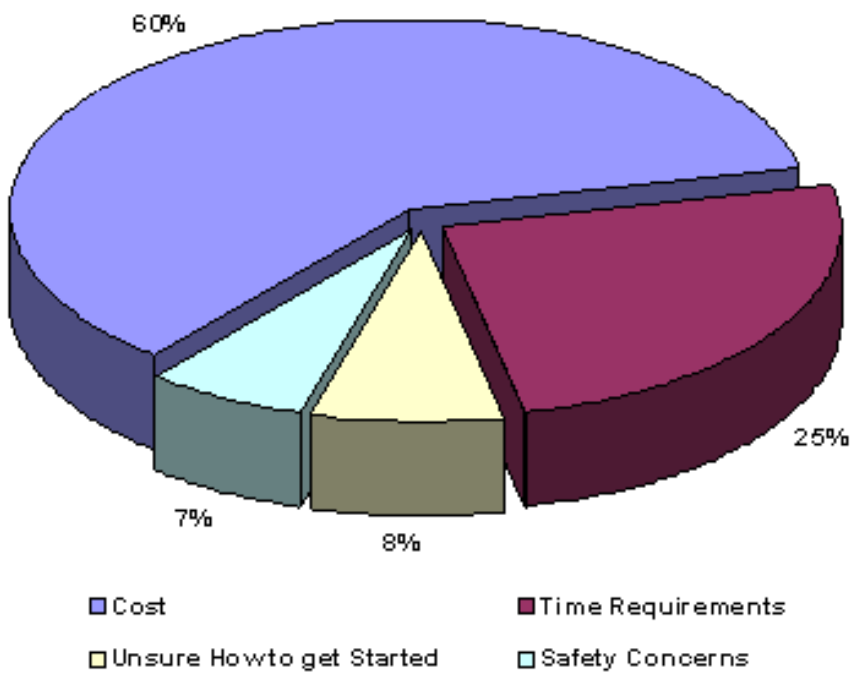


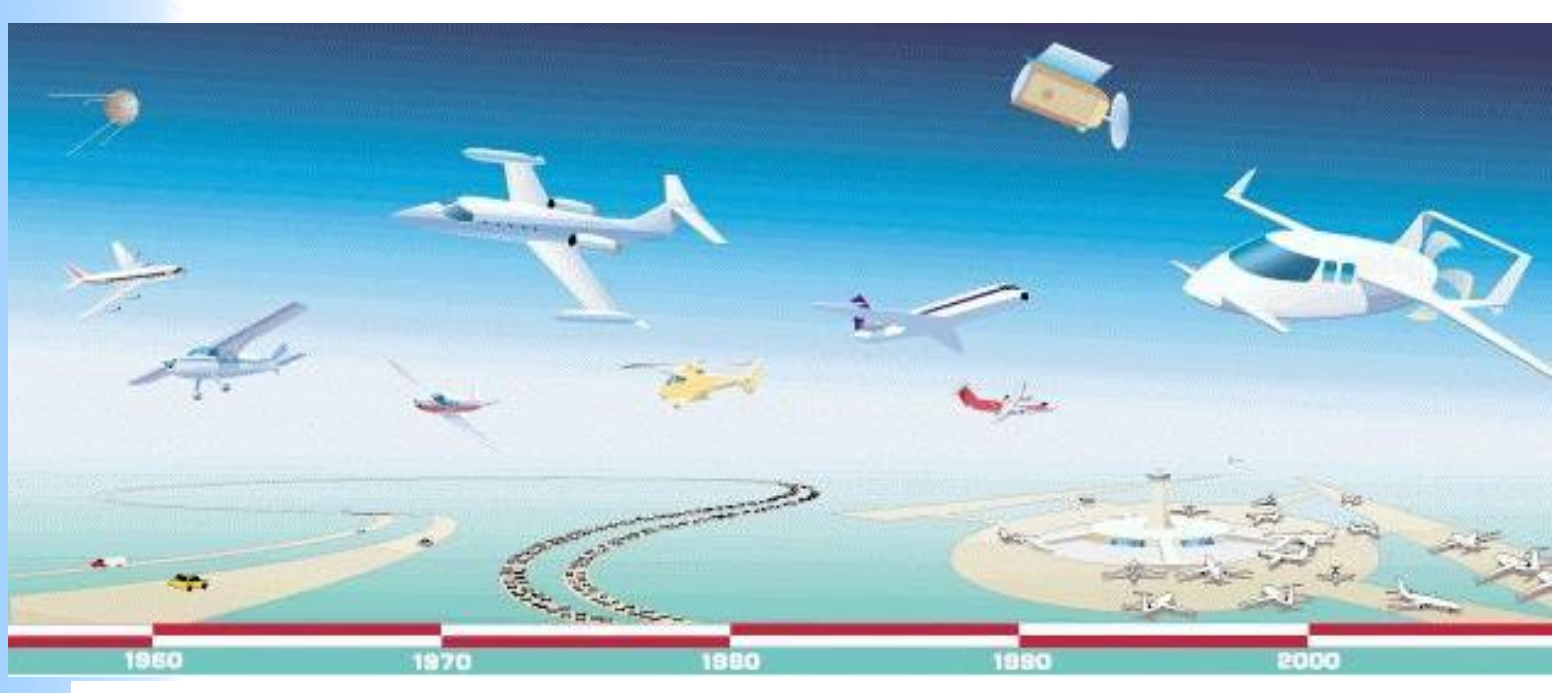


AGATE Survey Results

Barriers

Barriers To Learning How To Fly





AGATE Survey Results

Survey Address

If you have not taken the AGATE survey, please do so now so your views may be heard by those designing a Safe Small Airplane Transportation System. The web address of the site and survey is:

http://apats.org

2001 AGATE AirVenture '01 Meetings

Hosted by the AGATE Alliance Association, Inc.

The AGATE AirVenture 2001 meeting will be held Sun July 29 - Tue July 31. These meetings are member only and by invitation, please pay your registration fees at the AGATE Alliance Registration desk.

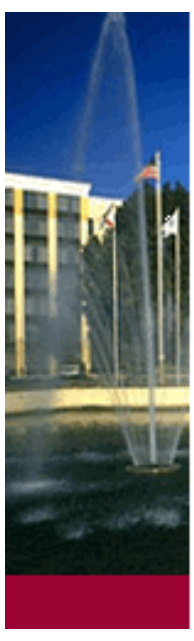
The EAA's AirVenture'01 lasts from July 24 (Tue) - July 30 (Mon) 2001

Casual attire for all events

Meetings

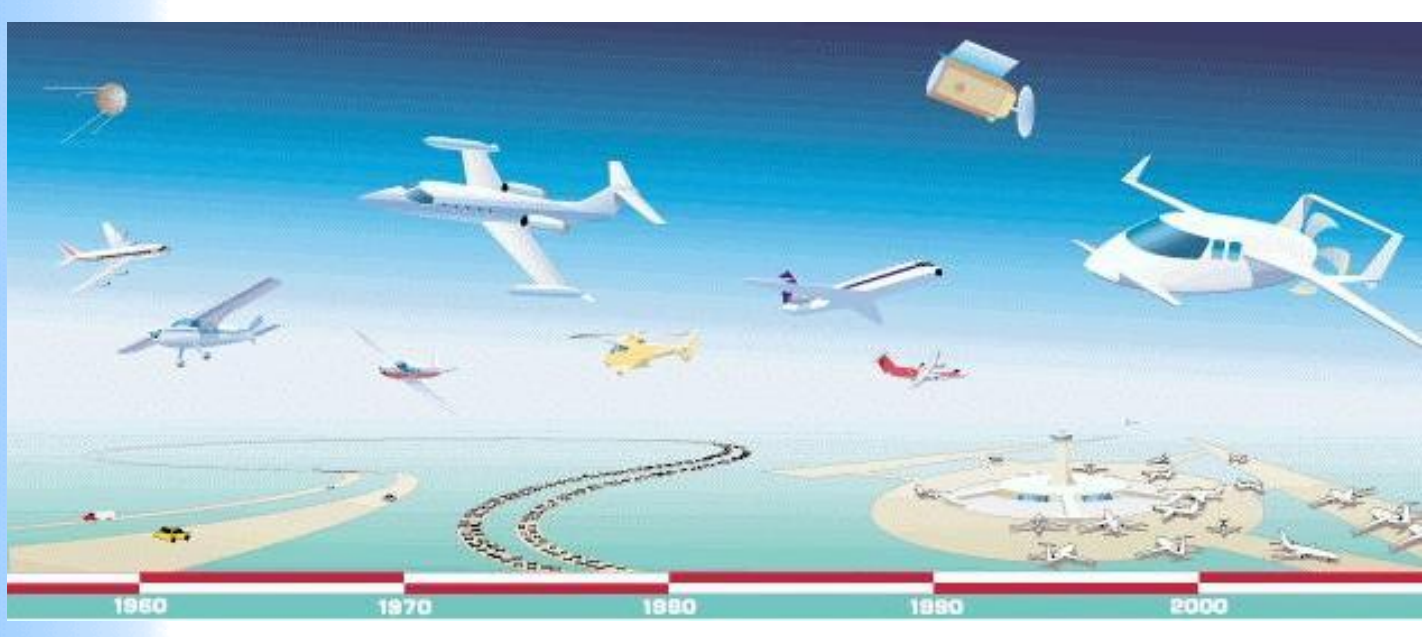
SAWP	**Sunday**	29-Jul	6:00pm - 10 PM	Batten Board Room - EAA Museum
Flight Systems WP#1	**Monday**	30-Jul	8am - 5pm	Batten Board Room - EAA Museum
Flight Training Curricula	Monday	30-Jul	12:30pm - 5pm	AGATE Trailer Behind NASA Building
ID&M	Monday	30-Jul	6pm - 10pm	Batten Board Room - EAA Museum
AGATE Final Plenary Session	**Tuesday**	**31-Jul**	9am - 4pm	Vette Theater - EAA Museum
AGATE Close Out Evening	**Tuesday**	**31-Jul**	6pm - 9pm	EAA Museum
EC/AAAI Board Meeting	Wednesday	1-Aug	8am - 5pm	Batten Board Room

Hotel Information



The Hotel is about a 20 min drive from Oshkosh Airport (AirVenture Locale).

Maureen Sgambelluri
AAAi
Revised: July 16, 2001.



Images

AGATE cockpit

Modified Cessna 172 cockpit

Modal Node

AGATE aircraft landing

Skyways

Aircraft Systems

Links

GO TO Mid Page GO TO Bottom

Link	Description
NASA Links	
Aviation Safety Program	NASA's new initiative to improve Aviation Safety (GA & Airlines)
Advanced Subsonic Technology Program	Subsonic Aircraft research as part of NASA's Aeronautics focus
Legacy CD-ROM from NASA Langley Technical Library	179 selected NACA/NASA reports that cover General Aviation Airplane research.
NASA General Aviation Propulsion Program	Web site for the NASA Lewis Research Center managed General Aviation Propulsion Program (GAP)
NASA Technical Report Server	Search for NASA Technical Publications. "General Aviation" is a keyword
NASA RECON	**RECON** (**RE**search **CON**nection) is NASA's database of aerospace & aeronautical information.
NASA Technology Transfer	NASA technology announcements
AGATE Links	
Members	Links to the Web sites of AGATE Members
FAA	
FAA Home Page	The principal FAA web site
FAA Flight 2000 Program	The FAA program to create a system for direct routing for all users - GA & airlines
FAA FAR's	Well organized hyperlinked FAA Regulations for ease of use by Dr. Eichhorn, Mr. Yoshpe & Sigal Yehudai Yoshpe
Other Government	
AFRL	The Air Force Research Laboratory offers a $3,000 team award for innovative use of Air Force technology in the General Aviation Design Competition
NCAR	The National Center for Atmospheric Research's Web site for advanced aviation weather prediction research
National General Aviation University Design Competition Virginia Space Grant Consortium	The Virginia Space Grant Consortium co-ordinates the NASA-FAA-AOPA-EAA National General Aviation University Design Competition
Aviation Newsgroups	
rec.aviation rec.aviation.ifr rec.aviation.marketplace	Airplane & Flying Discussions
sci.aeronautics	Technical discussions on aeronautics

GO TO The Top

13:50
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Current weather
Traffic
Clearance
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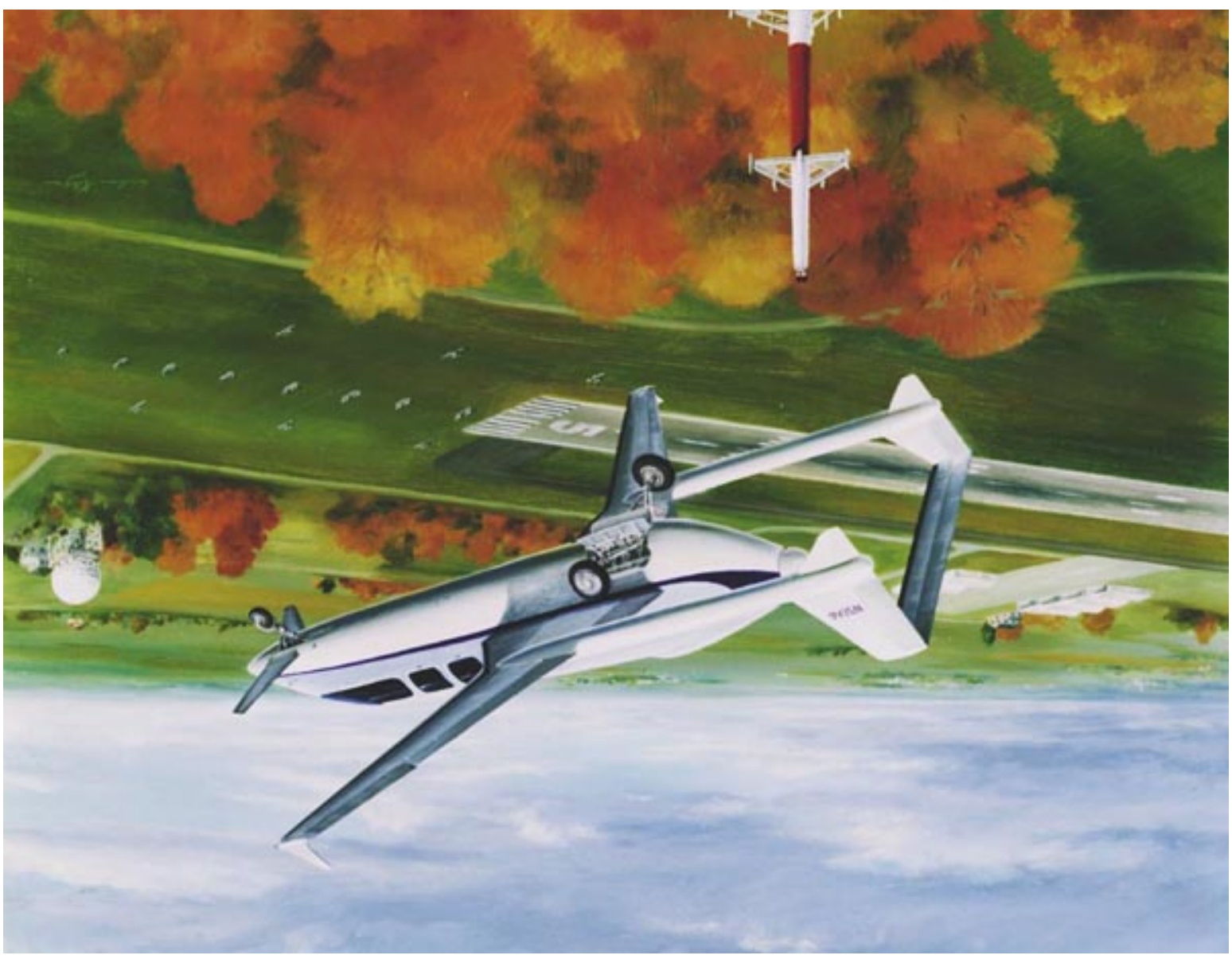

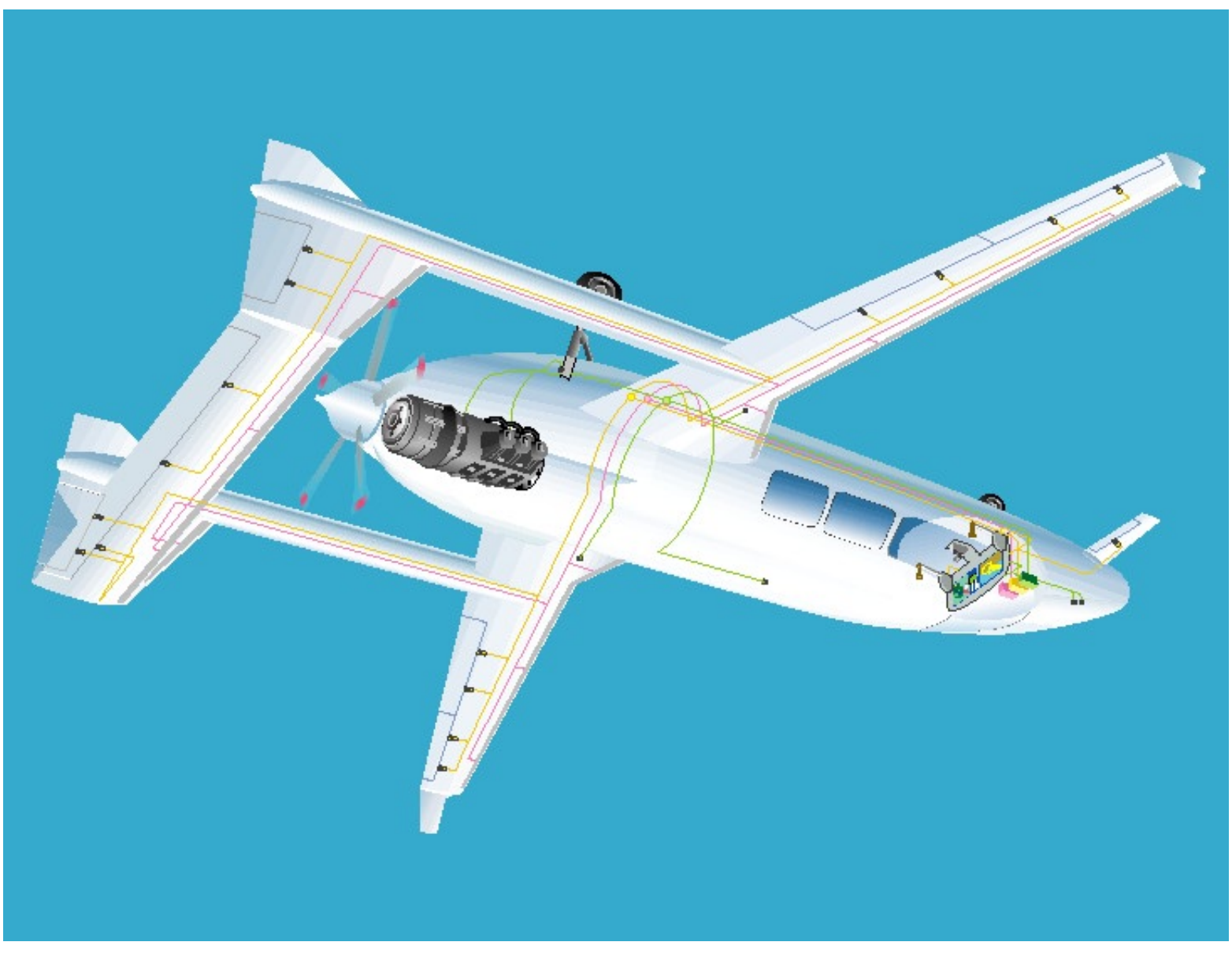

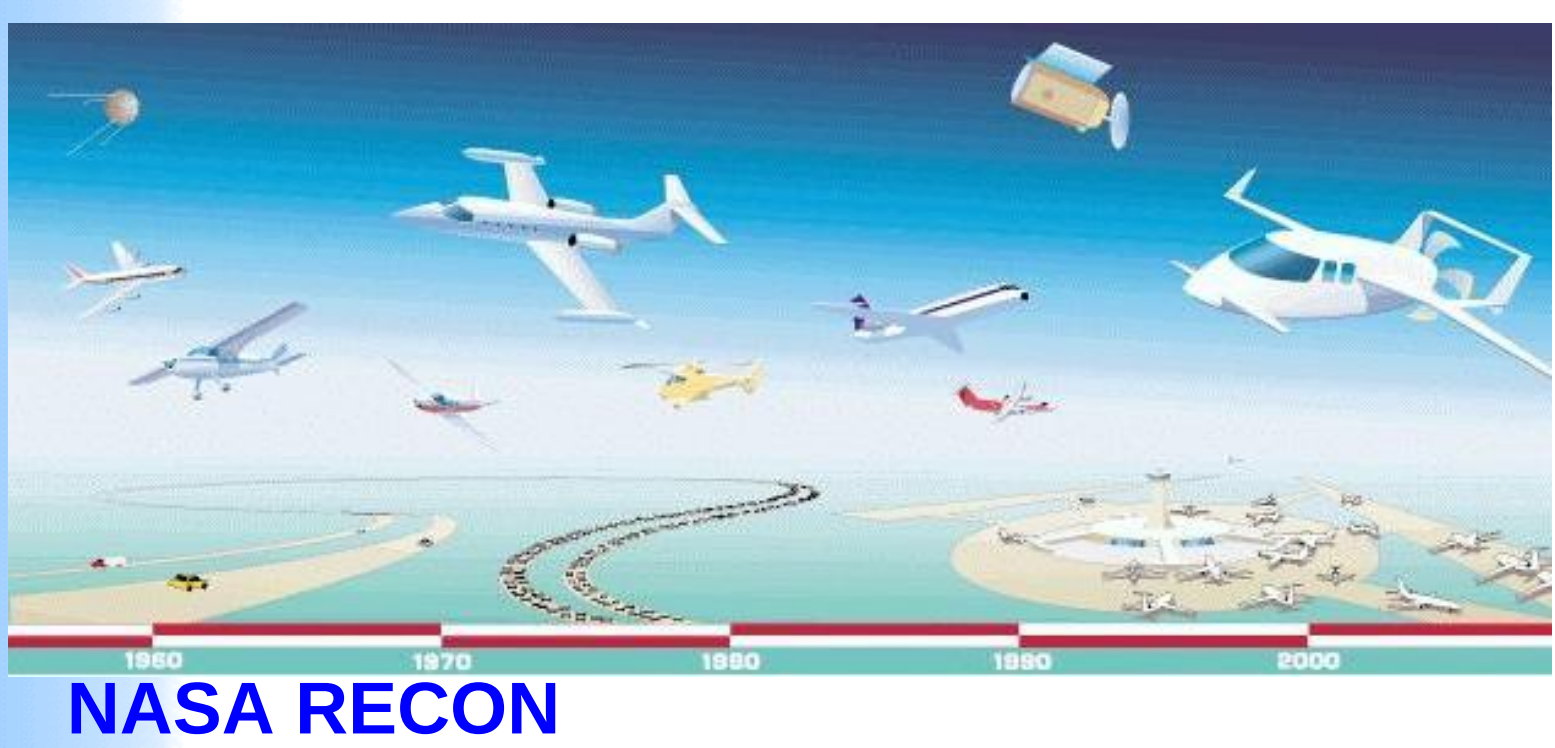

NASA RECON

NASA's database of scientific and technical information.

RECON (**RE**search **CON**nection) is the National Aeronautics and Space Administration's own in-house computer database of aerospace and aeronautics materials. Containing over 3 million records, it is the largest and most comprehensive aerospace database in the world. It includes citations for open literature and techical reports, spanning the years 1915 to the present. Since it is strictly a bibliographic database at this time, it does **NOT** contain the full text images of any titles.

RECON is maintained by the NASA Center for AeroSpace Information (CASI) at the facility located at the Baltimore/Washington International Airport in Maryland.

- Open a RECON search session
  - RECON Select -- An experimental RECON interface using WAIS, covers 1970 - present.

Member Input: Request help or comment on system.

**** Last Edited Thursday, March 14, 1996 by Bill Wolfe***

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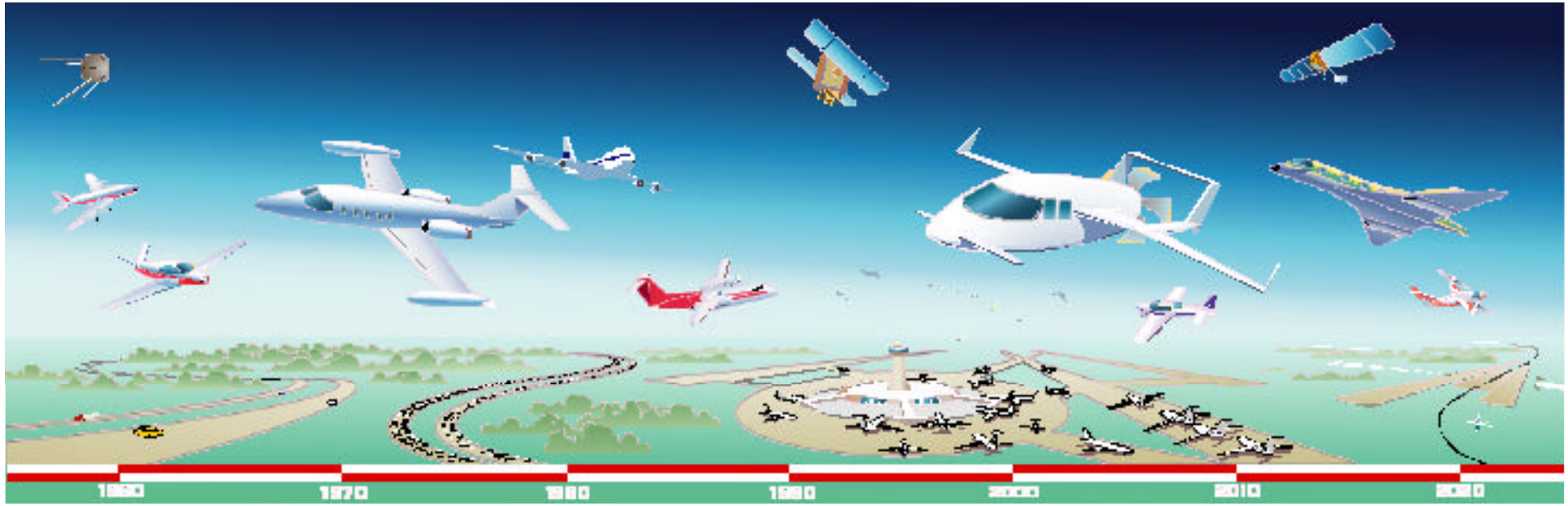
Aero-Space Technology



NASA Aero-Space Enterprise
National General Aviation Roadmap

Small Aircraft Transportation System

Dr. Bruce J. Holmes
NASA General Aviation Program Office

Outline

NASA Office of
Aero-Space Technology

The "Golden Rule" of the information age is "Time is the Scarce Commodity."

Early in the 21st century, transportation demand will soar beyond supply.

The Millennial Opportunity: SATS creates more time for more people.

- **Small Aircraft Transportation System (SATS) Concept**
- **National Market Opportunities and Challenges**
- **Suggested Industry Actions**

Solving 21st Century Transportation Challenges

NASA Office of
Aero-Space Technology

The Small Aircraft Transportation System
is a safe travel alternative
that frees people and products from today's system
delays
creating access to more communities in less time.

The Problem

Executive Summary:

PROBLEM: The nation's 21st century transportation demand cannot be satisfied by the planned investments in hub-and-spoke and highway systems alone*.

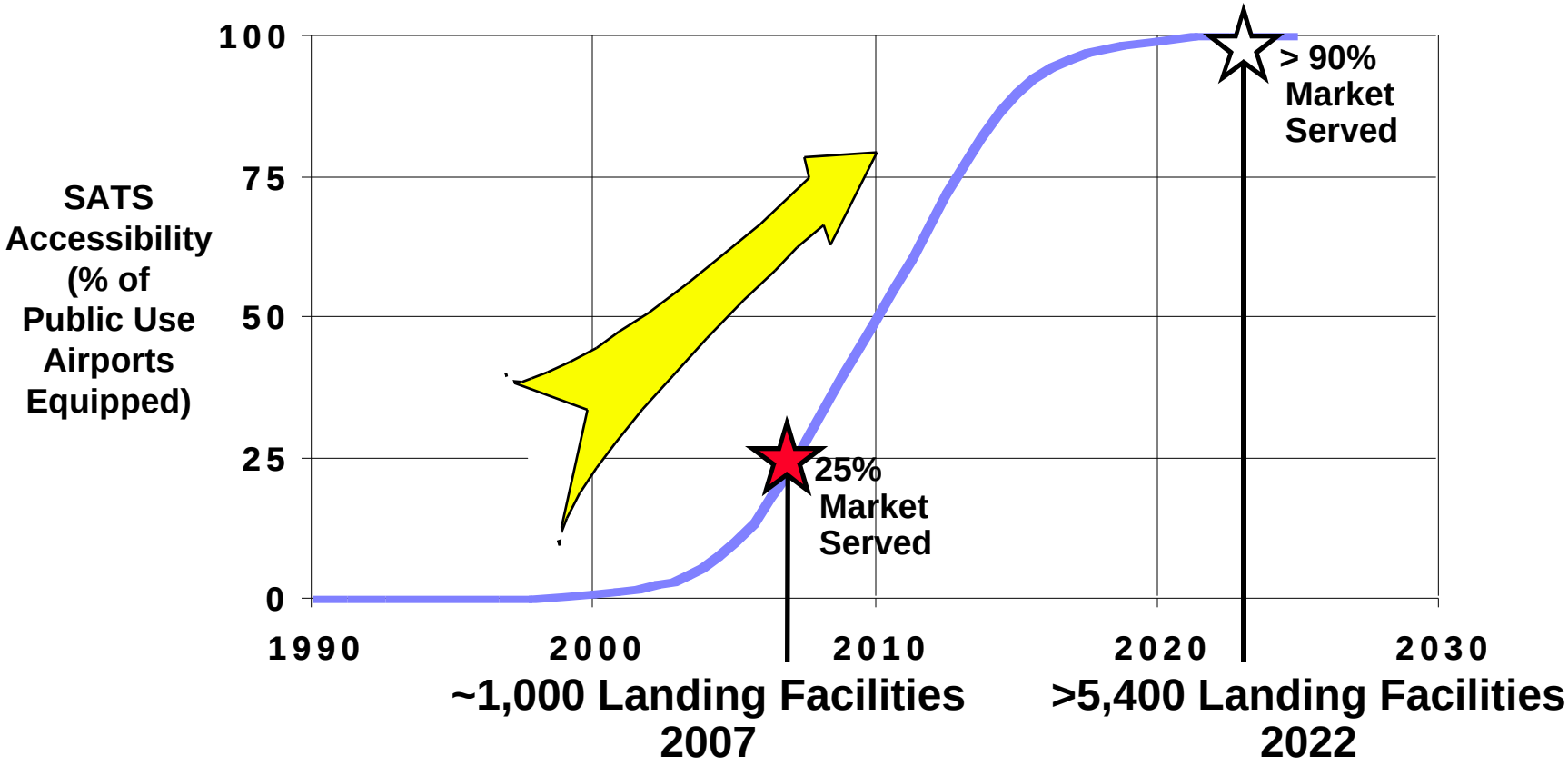
SOLUTION: The Small Aircraft Transportation System (SATS) concept can satisfy a large portion of the demand, relieving the pressure on existing ground and air systems.

ACTION NEEDED: National support and coordination is necessary for SATS as a key element in an **integrated national Aeronautics-Transportation investment strategy**.

National General Aviation Roadmap Goal

NASA Office of
Aero-Space Technology

"Enable doorstep-to-destination travel at 4 times the speed of highways Throughout the nation's suburban, rural, and remote communities Served by Public Use landing facilities."



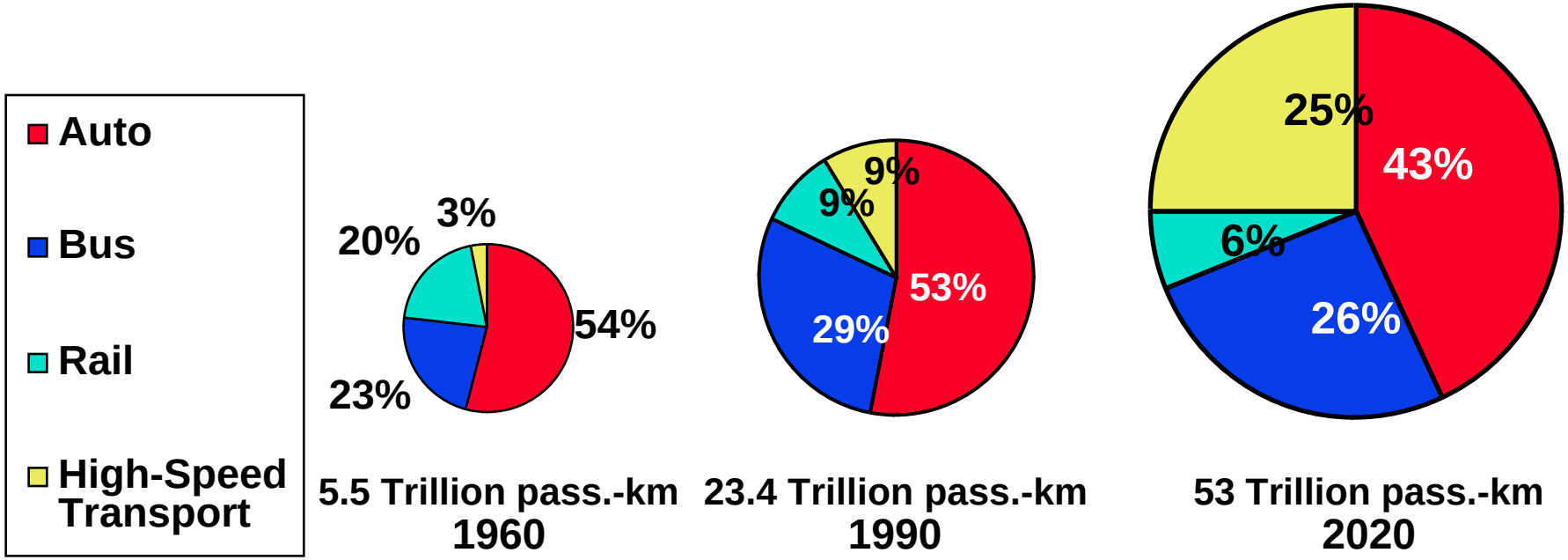
Strategic Planning Tenets

- **The innate human desire for personal command of time and space creates demand for distributed (personal) transportation systems.**
- **The Information Age will usher in a new magnitude for the value of time.**
- **The Baby Boom generation's peak spending (traveling) period coincides with saturation of the hub-spoke airway and interstate highway systems.**
- **The Third Migration Wave (beyond the suburbs), coupled with tele-commuting, creates new transportation demand and challenges.**
- **The revolution in digital bandwidth redistributes intelligence from centralized to distributed system nodes, enabling the aviation transition from centralized to distributed air traffic management (free flight).**

The Pig in the Python

NASA Office of
Aero-Space Technology

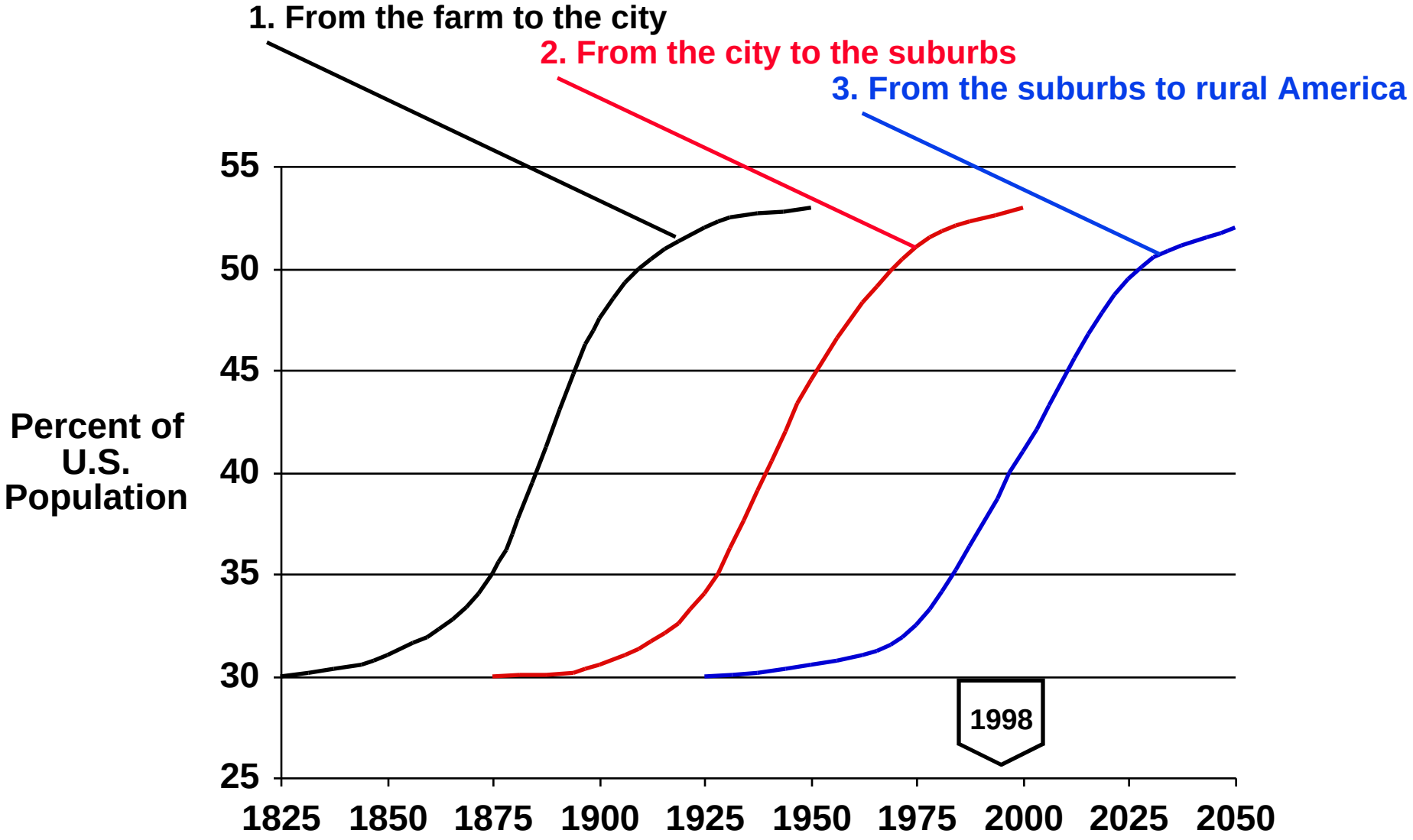
As *per capita* income rises,
***per capita* annual travel rises,**
personal daily travel time budgets remain constant,
and
high-speed modes gain market share
(Schafer and Victor, Sci. Amer., Oct. 1997)



Global Travel Mode Shares will be driven by
the largest population and spending wave in history:
The Baby Boom

The Third Migration Wave

NASA Office of
Aero-Space Technology



Innovation and Cost Life Cycles

(Trends follow classic "S-Curve" for innovations, Hugh B. Stewart, Recollecting the Future, 1988)

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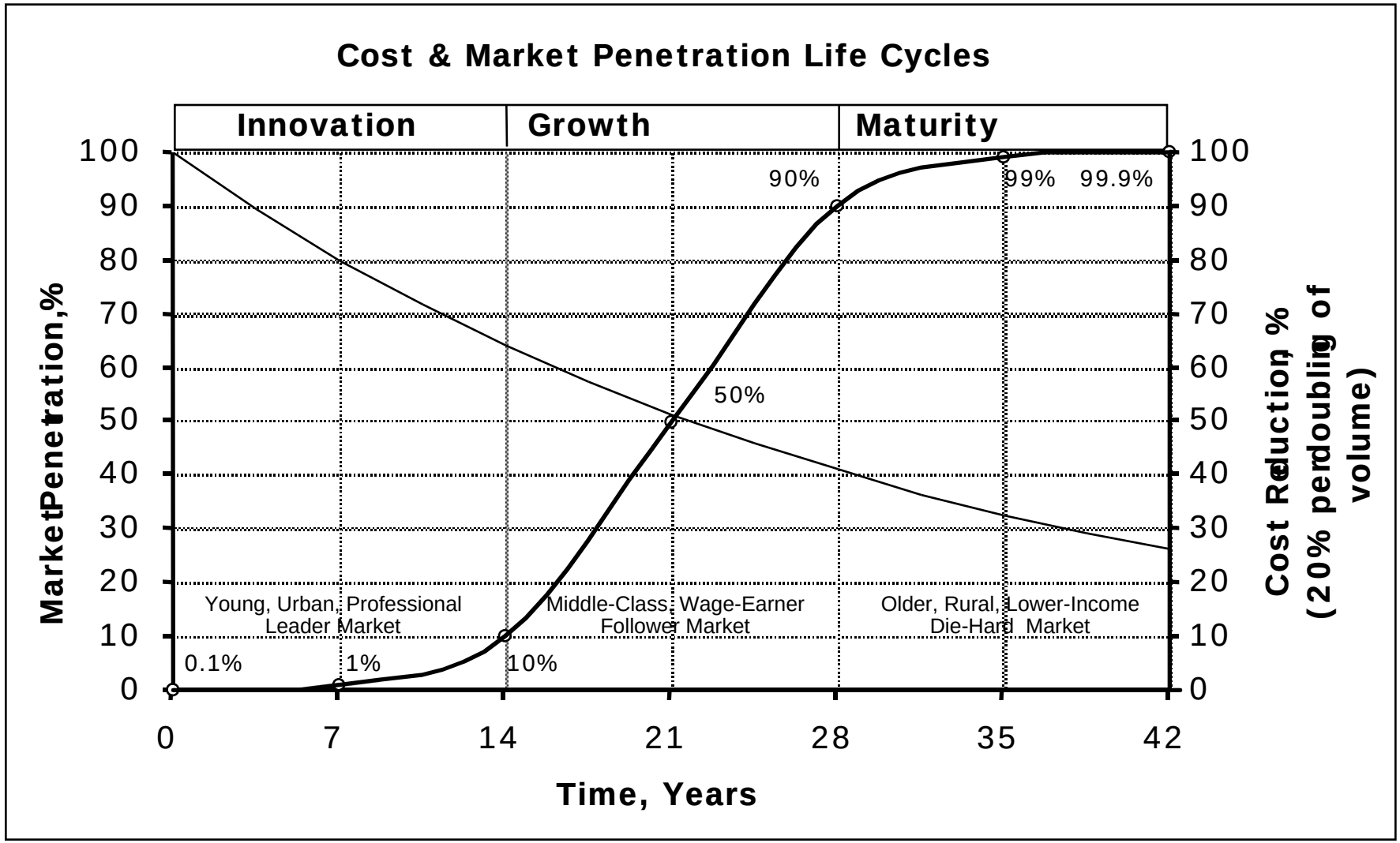

Life Cycle of the Piston Aircraft Market

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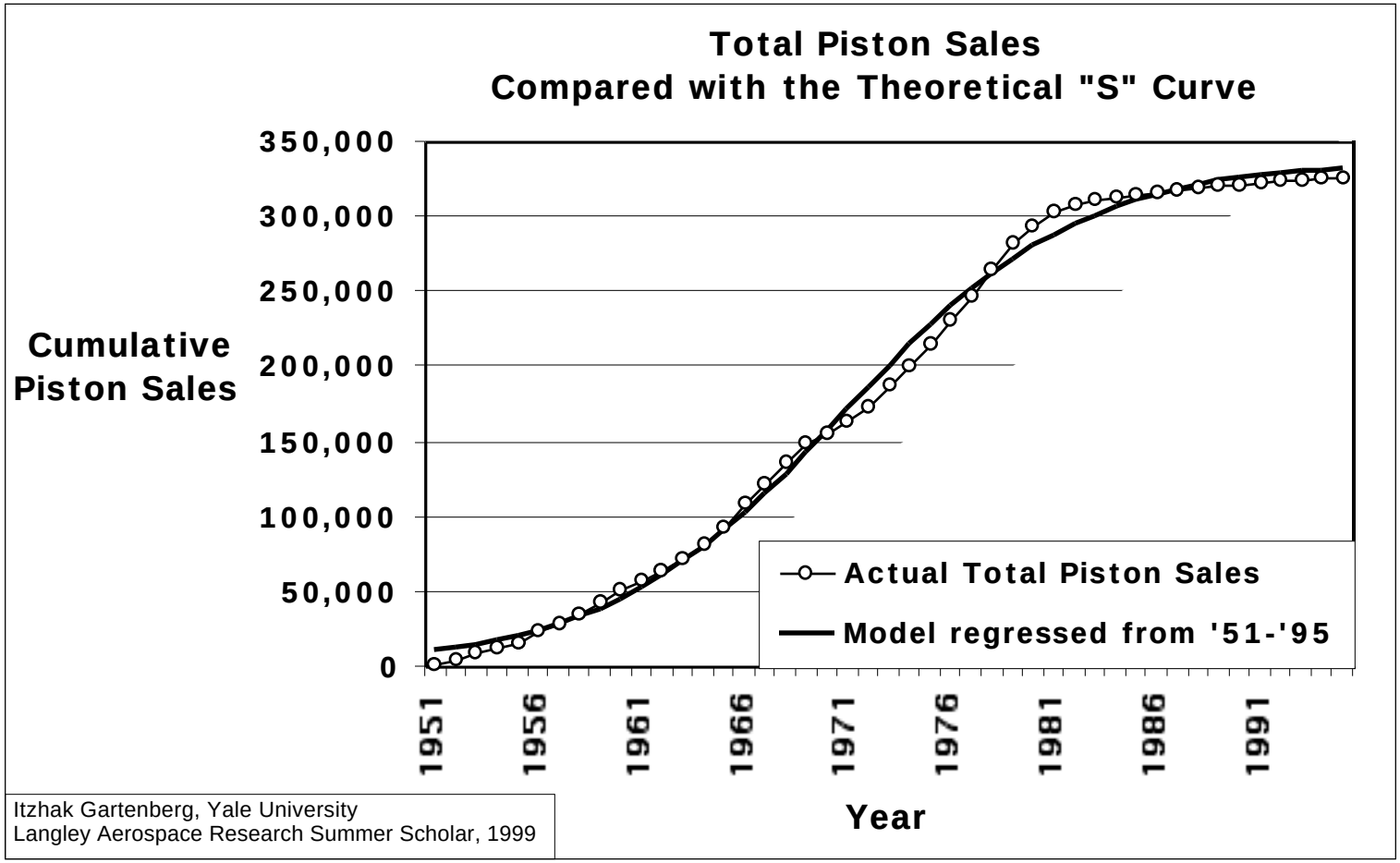


Itzhak Gartenberg, Yale University
Langley Aerospace Research Summer Scholar, 1999

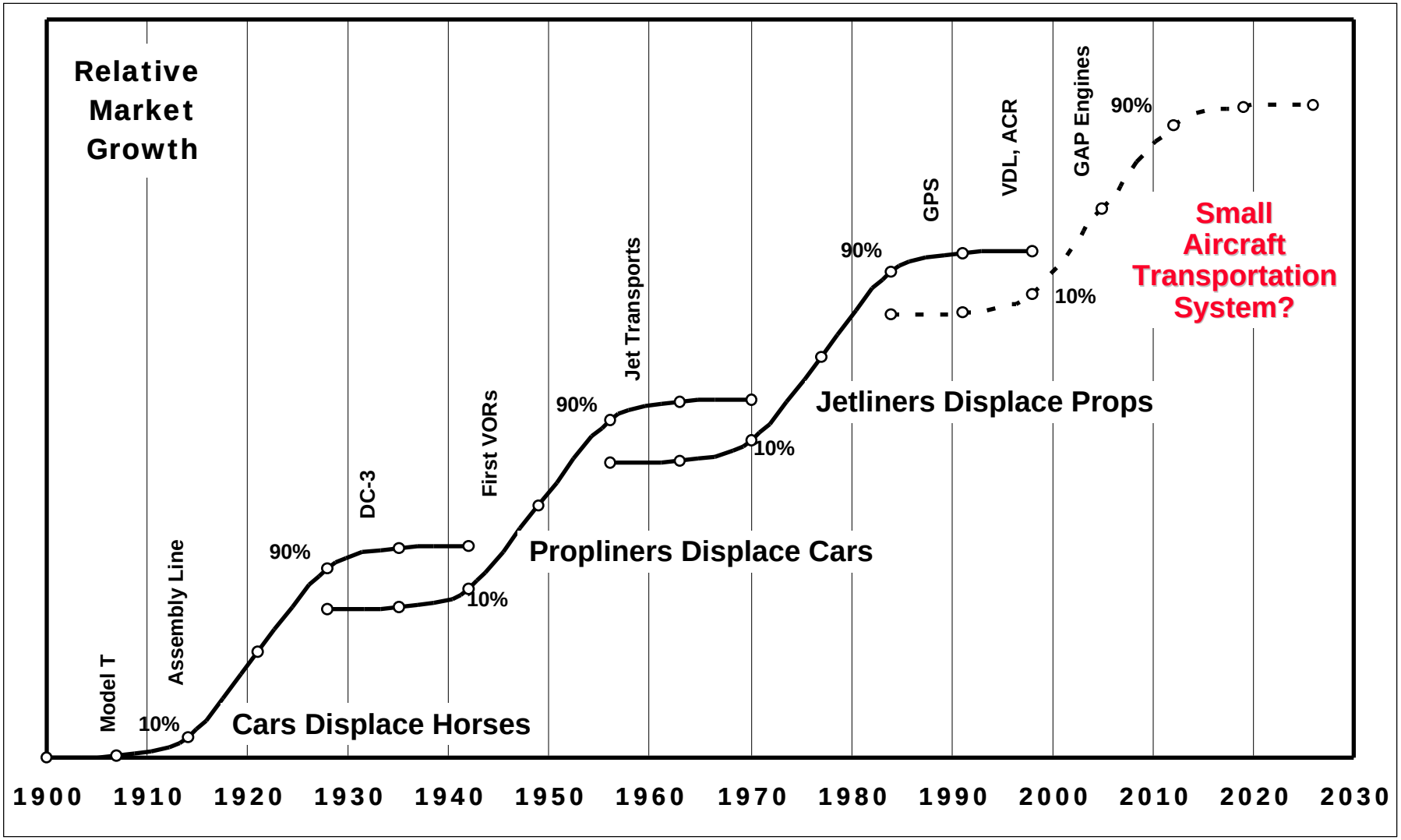
Figure 10

(R)evolutions in Higher Speed Travel

What is Next? More Speed to More Destinations

NASA Office of Aero-Space Technology

The "Atomic Structure" of Business Innovation Cycles



Small Aircraft Transportation System Mobility

". . .doorstep-to-destination at four times the speed of highways. . ."

NASA Office of
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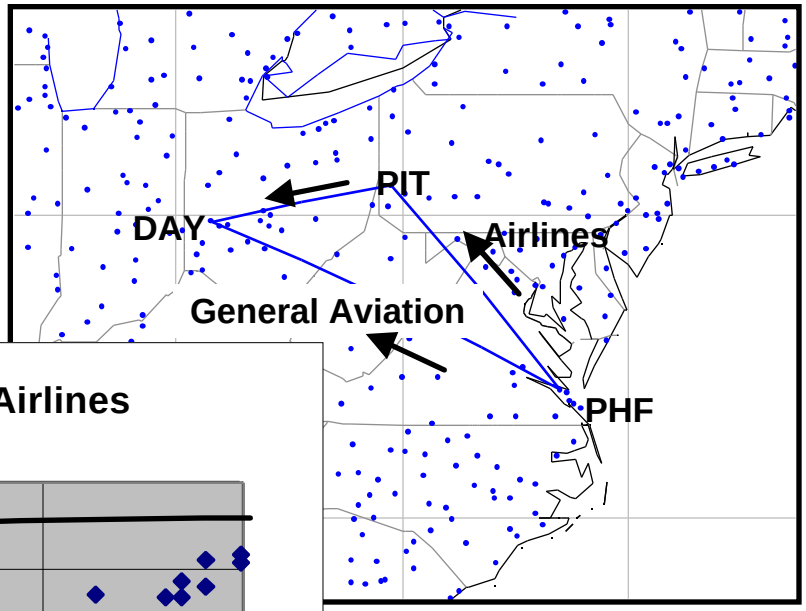
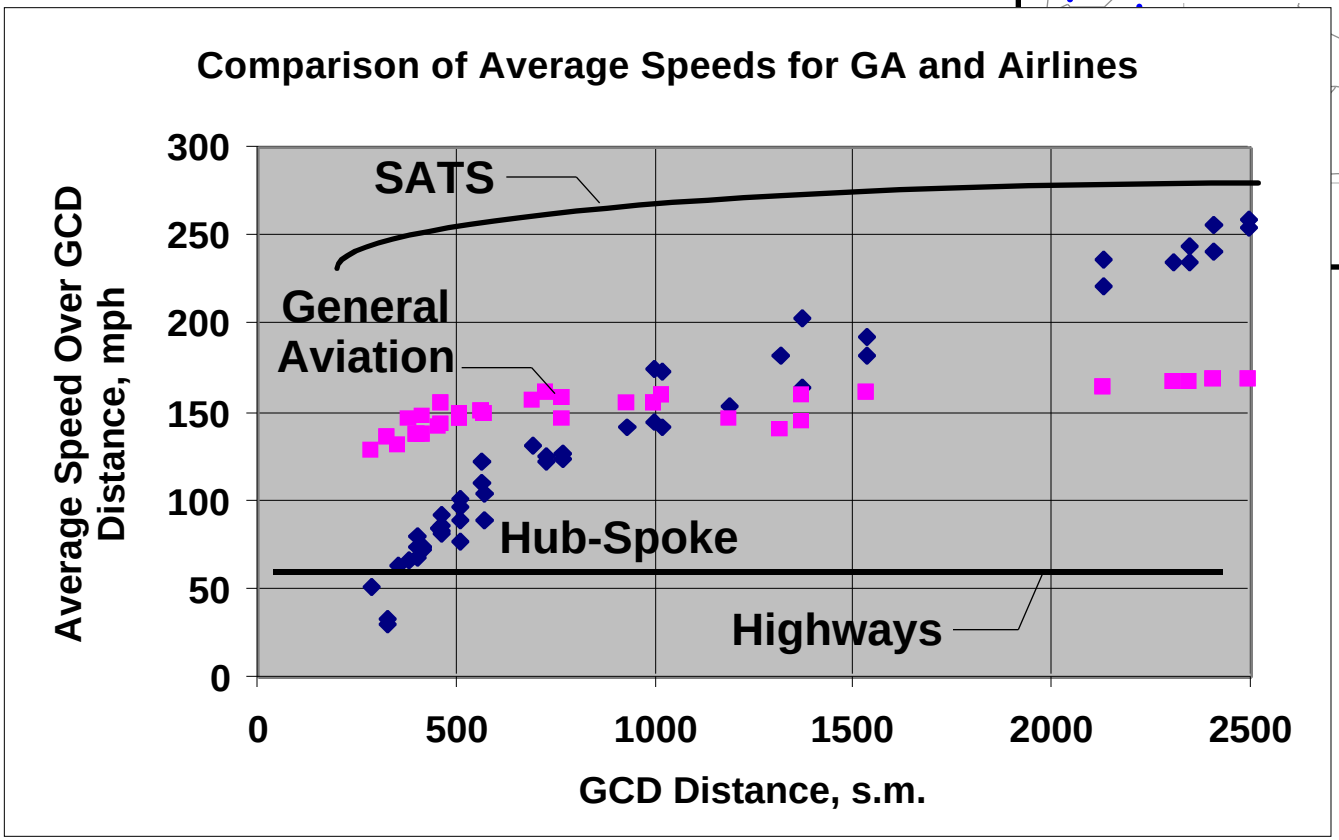
SATS reduces travel times,
while highways and Hub-and-spoke travel times
will continue to increase.





- Hub-Spoke: OAG times for 28 destinations
- General Aviation: time-optimized flight plans
- Including intermodal penalties (:45 +:45 for airline & :30+:30 for GA departure & arrivals)
- No GA destination benefit (for proximity of airports)
- SATS with new GAP engines: costs equal current General Aviation at 2 times the speed.

Figure 12

SATS Increases Accessibility and Mobility

(". . .creating access to more communities in less time. . .")

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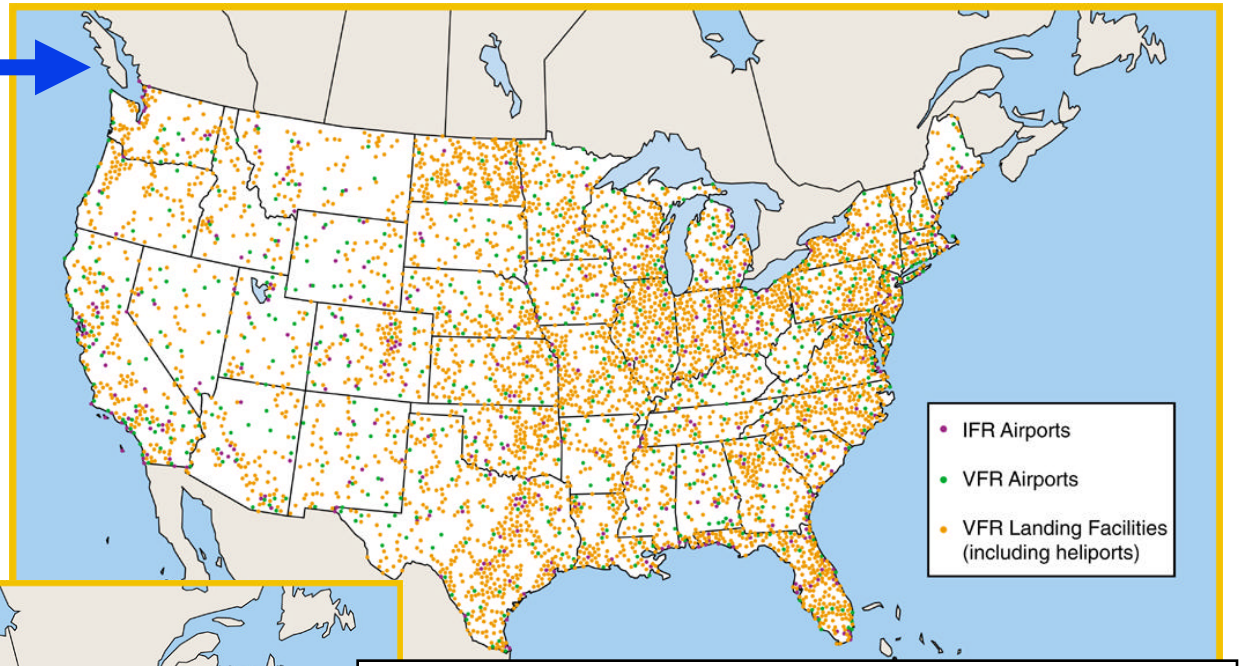
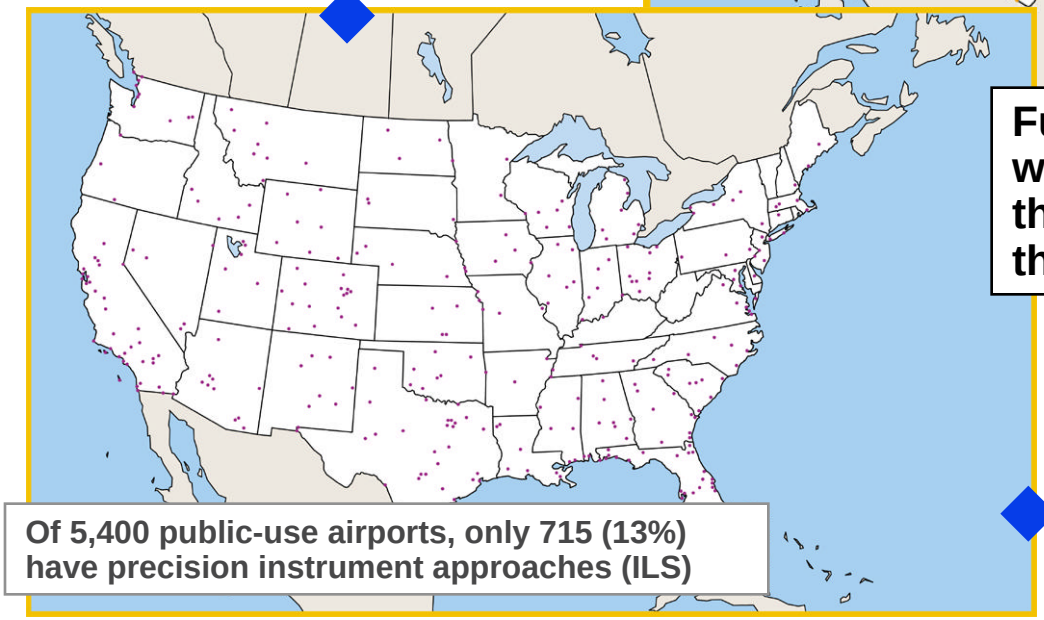
Aero-Space Technology

Expanded <u>Accessibility</u> to several times more destinations



Fully utilized 5,400 public-use near-all-weather landing facilities can increase theoretical NAS Throughput by more than an order of magnitude



Of 5,400 public-use airports, only 715 (13%) have precision instrument approaches (ILS)

Improved <u>Mobility</u> saving more travelers more time

Current States Roles in SATS Planning

- **SATS "Leader" States Committed to Support Program Planning**
  1. **Virginia**
  2. **Florida**
  3. **Nebraska**
  4. **North Dakota**
  5. **Oklahoma**
  6. **Kansas**
  7. **Illinois**
  8. **Indiana**
  9. **Wisconsin**
  10. **Washington**
- **Aerospace States Association SATS Resolution, July, 1999**
- **Leveraged Research Funding:**
  - **EPSCoR funding leveraged (*e.g.*, Nebraska, Kansas)**
  - **NASA Space Grant Program potential leveraging**
  - **SBIR / STTR leveraging**

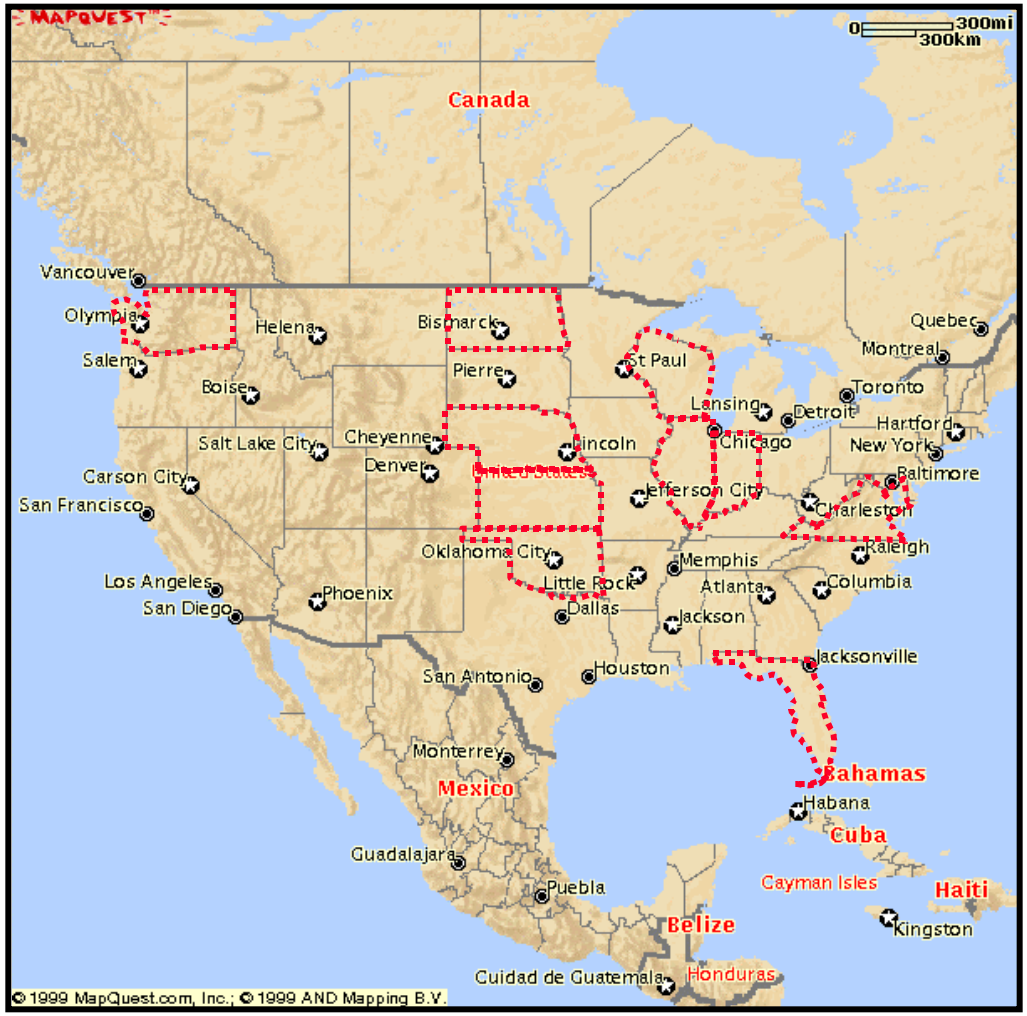


Figure 14

All-Weather Accessibility Means Economic Development

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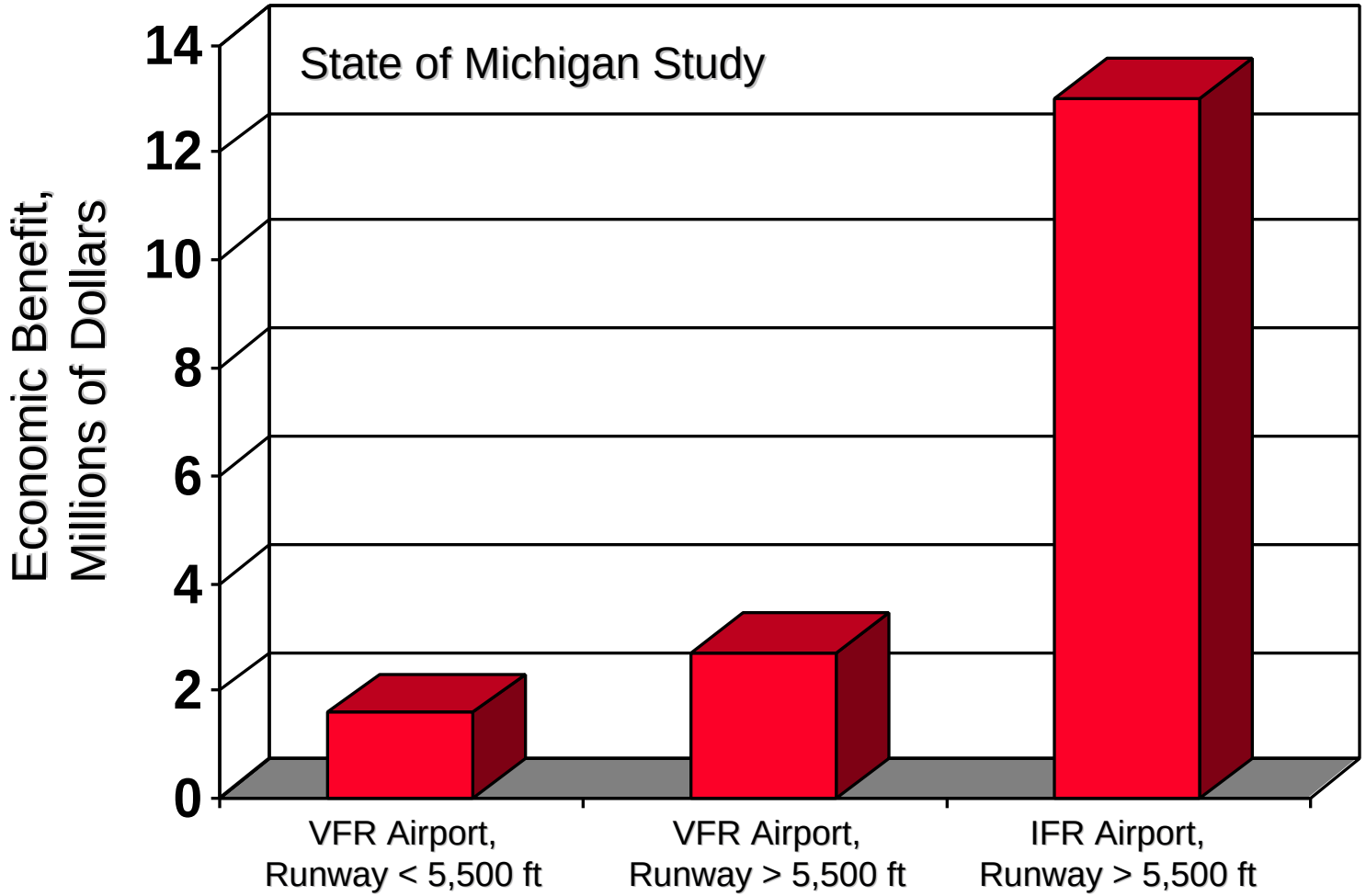


VFR - Visual Flight Rules
IFR - Instrument Flight Rules

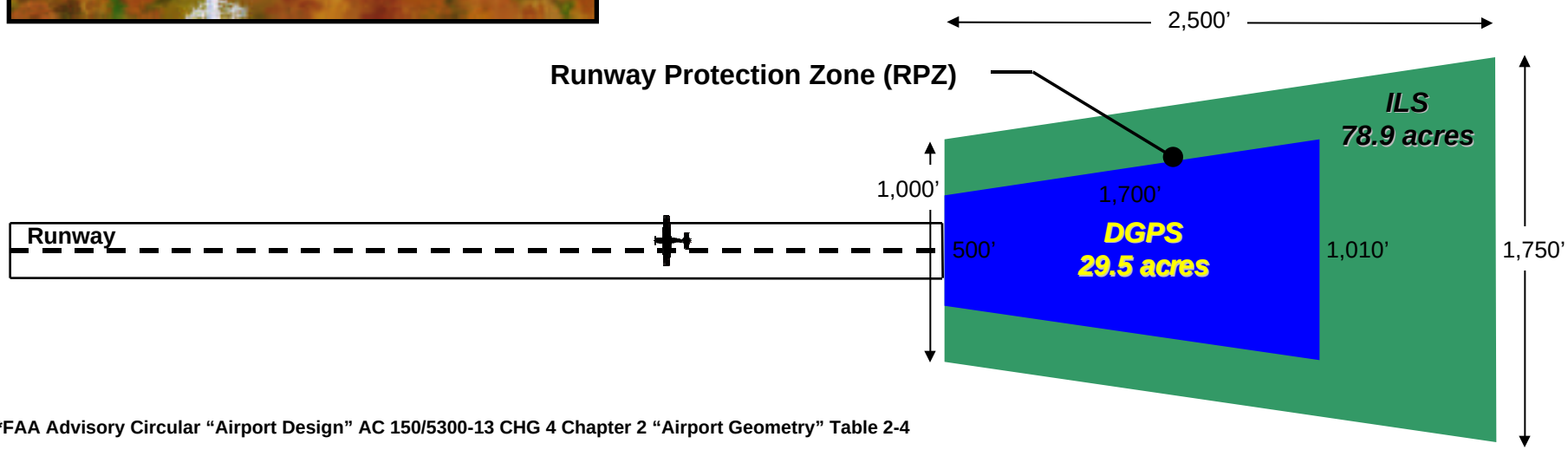
HITS System

Lowers Cost, Minimizes Dislocation, and Increases Safety

NASA Office of
Aero-Space Technology

A Highway in The Sky (HITS) DGPS-based approach guidance system may save over 49 acres per runway end compared to installing new ILS*

- **Avoids land and system acquisition costs**
- **Minimizes dislocation of existing land holders**
- **Increases safety for operators and community**
- **Reduces noise outside of airport boundary**



***FAA Advisory Circular "Airport Design" AC 150/5300-13 CHG 4 Chapter 2 "Airport Geometry" Table 2-4**

SATS Accessibility = Economic Development

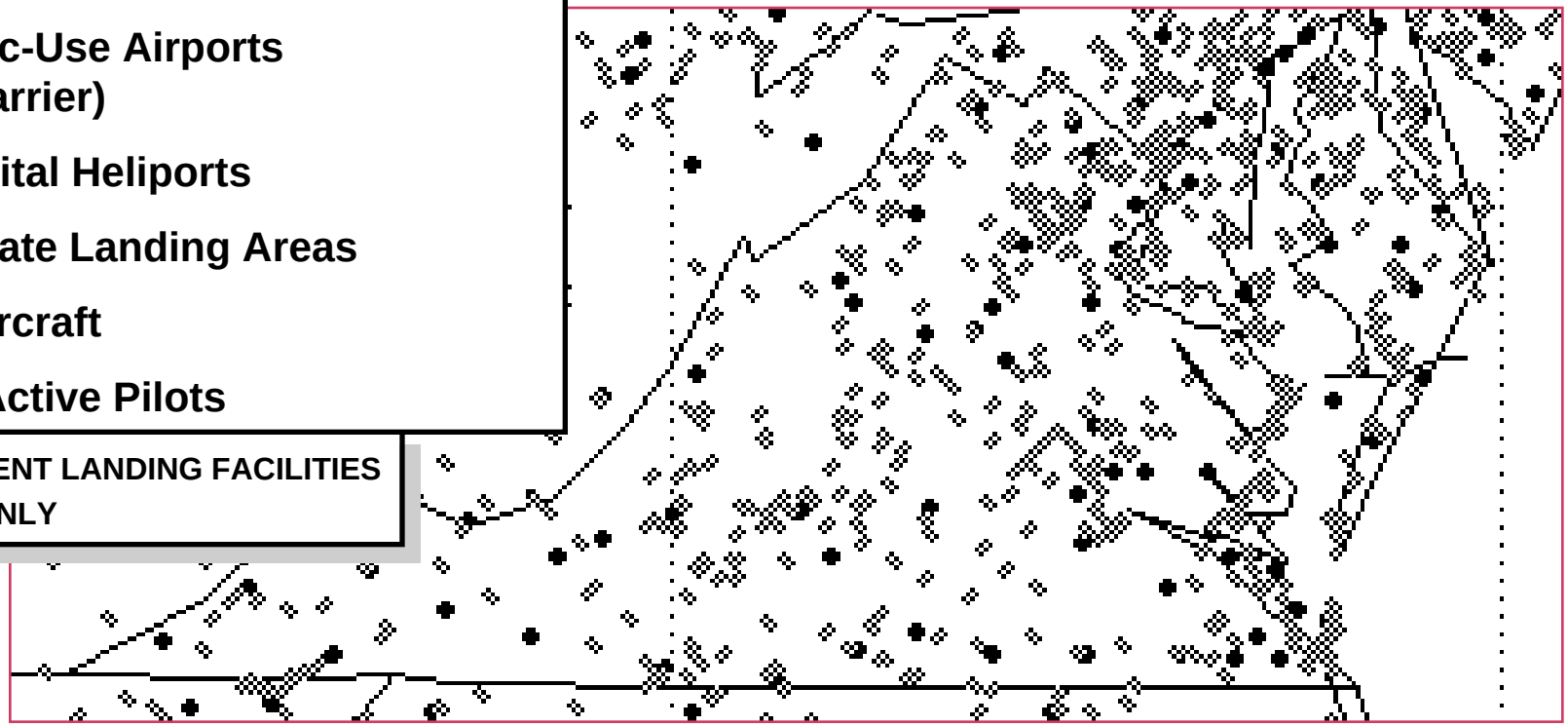
NASA Office of
Aero-Space Technology

Example for one state

Virginia General Aviation Today

- **~$175 Million in Economic Impact** (Primary & Secondary)
- **2,400 jobs from General Aviation** (Primary & Secondary)
- **68 Public-Use Airports (9 Air Carrier)**
- **54 Hospital Heliports**
- **227 Private Landing Areas**
- **4,104 Aircraft**
- **15,525 Active Pilots**

SATS will enable ~90% more accessibility by air for all Virginia's communities, expanding economic opportunities for all regions



A New Beginning

(Resulting from Current NASA Aeronautics Investments)

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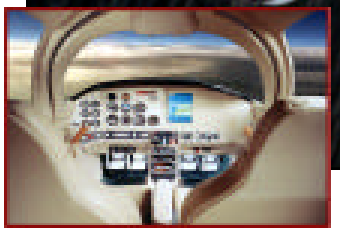

- **AGATE Alliance: 70 industry competitors collaborated under NASA leadership to create new, far-reaching technologies cockpit, airframe manufacturing, and flight training (1994 - 2001)**
- **Two newcomers represent the first new Single-Engine, Type-Certificated Airplanes in 15 years. Technologies derived from past 20 years of NASA Aeronautics research.**
- **Corporate commitments to new products and services signal the long-term potential for payoffs from these technology strategies**
- **Highway in the Sky (HITS) capabilities offer potential to deploy GPS/graphically guided approaches to all virtually all landing sites in the nation, leading to a 21st century Small Aircraft Transportation System**

AGATE/GAP Usher In A New State of the Art

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Lancair Columbia 300

The New Generation Cockpits and Aircraft

Cirrus SR-20

Williams V-Jet

SATS Is a System Approach to Safe Transportation Utility

NASA Office of
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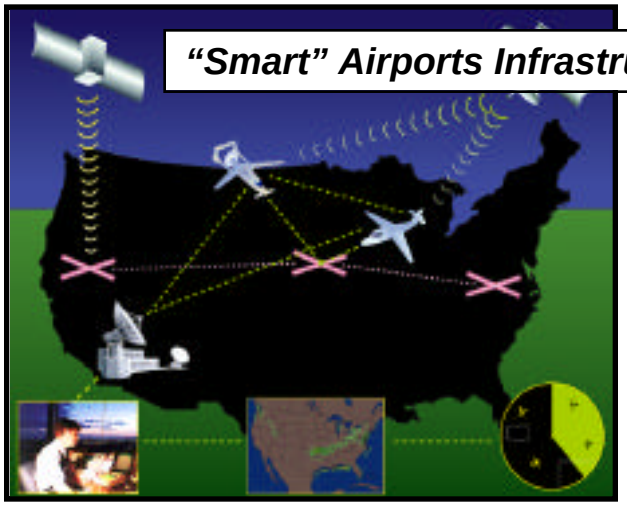
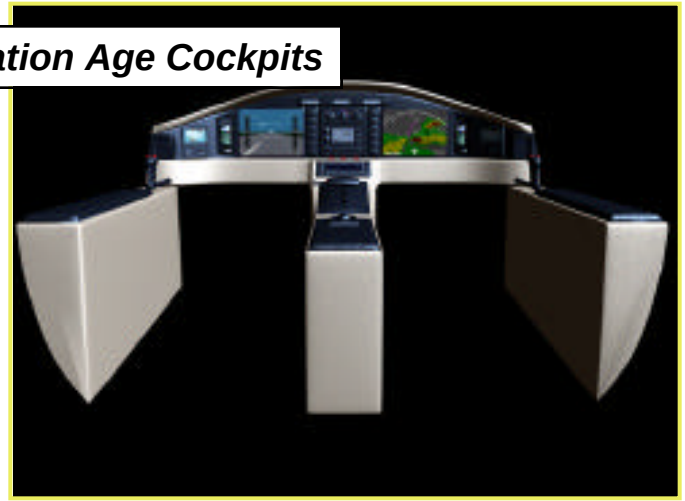
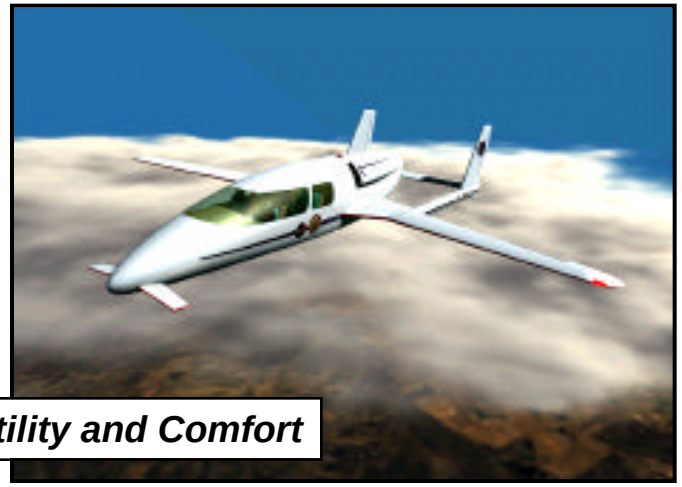




An Integrated System Approach To Safety

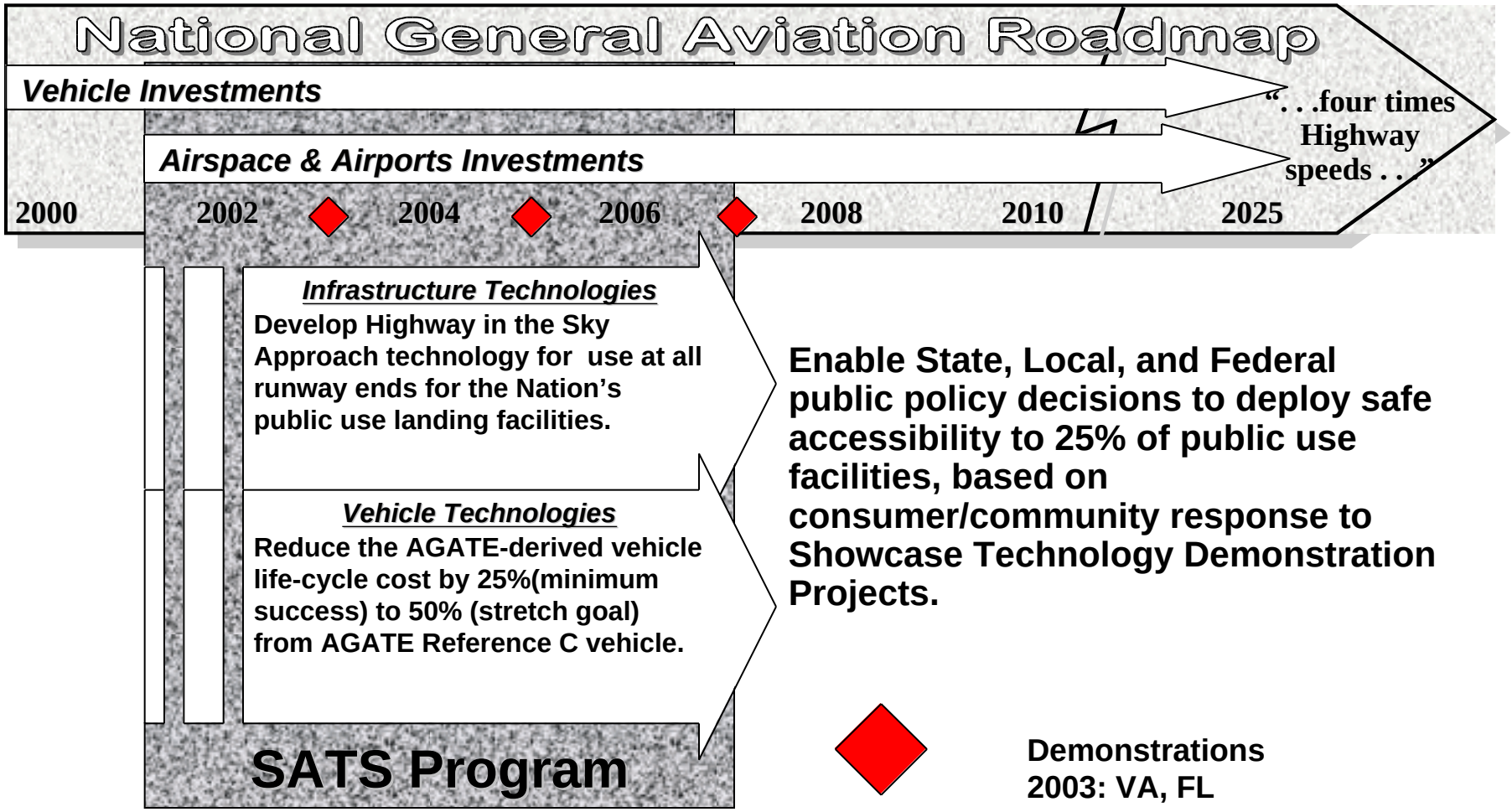


Technology Investments

- **Intermodal Transportation Systems** **Engineering**
  - ***Program System Engineering***
  - ***SATS Space Grant Partnerships***
  - ***National Public Outreach***
- **Digital Airspace Infrastructure**
  - ***Airborne Internet***
  - ***Smart Landing Facilities***
  - ***Runway Independent Aircraft Operations***
  - ***Showcase Demonstrations***
- **Robust Air Vehicles**
  - ***Autoflight***
  - ***Affordable Manufacturing***
  - ***Ultra-Propulsion***
  - ***Wireless Cockpit***
  - ***Cyber-Tutor***

Program Description

NASA Office of
Aero-Space Technology

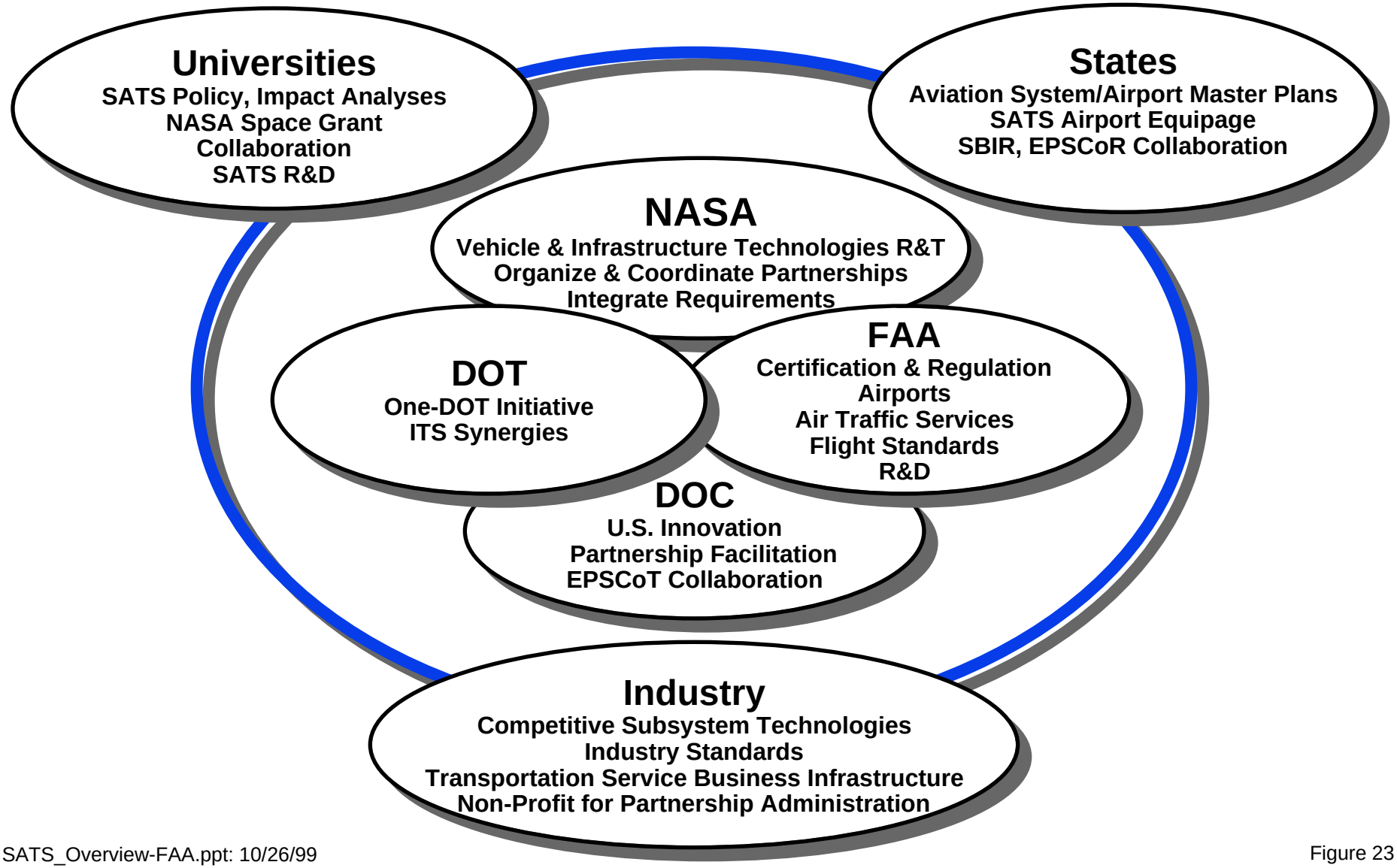


Enable State, Local, and Federal public policy decisions to deploy safe accessibility to 25% of public use facilities, based on consumer/community response to Showcase Technology Demonstration Projects.

Demonstrations
2003: VA, FL
2005: Leader States
2007: Regional

Candidate Federal-States SATS Partnership Roles

NASA Office of
Aero-Space Technology



Joint Agency Planning Position

NASA Office of
Aero-Space Technology

FAA/NASA Executive Committee

September 8, 1999

FAA Headquarters

Joint Agency Statement

SATS Program Description:

"The Small Aircraft Transportation System concept is a safe travel alternative that frees people and products from transportation system delays, creating access to more communities in less time."

Joint NASA-FAA supporting statements:

- FAA and NASA are working together to define a SATS operational concept as it relates to the transportation infrastructure of the U.S. and will begin a NASA funded research initiative to explore the feasibility and viability of implementing that concept.
- Under the charter of the NASA/FAA Executive Committee, the agencies agree to form a working group to define the FAA-NASA engagement in SATS program development and implementation planning

Conclusions

NASA Office of
Aero-Space Technology

"The Small Aircraft Transportation System is a safe travel alternative,
Freeing people and products from transportation system delays,
By creating access to more communities in less time."

- **SATS is an investment that preserves America's options for mobility and accessibility in an era of saturation of the highway and hub-and-spoke systems.**
- **SATS investments build on a solid track record of accomplishment by American industry working in partnership with NASA and the FAA.**
- **SATS strategies strengthen the U.S. knowledge-based industrial expansion.**
- **SATS gives people more time = more quality of life.**

The Small Aircraft Transportation System is a safe travel alternative, freeing people and products from transportation system delays, by creating access to more communities in less time.

Backup Charts

MAJOR PROGRAM ACCOMPLISHMENTS (4/98-4/99)

NASA Office of
Aero-Space Technology

- **Program Analysis**
  - apats.org implementation
  - AGATE current & latent market measurement complete (analysis underway)
- **Flight Systems Work Package, LaRC**
  - AGATE Architecture implemented on AGATE 1B
  - VDL Mode 2 and 3 Datalink MOPS completed
  - Raytheon Bonanza AGATE 1B flight experiments ongoing
- **Propulsion Sensors & Controls Work Package, LeRC**
  - Single Lever Power Control/FADEC initial development completed
  - Propulsion management & diagnostic system initial design & testing completed
- **Ice Protection Systems, LeRC**
  - Laminar flow manufacturing tolerances established
  - Collaboration with ID&M on integral manufacturing established
  - Graphical icing condition avoid & exit products developed
- **Integrated Design & Manufacturing Work Package, LaRC**
  - AGATE material qualification process submitted to Mil HNDBK17
  - AGATE Crashworthiness Design Guide published
  - AGATE Lightning Protection Design Guide published
- **Flight Training Curricula Work Package**
  - Completed first classes of students in AGATE Unified Instrument-private pilot curriculum
  - Delivered Integrated Cockpit Information System Learning Module CD-ROM
- **FAA Team AIR AGATE**
  - Revised AC's 23.1309 & 23.1311 completed

Industry Successes

Over 1997, the 1998 industry trends continue a three-year pattern of growth:

- **Billings up over 25%**
- **Deliveries up over 41%**
- **Single-Engine Piston deliveries up over 58%**
- **Exports up over 24%**
- **Used aircraft sales up over 20%**
- **Student Pilots up over 12%**
- **Pilot licenses up over 22%**
- **IFR Ratings up over 37%**
- **Industry employment up >20%**
- **General Aviation Total and IFR operations up 2% and 4%, respectively**
- **1998 was the safest year on record (for both rates of accidents & fatalities)**
- **Warren Buffett's purchase of Executive Jet Aviation and Flight International, and Toyota's decision to enter the lightplane market signals long-term potential for payoffs from NASA technology strategy.**

SATS Planning Assumptions

- Alliance-based program
- Cost-sharing (50/50 model)
- Collaboration for pre-competitive technologies
- Competition for competitive technologies
- FY 2001 to FY 2008 program with major demonstrations on 2-year centers
- FAA SATS Mission Need Statement influences NAS Architecture (5.x)
- U.S. industry and States will meet the challenge

Resolution of the Aerospace States Association

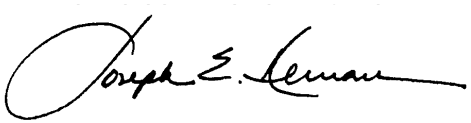
NASA Office of
Aero-Space Technology

RESOLUTION REGARDING THE PROPOSED

SAFE SMALL AIRCRAFT TRANSPORTATION SYSTEM (SATS)

- **WHEREAS** a variety of forces are converging to reduce the effectiveness of the nation's existing highway and hub-spoke air transport system to meet the growing needs of short distance, inter and intra-state travel; and
- **WHEREAS** these forces include the maturing of the hub-spoke air transport system, the increasing gridlock on the nation's highways, and the increasing value of human time; and
- **WHEREAS** the nation has an existing infrastructure of 17,000 airports for small, General Aviation Aircraft, of which at least 5,000 could be modified to meet the nation's emerging short distance transportation needs; and
- **WHEREAS** the Federal Government, acting through NASA, has undertaken cooperative technology development efforts with the nation's General Aviation industry to develop a new era of aircraft capable of effectively using these 5,000 airports; and
- **WHEREAS** the investment in, and control of ground infrastructure associated with such airports is under the jurisdiction of the nation's State and local authorities; and
- **WHEREAS** the Federal Government has offered to develop, with State governments, the means to upgrade those 5,000 airports with new capabilities, such as Global Positioning Systems (GPS), and link them together into a system to be known as the Small Aircraft Transportation System (SATS); and
- **WHEREAS** the development of a SATS has the potential to generate transportation-driven economic development benefits; and
- **WHEREAS** the coordinated development of a SATS would be of substantial benefit to the State governments in meeting the transportation needs of their citizens; and
- **WHEREAS** it is the purpose of the Aerospace States Associations to identify, support, and assist in the implementation of aerospace policies which involve coordination between the Federal and State governments,
- **NOW THEREFORE, BE IT RESOLVED** that the Aerospace States Association endorses and supports efforts by the Federal Government to undertake the planning and implementation associated with the creation of a Small Aircraft Transportation System (SATS).

ɔy a unanimous vote of the members voting.

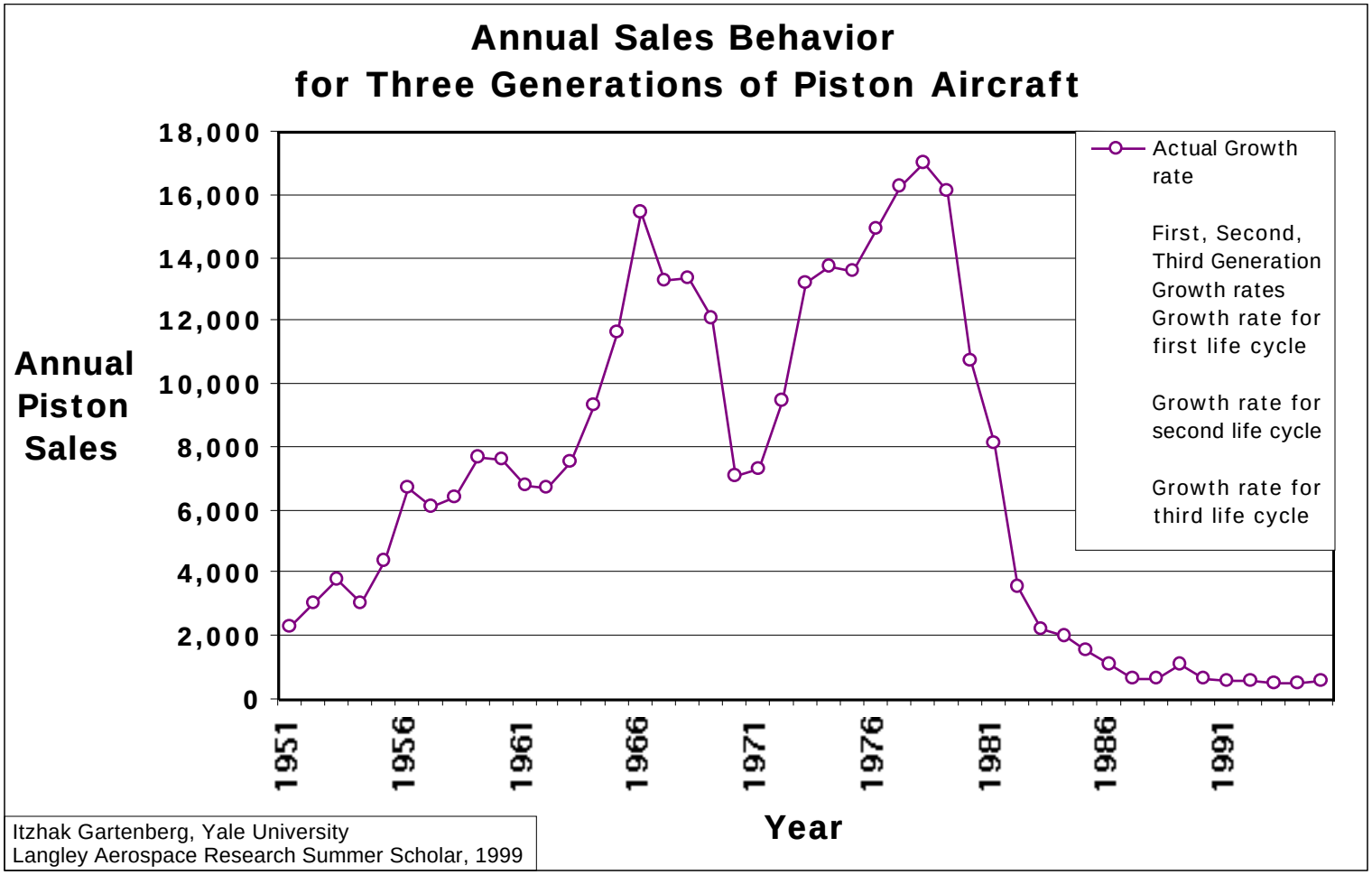


The Honorable Joseph E. Kernan (Lt. Governor, Indiana)

Chair

Life Cycles for Three Generations
Piston Aircraft

NASA Office of
Aero-Space Technology



Life Cycles for Three Generations
Piston Aircraft

NASA Office of
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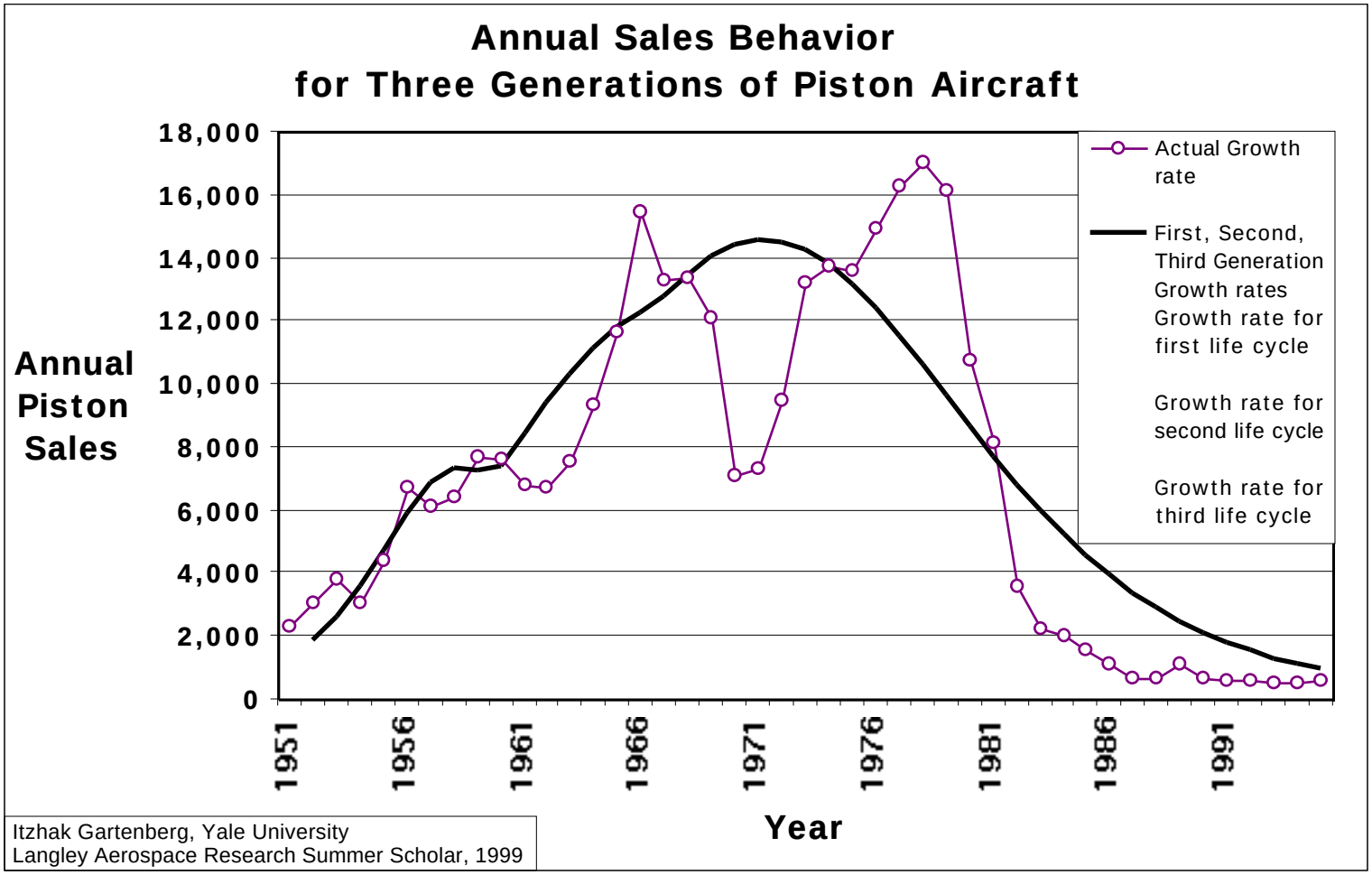

Life Cycles for Three Generations
Piston Aircraft

NASA Office of
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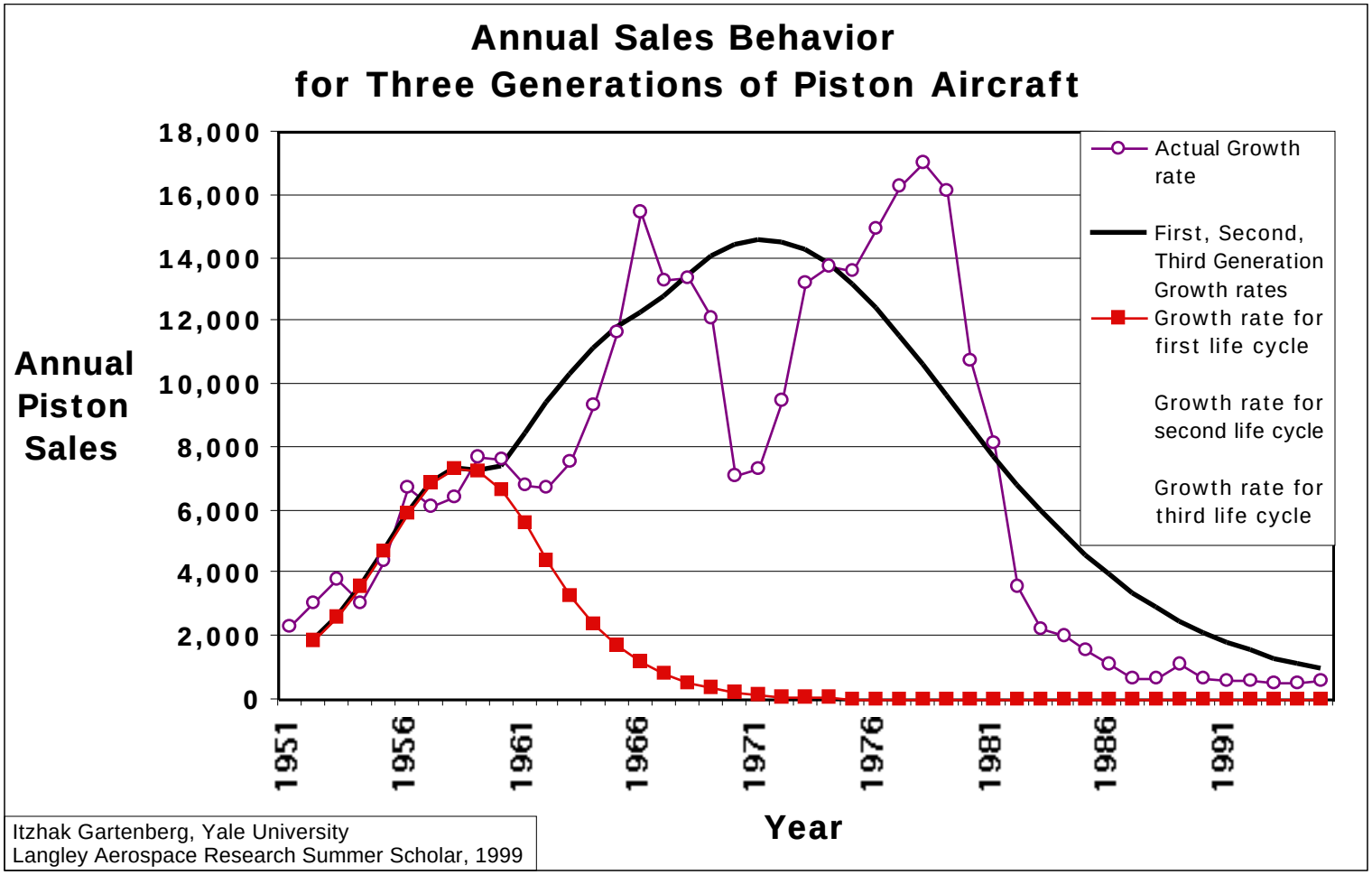

Life Cycles for Three Generations
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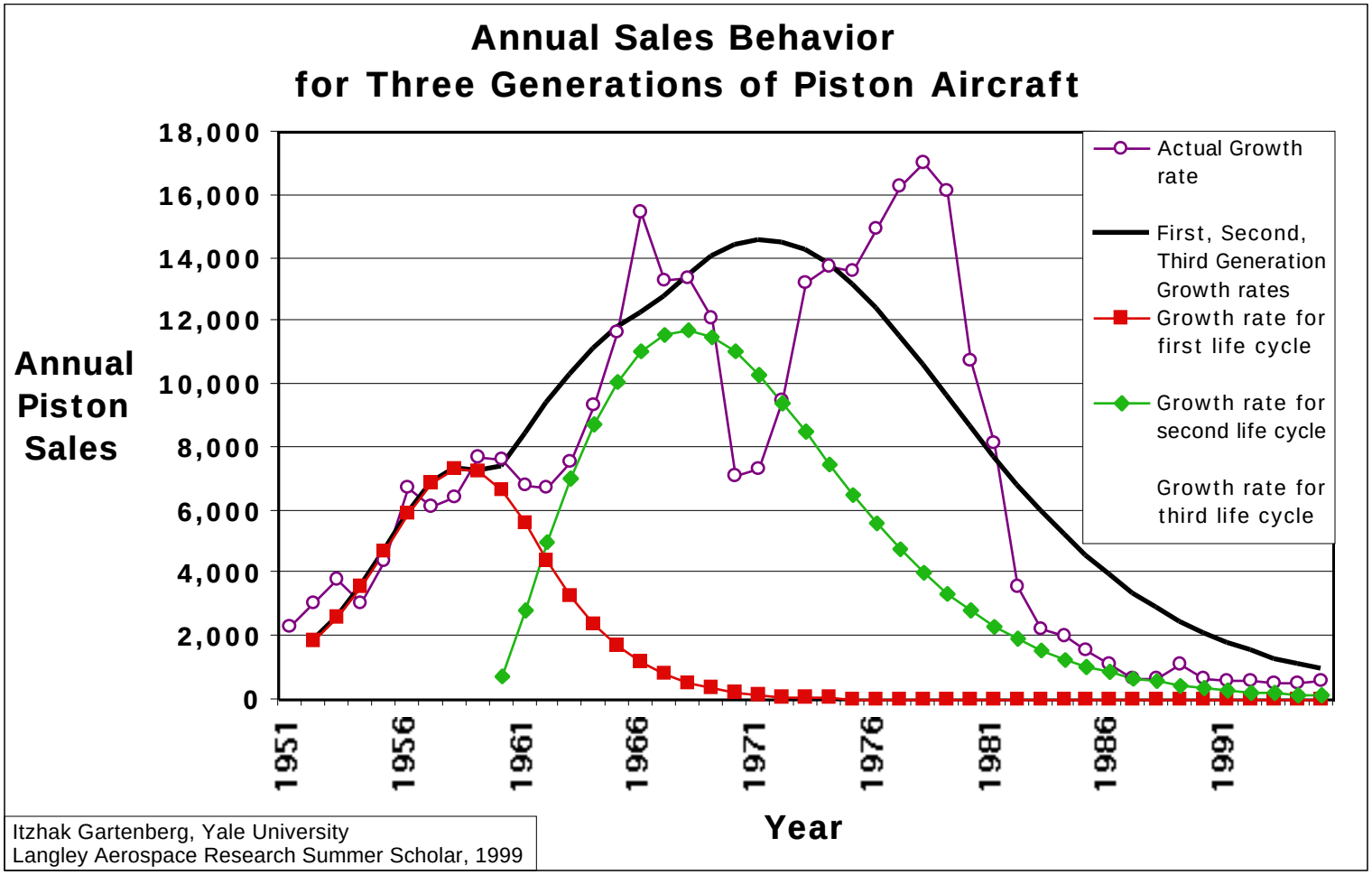
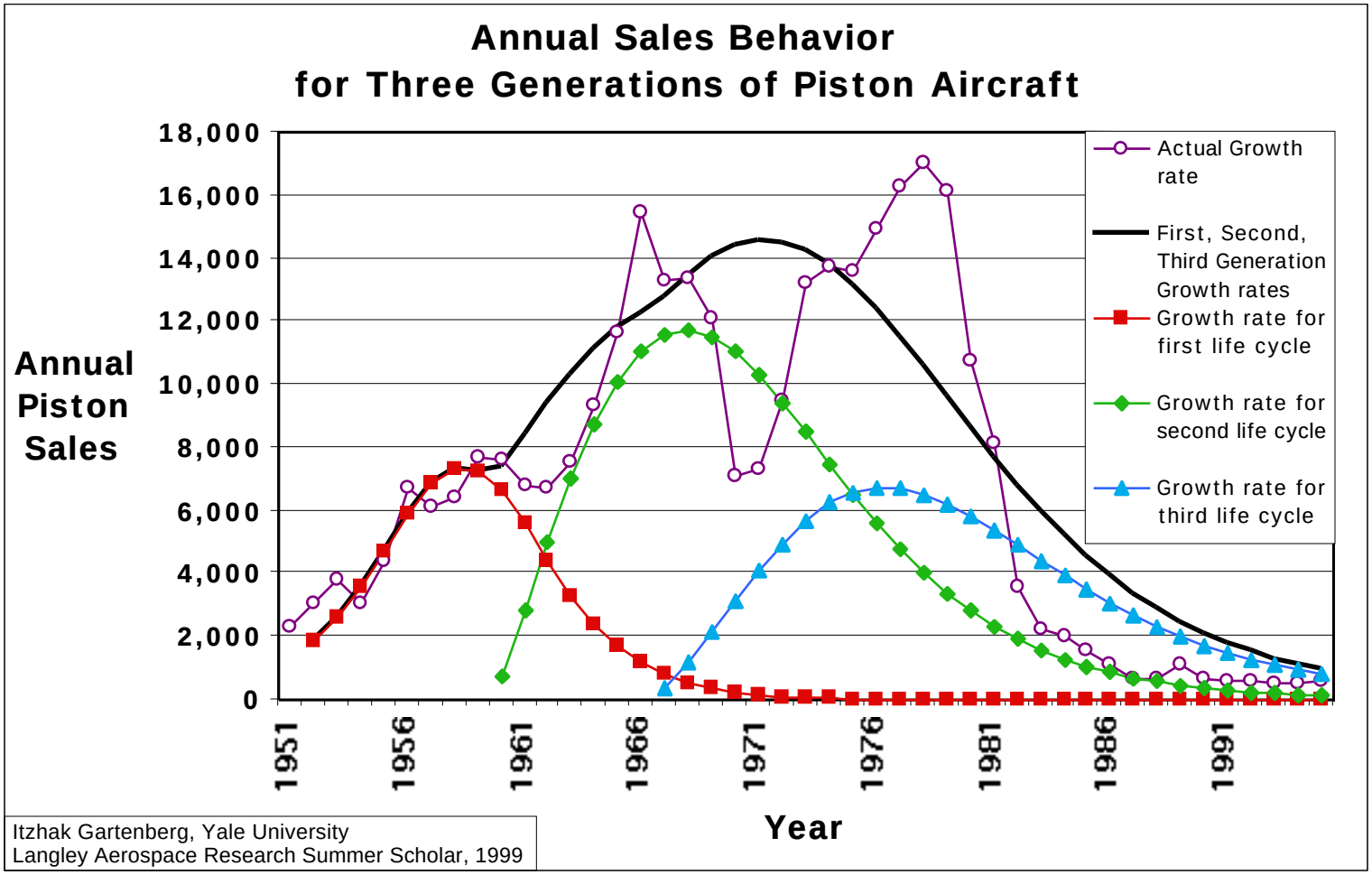


Itzhak Gartenberg, Yale University
Langley Aerospace Research Summer Scholar, 1999

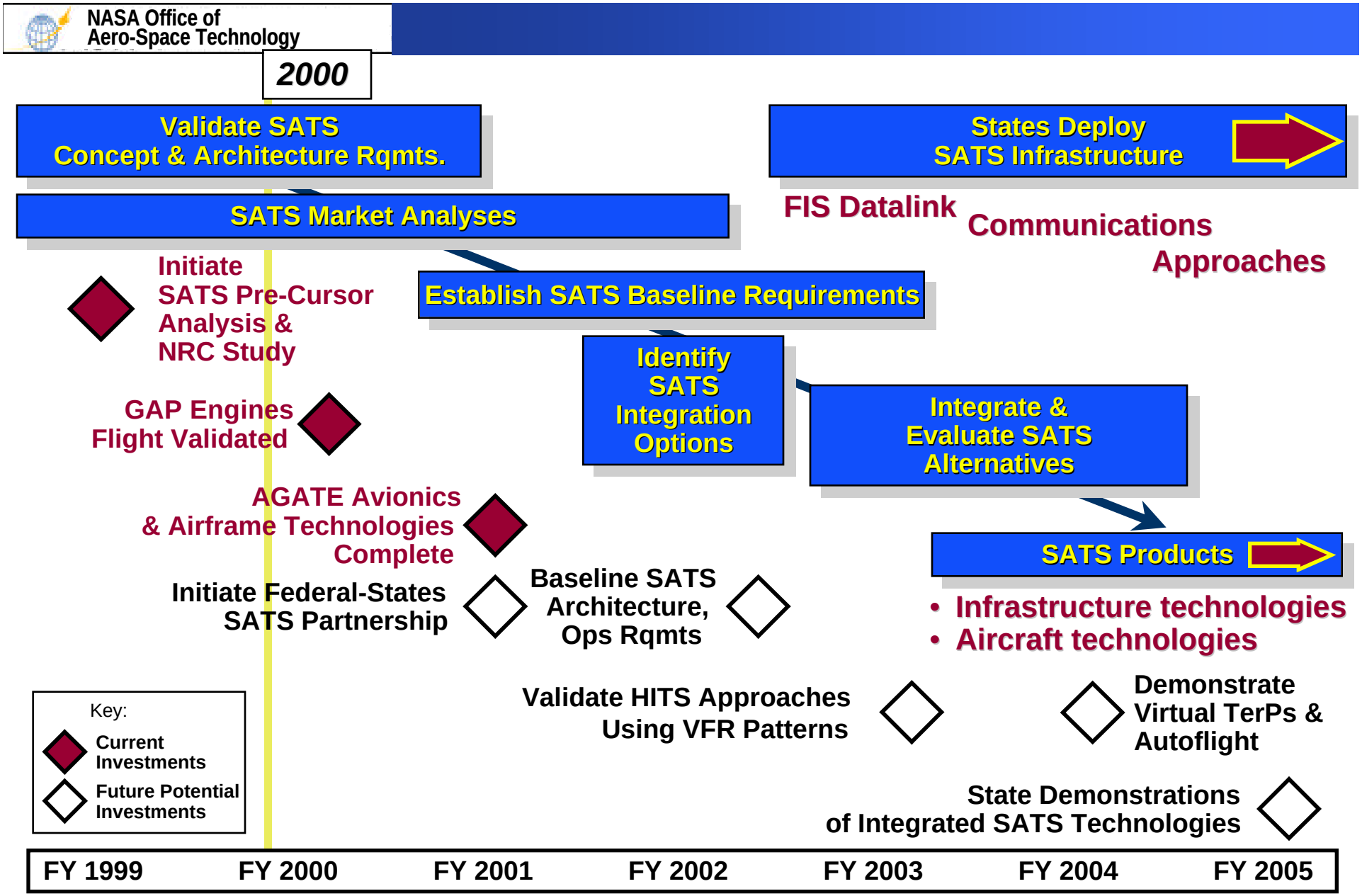
Life Cycles for Three Generations
Piston Aircraft

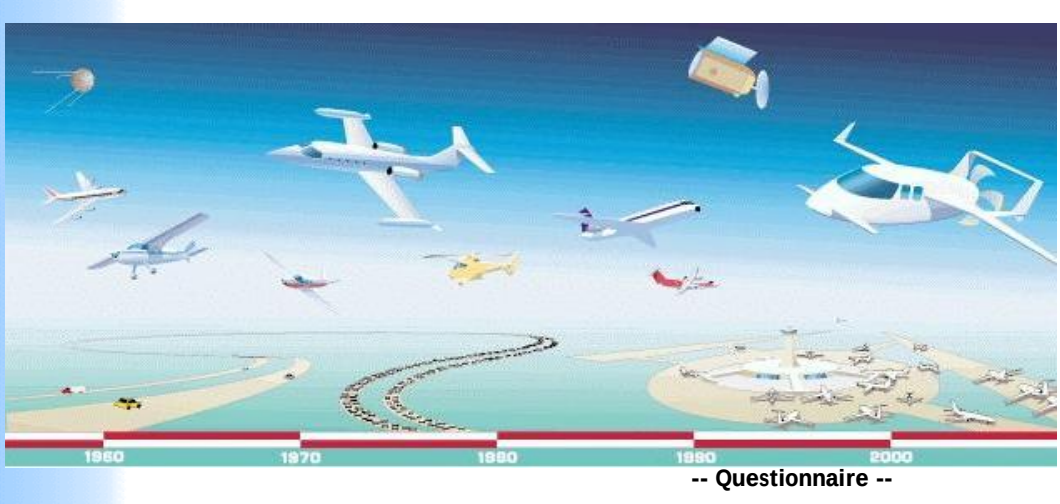
NASA Office of
Aero-Space Technology



Itzhak Gartenberg, Yale University
Langley Aerospace Research Summer Scholar, 1999

SATS Milestones FY 2000 - 2005





-- Questionnaire --

National General Aviation Technology Roadmap

PLEASE FAX BACK TO

757-864-8864

or mail to:

NASA General Aviation Program Office, MS 261

NASA Langley Research Center

Hampton, VA 23681-0001

The Small Aircraft Transportation System (SATS) concept increases mobility for the U.S. population. Mobility is defined as the ability to go where they want, when they want, faster that alternative travel modes with safety, simplicity, and affordability. New technologies are emerging for graphical weather information, satellite navigation, digital communication, air traffic management for free flight, affordable engines, simpler flight controls, and composite airframes. These new technologies offer vast improvements in lightplane safety, affordability, and ease-of-use. The purpose of the General Aviation Technology Roadmap is to establish a National strategic plan for future NASA investments toward the SATS concept. The purpose for this questionnaire is to survey the industry, government, university, and public to contribute to the Roadmap.

1. My role in transportation or aviation is (circle all that apply):
    1. Airframes (Manufacturer, Retrofitter, *etc.*)
    2. Air Service (Airlines, Air Taxi, Charter, Flight Instruction, Fractional Ownership, *etc.*)
    3. Airports (Manager, Operator, Owner, *etc.*)
    4. Avionics Manufacturer
    5. Comm./Nav./Surveillance Systems Manufacturer
    6. Engine Manufacturer
    7. Federal level (DOT, DoD, NASA, FAA, *etc.*)
    8. FAA Air Traffic Operations
    9. FAA Certification & Regulation
    10. FAA Flight Standards
    11. FAA Research & Systems Acquisition
    12. State level (Department of Transportation, Department of Aviation, *etc.*)
    13. Trade Association _____
    14. University
    15. Vendor or Supplier
    16. Other (explain)_____

2. My position in my organization is (circle all that apply):
    1. Air Traffic Controller
    2. Business Owner
    3. Corporate Officer
    4. Financial Management
    5. Flight Operations (Pilot, dispatcher, maintenance, etc.)
    6. Middle Management
    7. Professor
    8. Researcher
    9. Research Management
    10. Senior Management
    11. Student
    12. Technologist
    13. Other (explain)
    _____

3. The portion of my organization's or business unit's revenues derived from or expended for (fill in the blank for all that apply):
    1. Single-engine light planes is _____percent
    2. Twin-engine piston or light turbines is _____percent
    3. Business jets is _____percent
    4. Rotorcraft is _____percent
    5. Transport category aircraft is _____percent
    6. Other_____ _____percent

4. I AM AM NOT familiar with the technical progress by NASA and the FAA in the Advanced General Aviation Transport Experiments (AGATE) & General Aviation Propulsion (GAP) Programs in airframes, avionics, and engine technologies and certification reforms . (circle one)

5. I HAVE HAVE NOT studied and understood the National General Aviation Technology Roadmap materials. (circle one)

6. Please fill in the blanks with your sense of priorities for challenges in creation of a Small Aircraft Transportation System (rank in order of priority: 1 = highest priority).

_____ Aircraft technologies (airframes, engines, avionics)

Which?; Why?:_____

_____

_____ User training technologies (CBT, PC-ATD, embedded on-board, *etc.*)

Which?; Why?:_____

_____

_____ NAS Infrastructure technologies (CNS, ADS-B, WAAS, LAAS, *etc.*)

Which?; Why?:_____

_____

_____ Regulatory, standards, certification reforms (process, certitude, conformity)

Which?; Why?:_____

_____

_____Public policy (noise, land use, infrastructure funding, *etc.*)

Which?; Why?:_____

_____

7. Please rank the following technologies in order of priority (1 = highest; only one can be highest). Impact should be considers in terms of the following time frames for payoff:

- Near Term: 2001-2004
- Mid Term: 2004-2007
- Far Term: Beyond 2007

Priorities should be considered in terms of the following "Public Good" metrics:

- Mobility (the ability to go where you want, when you want, fast)
- Capacity (Utility and efficiency of the National Airspace System including General Aviation airports)
- Environment (Noise and emissions)
- Safety (Real and perceived)

System	Technology	Impact	Priority
Propulsion Systems	Noise & Emissions		
	Advanced Materials/Structures (metallics, ceramics, organic)		
	Advanced Simplified Subsystems (oiless engine, light weight gearbox, etc.)		
	Engine/Airframe integration (noise/vibration isolation, drag reduction, weight reduction)		
	Advanced unconventional heat engine concepts/configurations		
	Electric Propulsion		
	Alternate/unconventional fuels (methane, hydrogen, etc.)		
	Other (explain)		
Single-Crew Flight Deck Systems	Synthetic vision for electronic "virtual" Visual Meteorological Conditions		
	Flight controls for full flight envelope protection; ride quality; autoland		
	Advanced Expert Systems decision aiding, embedded training, and other advanced training technologies		

7. Concluded

System	Technology	Impact	Priority
	Other (explain)		
Airframe Systems	Thermoplastics, advanced metallics, and automated manufacturing		
	Advanced recovery (*e.g.,* whole airplane parachutes) and injury mitigation for heavier airframes		
	Alternative vehicle configurations (*e.g.,* personal rotorcraft)		
	Technology cost modeling and forecasting tools to predict the cost of new technology insertion into products		
	Other (explain)		
Communications-Navigation-Surveillance (CNS) Infrastructure Systems	"Smart" SATS airport Air Traffic Management (ATM in radar-less and tower-less airspace) & Flight Information Services (FIS) systems (airports databused and networked with IntraNets and InterNet Information Technology services)		
	All-Satellite CNS		
	Free Flight procedures for Terminal & Enroute		
	Tower & Controller Concepts for expanded SATS fleet (*e.g.* growth from 180,000 to 2x or 3x fleet size & operations		
	Other (explain)		

8. Please rank the following Regulatory, Standards, Certification, and Public Policy topics in order of priority (1 = highest; only one can be highest). Impact should be considered in terms of the Near- Mid-, and Far- Term definitions provided above. Priorities should be considered in terms of the previous "Public Good" metrics.

Topic	Issue	Impact	Priority
Regulation	Industry role in airworthiness certification for lightplanes (<6,000 pounds gross weight)		
	Electric Propulsion		
	Other (explain)		
Certification	Certitude reform (10^{-6} versus 10^{-9})		
	Process reform (streamlining; national standardization,...)		
	Conformity reform		
	Other (explain)		
Public Standards	General Aviation Free Flight		
	Avionics		
	Airports		
	Other (explain)		
Public Policy	Noise		
	Land use and zoning		
	Radio frequency allocations for SATS (FCC)		
	Other (explain)		

The vision and goal of the National General Aviation Roadmap is proposed to *"Stimulate dramatically expanded mobility through personal air transportation systems technologies, toward the goal of serving 25 percent of suburban, ex-urban, rural, and remote populations in 10 years, and 75 percent in 20 years."*

Please score the relevancy of this vision and goal statement **to your organization or business** with an "X" on the scale from 1 (least relevant) to 10 (most relevant):

1 2 3 4 5 6 7 8 9 10

Least Relevant Most Relevant

Please score the relevancy of this vision and goal statement **to the Nation and/or your State** with an "X" on the scale from 1 (least relevant) to 10 (most relevant):

1 2 3 4 5 6 7 8 9 10

Least Relevant Most Relevant

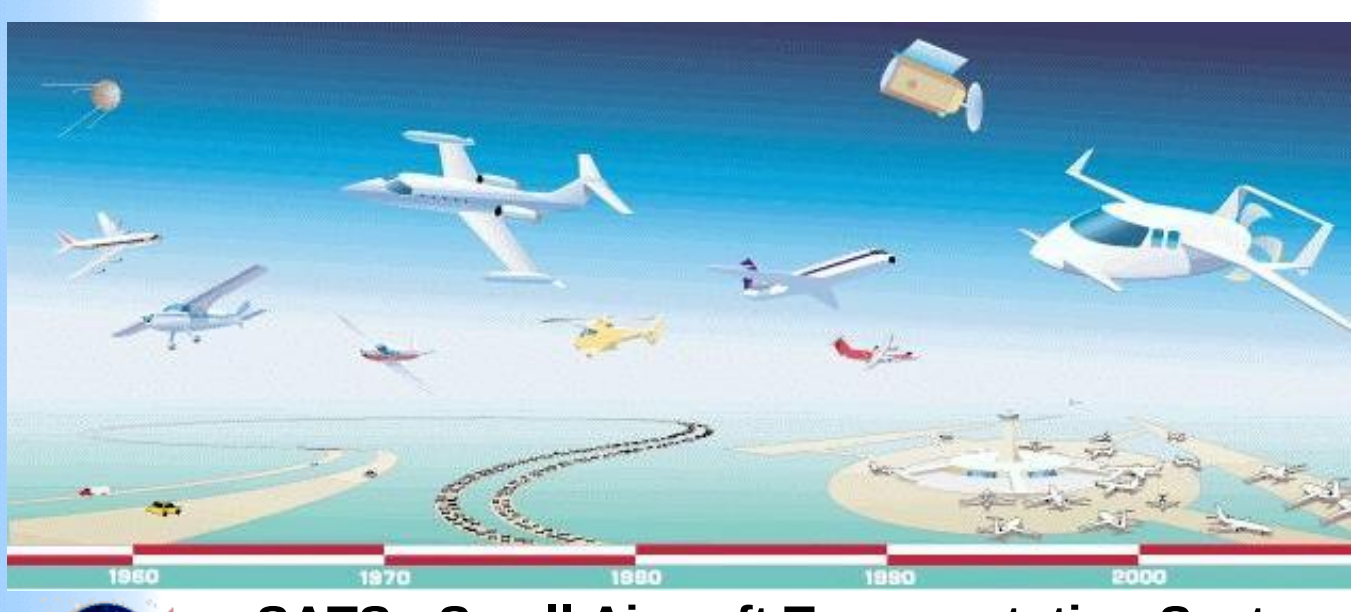
Please score the relevancy of this vision and goal statement **to yourself personally** with an "X" on the scale from 1 (least relevant) to 10 (most relevant):

1 2 3 4 5 6 7 8 9 10

Least Relevant Most Relevant

Thank you for your time on this survey. Please feel free to add any other thoughts that you have concerning the National General Aviation Technology Roadmap.

Go Back Home



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DOCUMENT ARCHIVE

JOIN SATS INTEREST GROUP

IMAGES & ANIMATIONS

LINKS:

FAA

EAA

AGATE

AOPA

GAMA (IE 4,5 /Netscape 5 only)

University of Nebraska-Omaha

SATS - Small Aircraft Transportation System

"The Small Aircraft Transportation System is a safe travel alternative freeing people and products from today's system delays, creating access to more communities in less time"

NEWS MEDIA STORIES

HIGHWAYS - OR PIE? - IN THE SKY
By JEFF LONG
Jan 30, 2000, Daily Press
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MISSION MAY LEAD TO MORE PRECISE MAPS
By JEFF LONG
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NASA Hosts Conference On Avionics Standard Databus
New Standard Could Lead To Lower-Cost "Plug-and-Play" Avionics
by Liz Swaine (lswaine@avweb.com)
Dec 20, 1999, The AVweb Group
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"Built-in chute lets pilot float plane to ground"
by Shamus Toomey and Chris Fusco
Dec 12, 1999, The Daily Herald (Arlington Heights, Ill.)
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"Turn Left at Cloud 109"
By James Fallows"
Nov 21,1999, The New York Times Magazine
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SATS NEWS

Nov 10, 1999 SATS Planning Workshop at NASA Langley
In preparation for a SATS Program Readiness Review (PRR) in April '00 and a Non-Advocate Review (NAR) in July '00, a Gov't only Planning Workshop will be held at the NASA Langley Research Center November 16-18, '99. NASA and the FAA will begin developing a detailed SATS Program Plan including milestones, objectives, and program deliverables. The workshop will focus on the technical challenges facing the program and plans for overcoming them. Although there has been no formal approval of the proposal SATS Program, planning is moving ahead for a FY01 start.

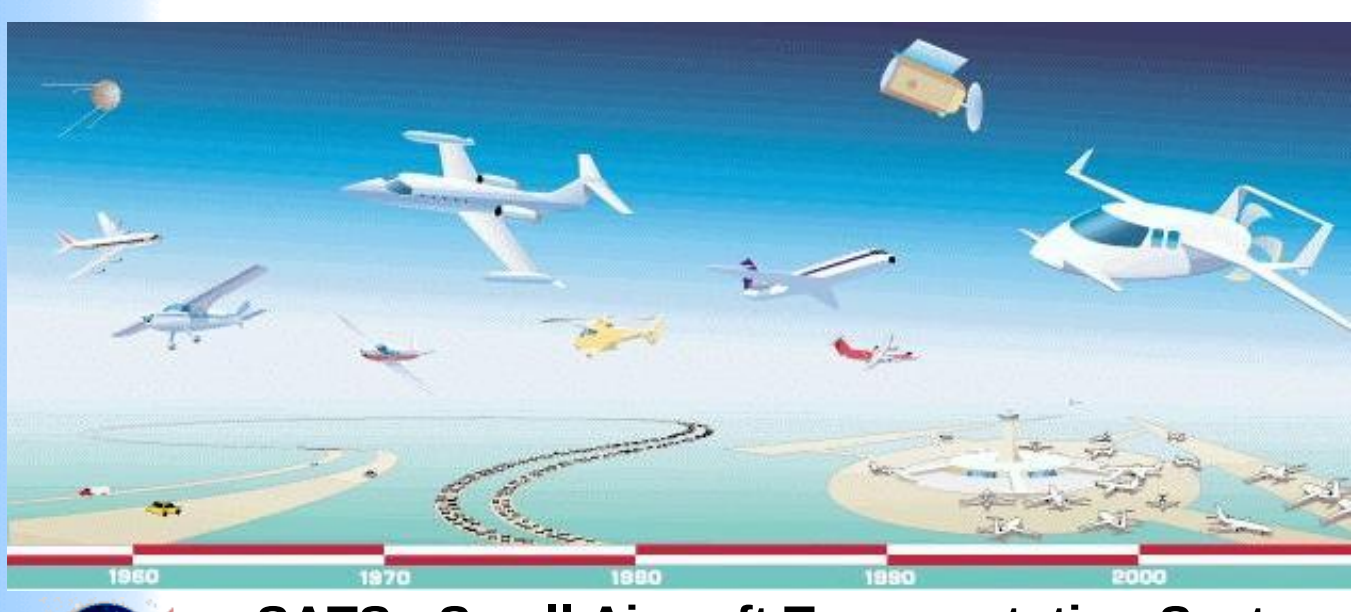
Sept 19-22, 1999 NASAO Conference, Williamsburg, Virginia

NASA and the FAA participated in the 1999 NASAO (National Alliance of State Aviation Organizations) Annual Conference held in Williamsburg, VA, September 19-22nd . Donna Roper, Langley Public Affairs Office, organized the NASA exhibits, which covered the Aviation Safety Program, UEET, Capacity, and SATS. NASA representatives from Glen Research Center, Langley Research Center, and NASA Headquarters staffed the exhibits and provided information to conference attendees on NASA research and technology development. The SATS booth featured a 25% scale model of a "futuristic" general aviation aircraft, a video illustrating the SATS concept of operation, and posters from both NASA and the FAA describing on-going related research. The SATS booth was staffed by Dr. Bruce Holmes, Jim Burley, and Dave Hahne from NASA Langley, and Mr. Jim McDaniels and Mr. Peter McHugh fom the FAA.

Sept 17, 1999 SATS Proposal submitted to OMB

The SATS proposal, developed over the course of this summer, was presented/submitted to OMB by the NASA Administrator, Mr. Dan Goldin and the Aeronautics Deputy Administrator, Gen. Sam Armstrong on Friday, Sept 17th.

Web Hosting by the AGATE Alliance Association, Inc. (AAAI)
Responsible NASA official: Jim Burley (j.r.burley@larc.nasa.gov)
Curator: Dale B. Castle (dale.b.castle@larc.nasa.gov)
Last Updated: January 31, 2000



SATS - Small Aircraft Transportation System

"The Small Aircraft Transportation System is a safe travel alternative freeing people and products from today's system delays, creating access to more communities in less time"

SATS Documents

Presentation	Author	Size
Meigs Field, Chicago, Jan 28, 2000, (MS Power Point)	Dr. Bruce Holmes, NASA General Aviation Program Manager	15M
Virginian Pilot editorial board meeting (MS Power Point)	Dr. Bruce Holmes, NASA General Aviation Program Manager	19M
SATS Meeting Agenda	David Hahne, SATS Blue Team Leader, NASA LaRC	165K
National RoadMap National GA Roadmap and SATS Concept	Dr. Bruce Holmes, NASA General Aviation Program Manager	1.7M
National GA Roadmap presentation to FAA, Oct 1999 (Acrobat PDF)	Dr. Bruce Holmes, NASA General Aviation Program Manager	2M
National GA Roadmap presentation to FAA, Oct 1999 (MS Power Point)	Dr. Bruce Holmes, NASA General Aviation Program Manager	18M
Transportation Market Study	Bill Hammers, Optimal Solutions	1.7M
FAA Mission Need Statement for SATS	Jim Rowlette, FAA	760K
Partnerships & Alliances Panel Discussion	Jack Sheehan, Exec. Director AAAI	80K
State of the Art: Avionics	Scott Asbury, NASA LaRC	3.5M
State of the Art: NAS Infrastructure	Jeff Breunig, Arthur D. Little, Inc.	880K
State of the Art: Training	Dr. Steve Hampton, Embry Riddle Aeronautics University	160K
Instructions to Breakout Sessions	David Hahne, SATS Blue Team Leader, NASA LaRC	160K
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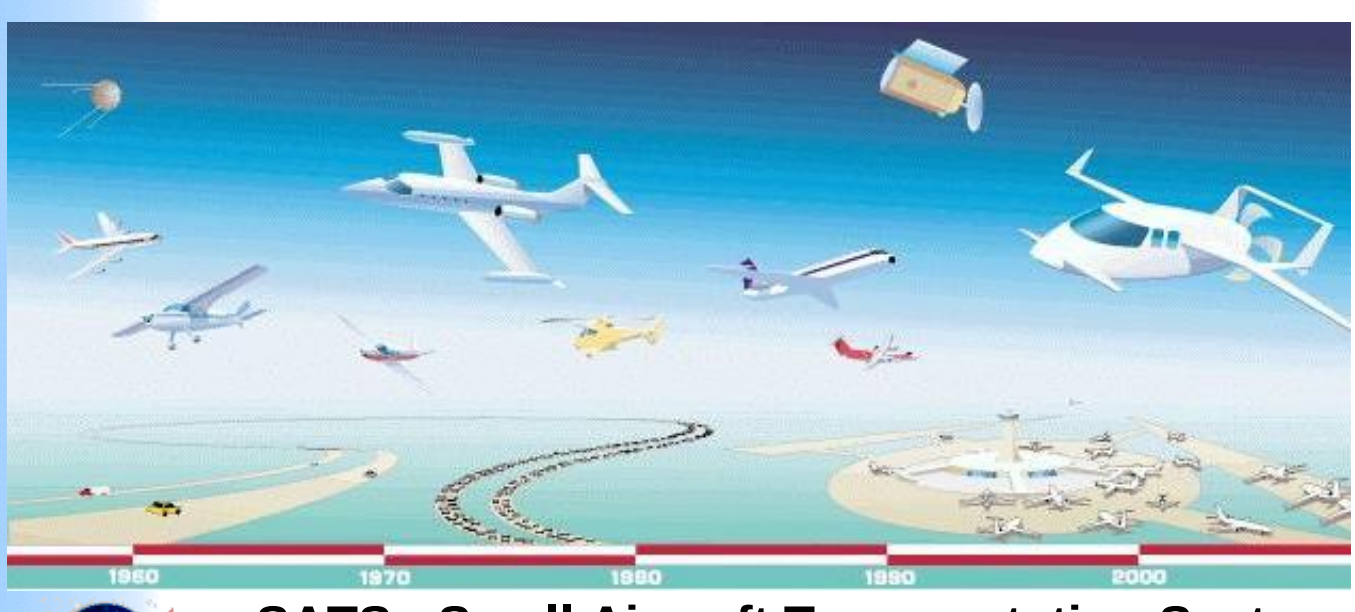
Last Updated: January 31, 2000



SATS - Small Aircraft Transportation System

"The Small Aircraft Transportation System is a safe travel alternative freeing people and products from today's system delays, creating access to more communities in less time"

SATS Images & Animations

Images

AirVenture '99: EAA Pavilion Exhibits
AirVenture '99: General Aviation/SBIR Exhibits
AirVenture '99: NASA Main Building Exhibits
Advanced General Aviation Transport Experiments (AGATE)

Animations

Advanced General Aviation Transport Experiments (AGATE)

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Last Updated: December 30, 1999

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User Response

** Last Edited Monday, Dec 28, 1999*

Go to Homepage

"Aviation Daydreaming"

NASA Administrator Daniel S. Goldin

SAE World Aviation Congress

San Francisco, CA

October 19, 1999

Thank you for that generous introduction.

Before I begin, I want to salute everyone at AIAA and SAE who worked so hard to make this conference happen.

[I would like to introduce the NASA team that here this morning . . .]

It is good to see so many of our partners and friends from around the world here today. I hope you won't take offense if I direct many of my remarks to Team America—the American aviation community.

We at NASA have a unique relationship with the rest of Team America. We develop and validate long-term, high-risk, high-return innovative technologies. Then we hand it off to industry, and they develop, build, and operate the products *that are sold worldwide.*

Industry "puts the rubber on the road," or more appropriately, "lifts the wheels off the runway."

You know, in just a few years, we will celebrate the 100th anniversary of the Wright Brothers' historic flight.

What will we celebrate when we reach that milestone?

More importantly, when people in 2103 celebrate the 200th anniversary of human flight, what will they say about our efforts in the coming years?

Will it be, "The aviation sector really improved the quality of people's lives in the 21st century," or will it be "The aviation sector really blew it in the 21st century"?

Guess which one I *hope they put down in the history books* want to hear. The only way it will happen is for us to dare to dream.

And then roll up our sleeves and work together to make those dreams reality. *Small evolutionary changes won't do it.*

We already have a terrific team in government, industry, and academia that is working hard to make that happen.

These great people are being pushed to their limits because there is so much demand for air travel. But I don't think anyone could have predicted the unprecedented years of economic prosperity that has fueled our rush to our nation's airports.

The issue is that the necessary technologies are not on the shelf today.

And federal spending constraints have exacerbated the situation by limiting funding for developing cutting edge technologies.

Clearly, there are some daunting challenges in our future, including safety, capacity, noise, emissions, performance and cost. All these add up to improving the quality of life. But our combined intelligence and innovation are far greater.

We have come a long way since the DC-3. This is a mature industry that has contributed much to the overall quality of life – in America and the rest of the world. Aviation has made the world much smaller. Today, we can reach any point on Earth within 24 hours.

But there has been a price as well. With so much capacity to travel, the world has become a very cluttered place. America's hub and spoke system carried 680 million passengers this year. A number that will exceed 1 billion early next decade and reach 1.5 billion by 2020.

We are crowding our airways, our airports and our world. We want to travel to any place, at any time, from any where. But we demand it be done safely, conveniently and economically without adversely affecting the environment or our own neighborhoods.

These are clearly not mutually exclusive factors.

One must take a rational approach not only to understand the complex interactions among these factors but also to assure the goals we are trying to achieve are properly balanced.

This is a message to the regulators.

Right now, for a doorstep to destination trip under 500 miles, the average speed is just 80 miles an hour—not much faster than the highway system on those rare occasions it operates at peak speed.

We absolutely must move that average speed much closer to aircraft cruising speed.

Our challenge is to expand the capacity of our major airports and open access to the over 5000 smaller airports that can serve small cities and communities across our country. The goal: safer, cheaper, more accessible air transportation for all.

If we fail to meet the challenge, the alternatives are not good. Quality of life and economic prosperity will suffer.

Another risk faced by air travel is the Information Revolution. Business travel blossomed in the 1970's as availability grew and prices fell. People could travel affordably and conveniently.

However, as we enter the next millennium we will be able to "be" anywhere we want without having to physically be there. We are on the verge of ultra-high speed communication and wide-spread networks -- the "Internet II" – that will link us through "virtual presence." First it will be wall-sized, high-resolution displays with life-like 2-Dimensional imagery. But soon to follow are fully 3-D immersive environments. When all the senses say you are there, the geographic reality may not be relevant.

Business travel, the main stay of modern air travel, may go the way of the vacuum tube, if we do not rise to the challenge. That means being on an airplane can't be much different than being in an office. When you board the plane, you must be able to take your entire office environment with you and be able to communicate on a global basis.

The alternative is simple. We need to team up and meet the challenges head-on. That's what America is all about.

The future of air travel will be both evolutionary and revolutionary. Our medium and long-haul aircraft are very good. Still, we can make them somewhat lighter, more fuel efficient, more aerodynamic and significantly less expensive. But we are not talking factors of 10 and in most cases not even factors of 2.

The revolution will likely come in smaller aircraft—the more individualized craft, transporting 4 or 10 or 40, not hundreds—and in super- and hyper-sonic speed for long haul planes.

As commercial air traffic increases, we will see more accidents, unless we revolutionize the entire air transportation system. But the public doesn't care about accidents per mile per passenger. That's just gobbledygook to them.

Actual numbers of fatalities—that's something they personalize, thinking "wow, that could have been me."

We need to do everything we can to make the public feel safe, whether they fly or simply live near airports.

Right now, about 85% of all fatal accidents fit into one of four categories: limited visibility, weather, loss of control of the aircraft, and on-board system failure.

I'd like to take a minute to look at how we are responding to these issues.

NASA is committed to working with the FAA and the U.S. Aviation industry to cut the fatal accident rate 80% by the end of the next decade and then cut it in half again in the decade after that.

One of NASA's most exciting projects to enhance visibility is what we call artificial vision—the development of advanced sensors, digital terrain databases, accurate geo-positioning, and digital processing to provide a perfectly clear 3-D picture of terrain, obstacles, runway, and traffic.

This goes beyond simple visual imaging through clouds and weather. It enhances the elements you need to see and suppresses the ones you don't. It will ensure a reliable and easy system for threat avoidance, regardless of whether the threat is a mountainside or a recently constructed transmission tower. And it will provide clear warning advice and guidance to the pilot [A voice like HALE will talk to the pilot].

Such a system could enable safe and reliable day-night-all weather in-flight and on-ground operations. And not just for the most experienced pilots.

Today, anyone with cable television can get a better picture of the nation's weather than a pilot in flight. We've established partnerships with four separate teams to show how to bring an "Aviation Weather Channel" into the cockpit.

I don't mean that pilots will only view ground-based and aircraft-based radar images of weather systems. They will have the macro view as well as a real-time, micro view of all weather in the vicinity of the aircraft and along the flight path.

I'm talking about a 3-D depiction of complex weather patterns that clearly shows the locations of hail shafts and windshear, lightning and storm cells. It'll give us a pathway—the highway in the sky—for safely navigating through nearly any weather condition.

A few years back NASA, the FAA, and the aviation industry made a concerted attack on wind shear. In the 1980's, major wind shear accidents were occurring at a rate of one every two years. Through training, improved ground systems and NASA-developed forward-looking radar technology, the wind shear problem has been cut by a factor of 5.

We're also working with the FAA and the industry to better understand and model the turbulence hazard, then develop and evaluate prediction, detection, and avoidance technologies, including radar.

And recent NASA flight tests indicated that lidar could detect clear air turbulent conditions about 10 seconds ahead of the aircraft. We're working to stretch that timeframe into minutes.

Our goal is to eliminate turbulence as an aviation hazard within the next five years.

An issue closely linked to safety is capacity.

Right now, there is simply too much demand on a system ill-equipped to handle it. In 1996, air traffic delays in the U.S. averaged 8,000 hours each day at a daily cost of $10M. As air traffic increases in the current system, those numbers will skyrocket, and the quality of life for both the flying and non-flying publics will deteriorate.

And the short-haul system needs improvement too. It costs people more to fly the 150 miles from Washington, DC to Williamsburg, VA than it costs them to fly to San Francisco.

About 1/20th the distance for twice the price…doesn't motivate people to use air transportation for short-haul trips, does it?

And there are only one or two flights a day to Williamsburg. But travelers to San Francisco can almost pick the hour they want to leave.

Playing the blame game won't solve the problem. The reality is that we are pushing against the limits of our existing technology.

That's why NASA is committed to providing technologies that will enable tripling of the throughput of the aviation system within the next decade or two. And with our partners in the FAA, industry, and academia, we will do it, and under conditions that are far safer than today.

The total suite of tools we are working on now should improve throughput in the terminal area and in the routing process.

One tool is the Final Approach Spacing Tool (FAST), which has been tested at the Dallas-Fort Worth airport. The result? A 13-15% improvement in numbers of takeoffs and landings—the equivalent of adding a new runway.

We are also working on a wake vortex sensing and prediction system that allows controllers to more accurately space aircraft on approach. One recent study suggests that reducing the average aircraft separation by one mile could increase total capacity by 30%.

To triple capacity, we also need new aircraft classes that will off-load the main runways of our nation's most congested airports and decrease costs and increase accessibility in the short-haul system. This will include Runway Independent Aircraft capable of take-off and landing on whatever ground is available—independent of size and direction.

Beyond safety and capacity, noise is another major challenge.

In 1998, 350 airports throughout the world had local noise restrictions in place. If we can't design engines and airframes that are significantly quieter than today's, we will soon be unable to sell American planes in many markets.

However, we're already well on our way to a 10 dB reduction of noise within the next 10 years.

And we can do even better. It will take the best and brightest of Team America to make it happen though.

Since we're here in California, I'll take this opportunity to discuss airplane emissions and the resulting smog.

If this isn't a quality of life issue, I don't know what is. We all know that 70 Million people currently live in areas that exceed the federal standards for NOx and ozone. These gases have known linkages to respiratory diseases which particularly attack the young and the aged.

Right now, airports across the nation are being restricted from growing, either because of the smog-producing gases or the noise from their airplanes.

This is not a social issue . . . this is not a tree hugging issue . . . it is an economic issue.

Soon, you may not be allowed to land in certain cities because of the emissions or the noise of the airplane you are flying in.

We need a clear investment plan for developing rational solutions to noise and emissions problems. We do not need arbitrary regulations -- in advance -- put in place before technologies are developed, verified and available.

Today NASA researchers working with industry have a combustor concept that might eliminate 70% of the NOx emissions. This may be in the laboratory today, but we hope to see it in the engines of the future.

This is not just about eliminating the barriers to growth, it is about competition too. When we solve the safety and environmental problems, we will increase the value and competitiveness of U.S. aircraft.

At the same time, Team America will work on the revolution of the entire air-space transportation system.

What good will it do us to have incredibly smart, safe and reliable aircraft

if the entire air transportation system doesn't support them?

That's right…the entire system. All 5000 plus airports throughout our nation.

Everything is inter-related here—the evolutionary advances will set the stage for the revolution in aviation.

And what are the revolutionary areas?

I'm talking about vehicles and vehicle concepts spanning the entire range of systems, speed, capacity, and capability, that creates a fully integrated, full-service transportation system.

That's a revolution we need to make happen.

Beyond aircraft that carry people and cargo, we are developing aircraft for non -conventional applications, like disaster relief coordination.

Such aircraft provide a low-cost infrastructure for rural areas or areas where communications are temporarily destroyed—like a hurricane ravaged area.

It would be like an AWACS for everyone.

Fully autonomous FAA-certified flight durations up to 6 months are needed for this application. As an example, the Helios, currently flying at NASA Dryden, is a prototype for this new aircraft. It will fly at up to 80,000 feet, making it independent of weather and other potential threats.

An aircraft like the Helios could be deployed to a disaster area to provide cellular telephone relay for relief workers and high-resolution imagery for rescue targeting. The aircraft could have been used over North Carolina to target people for rescue or for food and supplies if rescue is delayed. Longer-term environmental monitoring and research, border patrol, communication, and drug surveillance are additional roles for this aircraft.

For years, there seemed to be no outlet for radical new ideas. So we started a program to develop revolutionary aircraft for new applications—REVCON. If you have ideas for revolutionary aircraft, submit them to us – to NASA.

Right now, we have REVCON projects that take us far into the future.

For example, the Blended Wing aircraft, which we are working on with our industry partner, integrates engine and airplane designs to create a low noise, low emissions, more volumetrically efficient operating system.

And we are working on technologies to produce a substantially improved supersonic engine. One approach, the Pulse Detonation Engine, gains higher reliability, lower cost, and a longer life by eliminating complex rotating turbo-machinery components.

Beyond revolutionary vehicles and vehicle technologies, we are working to revolutionize the entire air transportation system.

One approach NASA is exploring involves the infrastructure and aircraft breakthroughs that will allow America to realize the full potential of General Aviation.

We hope this approach will free people and products from gridlock and hublock delays, by creating faster, lower cost, and safer access to more communities.

A preliminary goal for this technology is to cut inter-city travel time by more than half, and then a factor of two again, while maintaining affordable costs.

Think Learjet performance for travelers at a fraction of today's prices.

Think precision approaches to virtually every runway end and helipad in America.

Think economic development enabled by accessibility for any community regardless of population or existing industrial base.

In a few decades - with aggressive, visionary, and bold investments – we could put together all the technical achievements in safety, noise, emissions, capacity, cost, and revolutionary designs. We could produce a seamless transportation system with tremendous "doorstep to destination" speeds.

What might such a system look like? Let me take you on a little journey.

A husband and wife and their two children are headed home to Pigeon Forge, Tennessee—in the heart of the Smokey Mountains—after taking their oldest daughter to Chico, California, where she is starting college.

The wife is a military aircraft design engineer for a West Coast firm. Next-generation fully immersive collaborative computer environment technologies, like NASA's Intelligent Synthesis Environment (ISE), let her work with the design team even though they live thousands of miles apart.

This family came into the San Francisco Airport from Chico on a Runway Independent Aircraft, an advanced version of the V22 Tiltrotor. They were a little disappointed, however, because they really wanted to try out the new STOVL aircraft just completing certification. It has a morphing, mission-adaptive wings, derived from technologies NASA began working on back in 1999.

At SFO, they board a modern, quiet, low emission transport aircraft that has just completed a self-check of its structures and flight systems and certified itself "ready to fly" by using its integrated vehicle health management system.

As they push away from the gate, the fog is thick and visibility is low, but safety is not affected and the flight will not be delayed. The crew is using the advanced taxiway and runway navigation and visualization tools developed by NASA and the FAA. A computer that efficiently manages planes on the ground and in the air clears the pilot for takeoff.

Enroute to Chicago O'Hare, the family uses the integrated communication system to confirm their rental jet. They are looking forward to the one-hour shuttle jet ride to Pigeon Forge because they can stop in Kentucky to see relatives if they want. They have that luxury, because their door-step-to-destination time has been cut by a factor of four.

In Chicago, they get off the plane . . . and follow the signs to the Hertz Rent-A-Jet counter.

The family confidently boards their rental jet . . . the days when General Aviation airplanes were a factor of 10 less safe than scheduled airplanes have long passed.

In fact, they pre-flew this trip during the flight to Chicago, using their laptop. The simulation included real-time updates, optimized route planning, and it assures the family's safety when they make the actual flight.

The trip is surprisingly inexpensive.

As a matter of fact, thanks to the advances we spoke about earlier, the price of all airplanes has come down dramatically.

Both the husband and wife can fly . . . because years ago, their employers saw the advantage of personal air transportation to business . . . and knew that with personal air travel they could accomplish in one day what used to take 3 or 4 days back in 1999.

Their middle child is 15. Next year he will enroll in "Flyer's Ed" at school.

The rental jet is equipped with intelligent avionics . . . and the family cannot even fathom that there was a time when people didn't have real-time, on-board assessment of aircraft health, local atmospheric conditions, artificial vision, and air traffic. They pity pilots in the "aviation Middle-Ages" – the 1990's.

In 2020, controlled flight into terrain and weather hazards are no longer major causes of accidents, and general aviation will never again take a back seat in safety.

Unlike the old days in 1999, the pilot's route is nearly a straight line because of the Free Flight capabilities developed by NASA and the FAA. The "Smart Airport" system provides excellent separation and sequencing of aircraft, even without control towers or radar, and an

"Airborne Internet" provides real-time weather, traffic, and landing facility data. With these new systems pilots avoid constant flight path re-vectoring– saving fuel and time, while increasing safety and reliability.

The plane slips quietly and cleanly through the air. It is much quieter outside the plane and inside the plane for passenger comfort. Engines are quieter, and smart airframe and interior wall structures actively cancel out most of the noise that would otherwise be heard and felt in the cabin, eliminating travel-induced fatigue.

The plane's 3-D, multi-media communications environment allows them to virtually visit their Kentucky relatives. During the conversation, they smell the turkey cooking and are invited to stop for dinner. They leave their rental jet at a small unattended "Smart Airport" in eastern Kentucky where their relatives are waiting to pick them up.

After dinner with their relatives, the family takes a cab to the airport. And after a short plane ride to Pigeon Forge, they are home in time for bed.

A bold vision? Sure.

Can we get there? Absolutely.

We just have to work together with the same goal in mind–air flight anywhere, anytime, by anyone. With increased safety and increased reliability, even as capacity skyrockets.

That will enhance people's quality of life and it will energize the aviation industry like nothing ever has.

And what lies ahead? What the nation needs is a radical new paradigm for transportation management. From a systems perspective, any trip we make involves more than one mode of transportation. Therefore, we must integrate communications and transportation – If we want to compete with Internet 2, 3, and 4.

We need a system that recognizes and accounts for tremendous information management. Imagine planning your entire route and knowing at any point along the way, this system is ensuring that your connection at the next node will be seamless – no delays.

The revolutionary pathway to future air travel will require embedding levels of intelligence throughout the entire air transportation system. This will enable systems that can adapt to unanticipated problems, recognize and mitigate failure modes and rapidly evolve to counter changing conditions and environments.

We are moving into a technology domain called: "soft computing". How many of you are familiar with this term? This is the wave of the future.

This technology is how we will deal with uncertainty and risk in both the design and operational environment. This will take us from the deterministic world into the real world of complex, dynamic processes for modeling, designing and operating our engineering systems.

The most commonly known example is neural networks, which mimic the function of the human brain. Neural networks assimilate vast amounts of data and extract information – trends, patterns, solutions--the kind of thing we do when we learn and think.

Today we can build systems with hundreds to thousands of neural connections. In the future they will have millions of connections in a package the size of a sugar cube.

NASA applied neural networks to the flight controls of an F-15 aircraft. The traditional flight control software system required one million lines of code. We reduced it to about ten thousand.

We demonstrated improved performance. We introduced software faults, and the system identified the problem and self-corrected in seconds – it learned as it

We simulated loss of aileron roll control, and the system adapted and returned aircraft control authority.

Embedding intelligence into future systems will free us from this dreaded "curse of software". The majority of the problems that occur in NASA spacecraft are software related. The software has become so complicated that absolute validation – absolutely no errors – is impossible to achieve. And a single error on any line of code can be disastrous. But soft computing is error tolerant and self-correcting.

It will enable the cockpit and the space systems of the future. Imagine this. The cockpit will not be an array of dials, gages or even multi-functional displays. It will be a fully immersive environment where pilots have a 3-dimensional view of the world around them and of the aircraft they are flying. They will have a fully transparent view of all systems from any vantage point.

This "virtual" cockpit will hold more than just a crew. Anyone and everyone the pilot needs will have the same view of the aircraft even the controller. A complete engineering staff and operations team will be there with the pilot if needed. Not physically there, but there nonetheless. Couple this with integrated health management systems and intelligent monitoring, intelligent diagnostic systems, and multi-layered pathways for true adaptive failure recovery, and we will achieve unprecedented safety and operational reliability.

We will monitor every parameter, every second of every flight every day of the year.

We'll be able to answer questions like:

Are approach patterns at certain airports becoming less stable and consistent?

Is a certain noise abatement procedure diminishing safety margins?

Is a certain engine under-performing and heading for early failure?

In short, we'll begin to have intelligence in our systems.

We will move from data . . . to information . . . to knowledge . . . to intelligence.

And the ultimate future of aviation will extend beyond Earth's atmosphere. It is NASA's job to understand and remove the technical barriers to that.

And 100 years from now, when space is open to the public, you will be the ones who take them there.

When? I don't know. But if we don't begin dreaming, we will never get there. We won't even believe that we can.

One way we're trying to enable easier access to space is through our X-vehicle program, which innovates and integrates aeronautical and space technologies.

Advanced propulsion system technology that NASA is developing today will enable future aircraft to cruise at high altitudes and at either supersonic or hypersonic speeds.

An initial demonstration of one of these technologies is planned for next year with the first flight test of the X-43, Hyper-X, flight test vehicle. The Hyper-X is an airframe –integrated, supersonic combustion ramjet (SCRAMJET) powered vehicle. Its propulsion system contains no rotating machinery, but rather uses the aircraft's shape to provide compression of the flow entering the engine, where the combustion process occurs in a supersonic stream. And the shape of the vehicle's aft end acts as a nozzle for thrust.

And this is just one of many vehicles to come. Each will be a testbed for different vehicles technologies and speed regimes.

The future will bring us many technological surprises, often coming from unexpected places such as biology. This area is the last great bastion of science to be brought into the realm of technology.

We have made great strides in understanding the underlying processes that have evolved over the past billion or so years and now this knowledge is about to revolutionize all areas of engineering. It is somewhat ironic to be saying this about aviation since the original inspiration for flight came from biology.

From biology will come concepts for sensors, brain-like computers and distributed nervous systems far beyond even the neural networks we are developing. Biology based systems can be orders of magnitude more

power efficient, compact and sensitive than conventional silicon systems.

The related field of nano-technology will deliver material systems made from the bottom up – atom by atom – that will approach theoretical limits. Perhaps 100 times stronger than steel and 10 times stronger than the best graphite fiber. One such concept is carbon nano-tubes–tiny nano-scale fibers that self-assemble from carbon-based precursors under the right conditions.

We may literally grow aircraft skins in the future. Not just for structure, but multi-layered for environmental protection and with imbedded sensor grids. When they are damaged they may even self-heal, just like we do when we are injured.

What an amazing future we have before us!

Everything I talked about is going on at NASA, but NASA will not be able to do this all by ourselves, nor do we have a monopoly on innovative technology.

We need to develop even stronger partnerships:

with the FAA

with the DOD

with the Large Airframe and Engine Companies as they evolve aircraft designs

with small & start-up companies for more revolutionary concepts

with academia.

Partnerships between traditional aerospace disciplines and information technologies and between the aeronautics and space transportation disciplines.

As partners, we need to dare to dream.

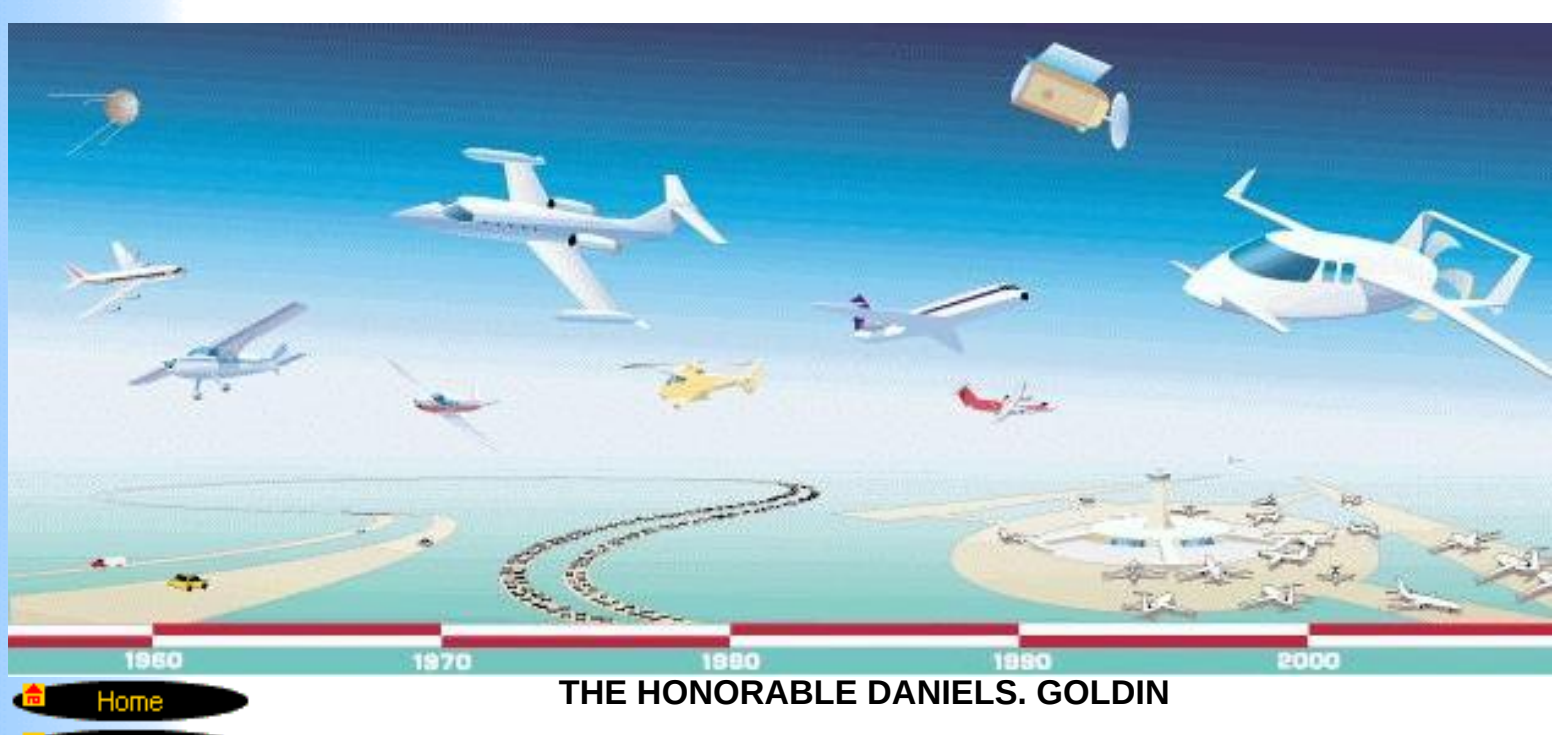
And as we dream this morning, let us remember the words of T.E. Lawrence:

"Those who dream by night in the dusty recesses of their minds wake in the day to find that it was vanity. But the dreamers of the day are dangerous men, for they may act on their dreams with open eyes, to make it possible."

So become daydreamers.

And together we will build an air transportation system that will still be improving the quality of life 100 years from now.

Thank you.



THE HONORABLE DANIELS. GOLDIN

NASA ADMINISTRATOR

REMARKS BEFORE THE

AMERICAN BAR ASSOCIATION FORUM ON AIR & SPACE

CHICAGO, ILLINOIS, JUNE 10, 1999

Thank you for your kind introduction. And thank you for being here today.

It is an incredible time to be at NASA!

Just last Sunday, our multi-national crew successfully completed a four million mile mission to supply the International Space Station. During the mission, the world watched in wonder and amazement as the crew completed its duties.

They made it look so easy, but it was only "easy" because we had a very clearly defined highway designed to lead us to mission success. Today, I'd like to present you with the beginnings of a similar highway for enhancing the success of aviation in America, as well as discussing your role as trailblazers along the way.

I am excited to be with you, because we share a commitment to a thriving air transportation industry. At NASA, our commitment runs deep, because you can't spell NASA without Aeronautics.

That was one of my first messages when I became NASA Administrator 7 years ago and I am very committed to it. Instead of talking to you about the programs we have in place and the goals we intend to achieve, I would like to take you for a ride on a new highway in the sky. On this imaginary ride, you will get a mental picture what the future of the aviation industry may look like – it is plan set in place today with tools developed by NASA, jointly tested with the FAA and ultimately made a reality by FAA implementation. This is the mantra of this speech . . . and NASA has committed a 100 million dollars a year over the next five to make the skies safer.

Bear in mind that NASA is primarily concerned with safety and technological improvement . . . unfortunately we can't promise the in-flight food or movies will be any better.

The year is 2020 . . . a husband and wife and their two children board a commercial airline at Chicago O'Hare – and it is indisputably the world's busiest airport.

It's cold and foggy that evening. But they're not worried about delays. The pilot will be able to see through the fog because of high-definition synthetic vision.

Of course, this capability has also been available in General Aviation cockpits for years.

They push away from the gate; it will only be moments until they reach the runway for take-off because they are using advanced taxiway navigation tools developed by NASA and the FAA. The pilot is cleared to the runway by a computer that efficiently manages planes on the ground and in the air.

Their desitination: San Francisco. Unlike the old days in 1999, the pilot's route is nearly a straight line because of the intelligent air traffic control system developed by NASA and the FAA. The system provides excellent separation of aircraft, provides the pilots with real-time data and avoids constant re-vectoring of its path – it saves fuel, it save time and most importantly it save lives.

The pilot's cockpit displays will fuse information from many different sensors to give the pilot a complete visual picture – one-stop shopping for all flight data. Data from infrared, radar, TV, LIDAR and even a technology similar to night vision goggles will be integrated. Whether in a deep downpour, pitch black, or thick fog . . . the pilot will always see a sunny day and have total situation awareness. The pilot will even clearly see small objects like high-tension wires. And using technology developed in 1999 by NASA, pilots will be able to avoid clear air turbulence. The on-board computer will detect unusual patterns of tiny dust particles at least 35 miles ahead and give the pilot the distance, size and severity of the upcoming turbulence. So this flight, unlike those in 1999, is perfectly smooth and many times safer.

As it flies over the Rockies the jet is keeping the pristine air pristine. Compared to 1999, it has much lower carbon dioxide and nitrous oxide emissions. It is also much quieter outside the plane and inside the plane for passenger comfort. While engine noise has been reduced, actuators, which are like heavy duty speakers, are placed between the airframe and the interior walls to cancel out the residual engine noise heard in the cabin. Yes, it really works! NASA has also helped redesign airframes to relocate pressure wave patterns and further reduce noise around the passengers.

And because the FAA and NASA teamed together at the turn of the millennium and improved the certification process, this jet flies the latest composite materials. This allows the plane to operate at a much lower cost, much more efficiently and much safer.

In San Francisco, they get off the plane . . . and follow the signs to Avis and Hertz.

That's where they pick up the keys to their rental plane.

The rental plane is also surprisingly inexpensive.

As a matter of fact, thanks to the advances we spoke about earlier, the price of all airplanes has come down dramatically. Even the 4-seat personal jet they are flying cost about the same as a high-end luxury automobile.

Both the husband and wife can fly . . . because years ago, their employers saw the advantage of personal air transportation to business . . . and were

confident that the infrastructure would support it.

Their oldest child . . . is 15. He'll learn to fly next year at school.

The family boards their rental plane . . . comforted by the fact that the days when General Aviation airplanes were a factor of 10 less safe than scheduled airplanes have long passed. And because of the heads up displays and its coordination with the intelligent air traffic control they are flying a "highway in the sky." In 2020, controlled flight into terrain is no longer the number one cause of accidents.

In fact, both long haul jet transport and general aviation have surpassed the safety level that long-haul jet transports had back in 1999.

The rental aircraft is equipped with intelligent avionics. . . and our pilots cannot even fathom that there was a time when people didn't have real-time, on-board assessment of aircraft health, atmospheric conditions, and air traffic. They pity their predecessor who had to pore through 18 pages of nearly unintelligible computer printouts that were provided an hour before takeoff.

They fly to a remote area in the Pacific Northwest. That's where the grandparents have retired.

There was once a time when this area was not accessible for approaches. But now, General Aviation airplanes curve through the valley and land there all the time. Computers on all aircraft have digital maps in their databases of the local terrain, with updates broadcast continually from a commercial Litestar spacecraft constellation.

They drop the kids off and depart back for San Francisco in their rented small aircraft. There, they split up for their respective business meetings.

He boards another commercial airliner that takes him to Singapore. It's only a two-hour flight and costs no more than today's subsonic ticket prices. In 1999 aboard an experimental NASA F-15 fighter, the groundwork was established for this jet's neural networks. As it flies over the Pacific, through adaptive learning, the jet can rapidly react to catastrophic failures of critical flight control components, such as partial loss of a wing or damage to control surfaces or hydraulics. And no longer is the cockpit bound for a generation by custom built technology that quickly becomes antiquated. The FAA rapidly certifies new technology and ensures that all jets have the latest off-the-shelf technology.

Even this jet is environmentally friendly, because we solved NOx problem a long, long time ago.

She stays in the rental plane . . . because she wants to visit three separate clients . . . all in California . . . but each about 200 miles apart.

By car . . . the three sites would require a total of 12 road hours to conduct 2 hours of business at each location.

The total travel period could be up to 4 days. She would be away from her family for three nights.

But because of the advances in General Aviation I'm talking about today, she completes the business trip to these three locations in one extended business day. In 1999, a company took 80 orders for the vertical takeoff and land aircraft two years before the FAA had even certified them. In 2020, these aircraft help ease the traffic in the hub and spoke system and better yet, they help millions of travelers avoid airports entirely. Now they can land at verti-ports.

She picks up her kids and heads home the next morning.

Her husband will meet them back in Chicago . . . home of the World Champion Cubs.

Some will say this is impossible, especially the Cubs part. They say we don't have what it takes. Critics will say that this is a vision only for those who refuse to look at the real world.

At NASA and DOT, we couldn't disagree more.

We exist to discover what is possible. That is what America is about.

36 years ago, when John Glenn made his first flight into space, there were those who said we'd never get to orbit, much less to the Moon.

Almost 100 years ago now . . . when the Wright brothers were preparing for their flight . . . there were those -- reportedly, even their own father…who said we would never fly.

But we got to orbit and the Moon. And that GA plane in Kitty Hawk . . . made it into the air for 57 seconds.

Both changed the world forever.

When our future aviation system resembles the scenario I presented, we will need to go to a free flight system. That will mean a major revolution for long haul jet transport and general aviation.

And make no mistake, a revolution is what is needed. With the advent of the hub-and-spoke system, and increasing congestion, the average doorstep to destination speed is 50-60 mph for **air** trips of less than about 300-400 miles.

Think about it.

You are flying through the air at 300 to 500 mph during the part of your trip that is in the commercial airplane.

But your average speed from when you left your home to when you arrive at your destination is only 50 or 60 mph!

If the number of airline passengers doubles over the next 20 years as expected, our current hub-and-spoke aviation system will face hub-lock. Same day flight will be a thing of the past. Instead, we may have to put our names on waiting lists, like at today's restaurants. Maybe we'll even get to wear beepers to be notified when our seats became available.

Don't laugh -- one airline has predicted it could happen as early as 2012.

And even if we maintain current safety levels, the predicted growth of air traffic will lead us to over one accident a week by 2004. Accident rates might actually remain the same, but the perception would be that flying has become increasingly unsafe. We've worried about this.

We want to reduce the aircraft accident rate by a factor of five within ten years, and by a factor of ten within 20 years.

In support of the President's initiative on Aviation Safety and Security, NASA and the FAA have formed a partnership to accomplish The Aviation Safety Program.

NASA stepped up to this national priority and has committed to reprogram $500 million of the aviation enterprise's budget over 5 years.

Working with the FAA, we also set our goals in a very different way. We included partners and customers from "day one," and together, we defined the initial investment strategy, focusing on the highest pay-off areas for aviation safety: prevention, system development and monitoring, and accident mitigation.

With the aviation revolution we hope to achieve, sparked by the technologies I told you about, we may see a day when free flight is commonplace. Free flight will improve air travel affordability by increasing flight dependability and reducing delays, even at the busiest airports. Do you realize that if new technologies could shave just four minutes off every commercial flight today, it would provide additional capacity equivalent to another major airline? For an airline's bottom line, it would mean reduced fuel costs and millions of dollars in savings.

And just imagine what a full-scale revolution in General Aviation would do. We might move toward inexpensive fleets of business jets, and when they are retired from executive service, they may be to sold fractional partnerships. Then later "recycled" into fleets of air taxis and jet pooling. The possibilities are endless!

At its peak in 1978, the U.S. general aviation industry delivered 17,811 aircraft. In 1996, the number of aircraft delivered had fallen to 1,132. But the explosive potential for new plane construction in the vision I am presenting is staggering. It could easily revitalize America's aviation sector and take General Aviation far beyond its current revenue level of $15 billion a year.

GA is already leading the way in the entire aviation sector. Many of the most advanced technologies started in General Aviation and are now making their way into the commercial sector and, perhaps, eventually into the space program as well.

In addition to GA, space will be an area of incredible opportunity in the 21st century. I am leaving here to go to Paris as the President's Representative at the Paris Air Show. This show increasingly reflects the convergence of air and space transportation that will grow exponentially in the new millennium. In fact, I believe that there will be very little difference in the two within the next few decades —that the technologies necessary for success in both areas will be much the same.

The world is now preparing for the era of the International Space Station, and NASA has had a primary role in developing the highway to get us there. By the time the Station is fully assembled and operational, we need to already be at work on the next phase of the highway —the push into deep space and toward our dream of planting an American flag on the dusty red surface of Mars.

And as we increase access to space, you will be on the cutting edge of the journey, establishing the legal framework and infrastructure necessary for proper utilization of space. Right now, air and space law are separate disciplines. Air law is well-developed and widely practiced.

Space law is fundamentally different and in its infancy. But the dynamic growth in this area may rival the burgeoning of maritime law over the past two hundred years. The biggest challenge may be in merging the two into a seamless whole.

So whether you are involved in tort, contracts, manufacturing, regulatory oversight, or any other aspect of air and space law, a revolution in aviation combined with what we are doing in space means a revolution in your way of doing things.

Opportunities abound for those who will take the risks . . . and when we work together, we can amortize the risks and compound the rewards.

We know that at NASA. That's why we are working closely with our government partners at the FAA, DOD, and DOT to help usher in the new age of aviation in the air and in space.

We're counting on you to work with us and your clients in industry, academia, and the government to fill in the details of the highway that will lead us into the new millennium.

Thank you.

Return to SATS Home

NASA Administrator - Daniel S. Goldin Keynote Speech

Airplane Owners & Pilots Association (AOPA)

Palm Springs, CA October 24, 1998

This is a great time for NASA.

It's our 40th anniversary.

Yesterday morning, we launched Deep Space One, our first electric propulsion probe; we will turn on that electric engine in about two weeks.

In about a month, the first piece of the International Space Station will be launched.

And in just five days now . . . returning to space will be an astronaut -- and world-class record-setting aviator -- named John Glenn. Perhaps you've heard of him.

Next week's launch is getting a lot of attention . . . in fact, it has totally changed the kind of questions people ask NASA.

It used to be that people asked vexing questions like:

"What's **really** in Tang?"

"Have we been visited by aliens from outer space?"

Thoughtful second graders would ask questions like:

"Can you explain how the Microwave Anisotropy Probe satellite will distinguish between supersymmetric 11 dimensional cosmologies and supergravity models for the Universe?"

But all that has changed. Now people all over the country have one question and one question only:

"You're sending John Glenn to space -- how about sending **MY** Congressman to space?"

Kidding aside, I'm thrilled to be here today.

I'm thrilled because when it comes to what we do and who we are . . . there is a simple fact that is just as important as any shuttle mission. And John Glenn will be the first to tell you what it is:

You can't spell NASA without Aeronautics.

We are very, very serious about that.

And that was my message when I first went to Oshkosh as NASA Administrator 6 years ago.

We had a productive meeting. We set some aggressive goals. And, together, we've produced great results.

Let me show you a video that portrays the future of General Aviation and invite you to keep these images in mind as I talk about how we make this vision real. (NASA Small Aircraft Transportation System Video).

We established a truly unique government-industry partnership called AGATE (Advanced General Aviation and Transportation Experiments) . . . and now over 70 companies are working together on GA technologies for next generation avionics, airframes, and pilot training.

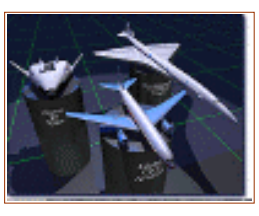
We established another partnership called GAP (General Aviation Propulsion Program) . . . and now companies like Williams and Teledyne Continental are preparing revolutionary engines for new airplane designs.

GAP, along with AGATE, combine for a commitment of over 1/4 billion dollars. Never before has NASA formed such far-reaching partnerships.

That is unprecedented in the last two decades of General Aviation research and development.

And we established something else too, . . . something that made AGATE and GAP possible . . . a new relationship between NASA and the General Aviation community. That relationship -- along with our partners in government and industry -- helped us develop our vision for aeronautics . . . what we call the Three Pillars for Success.

They are Global Civil Aviation . . . Revolutionary Technology Leaps . . . and Advanced Space Transportation.



Specifically, they encompass the following ten goals -- the first eight deal with aviation . . . and the last two with space transportation.

Global Civil Aviation

Global Civil Aviation

Goal One -- We want to reduce the aircraft accident rate by a factor of five within ten years, and by a factor of ten within 20 years.

Goal Two -- We want to reduce emissions of future aircraft by a factor of three within 10 years, and by a factor of five within 20 years.

Goal Three -- We want to reduce the perceived noise levels of future aircraft by a factor of two from today's subsonic aircraft within 10 years, and by a factor of four within 20 years.

Goal Four: While maintaining safety and reliability, we want to triple the aviation system throughput, in all weather conditions, within 10 years.

Goal Five: Reduce the cost of air travel by 25% within 10 years, and by 50% within 20 years.

Revolutionary Technology Leaps

Revolutionary Technology Leaps

Goal Six: Reduce the travel time to the Far East and Europe by 50% within 20 years and do so at today's subsonic ticket prices.

Goal Seven: Invigorate the General Aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 within 20 years, back to a level we have not seen since the 1970's!

Advanced Space Transportation

Advanced Space Transportation

Goal Eight: Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft by a minimum of 50 percent.

Goal Nine: Reduce the payload cost of low-Earth orbit by an order of magnitude, from $10,000 to $1,000 per pound within 10 years, and by an additional order of magnitude, from thousands to hundreds of dollars per pound, by the year 2020.

And at the same time, we want to improve reliability by a factor of ten or ten times ten.

And finally, Goal Ten: Reduce the cost of inter-orbital transfer by an order of magnitude within 15 years . . . and reduce the travel time for planetary missions by a factor of 2 within 15 years . . . and by an order of magnitude within 25 years.

I went back to Oshkosh earlier this year to get some feedback on our General Aviation goal -- goal # 7.

I have to tell you . . . I'm an optimistic guy.

I know it is a "stretch goal."

I know there are great challenges to overcome in engine and airframe design.

I know that there are great challenges to overcome in avionics -- both in the ways we navigate and communicate.

And I know that over-riding all of this is the great challenge to increase safety and decrease cost -- building planes that are easy to acquire, easy to use, easy to maintain, and easy to integrate into a revolutionized Small Aircraft Transportation System, or SATS. SATS adds to and enriches the National air transportation system.

Bruce Holmes, NASA's General Aviation Manager, talked in more detail about SATS earlier at this conference.

Again . . . I'm an optimist. There's a "can-do" spirit at NASA.

Then I ran into some of you and asked, "Are we going far enough?"

The message was loud and clear.

You agreed that we couldn't spell NASA without Aeronautics.

But you reminded us that -- figuratively speaking -- we can't spell Aeronautics without General Aviation.

The Ten Goals are great . . . but if we are to revolutionize aeronautics . . .

... if we are to integrate General Aviation into the air transportation system . . .

... if we are to change not only the way we do business . . . but also the way we live . . .

... if we are to do all this . . . we need more specific, concrete, targeted goals and technology roadmaps specifically for General Aviation.

Some of you may have heard the story about the chicken who asked her friend the pig to go into a Ham n' Eggs business together.

The Pig said: "For you, that's an investment. For me it's a commitment."

In Oshkosh, you told us that an investment wasn't enough. General Aviation needs a commitment with well-defined and clearly measured long-term, high-risk goals.

Not just for technology . . . but for certification and the infrastructure for a Small Aircraft Transportation System.

I'm here to tell you . . . with NASA and the FAA working together, this vision will become a reality. In fact, we want you to help us develop the specifics.

We've already taken an important first step.

Two weeks ago in Cleveland, at our Turning Goals into Reality Conference, I signed an agreement with Administrator Jane Garvey to ensure that NASA and the FAA would work closely together to improve safety and efficiency in our air transportation systems.

Working together, NASA and the FAA are cutting the time to certify composite materials by 75% and the cost to certify those materials by 90%.

We have also worked to make it possible to employ widely available software and computer hardware to reduce the cost while we increase the reliability and user friendliness of cockpits.

It is our hope and belief that this agreement allows us to do even more -- making sure that technology, certification and the Small Aircraft Transportation System fly together with no turbulence.

And it will ensure that as we reach new heights in safety and reliability . . . cost will continue to hit new lows.

Before I go any further, allow me to take this opportunity to thank FAA Administrator Jane Garvey for making this agreement possible.

In just over one year, Administrator Garvey has built up a record of accomplishment and a reputation for excellence. And what fuels that record and reputation -- as what I'm sure you all heard yesterday -- is passion, focus, and vision.

She is doing a wonderful job.

She has helped us get to where we are.

But remember . . . where we are . . . is just a starting point.

As we focus in on what technologies to pursue and what our "stretch" goals should be . . . we want -- and we need -- your input.

We'll start with **Engine design** . . . but remember: what we are talking about is a long-term vision -- a decade or two out in the future.

Maintenance and Reliability:

Currently, the average "active" GA airplane flies about 300 hours a year. At about that same time it needs an engine tune-up and possible replacement of engine parts.

And even with this major maintenance, the TBO (or Time Between Overhaul) is **still** only about 1600 hours. This represents one of the major cost

factors in aircraft ownership.

Clearly, if we are to put wings on America . . . we must do better.

There are cars that require a tune-up only after 100,000 miles.

They do not require replacement of engine cylinders or rebuilding of engine accessories along the way.

The equivalent for a GA airplane would be 3,000 hours of operation . . . or 10 years of flying before a major tune-up or an overhaul. Engines that are easy and inexpensive to maintain throughout their life cycle.

How's that for a goal? You tell us?

Propulsion:

Today, piston-driven General Aviation planes average about 150 miles per hour.

Again, I think we can do better.

We need to develop engines that, while consuming less fuel and weighing less, will more than double or triple the current cruising speed. I know many of you love your piston engines. Be prepared for a choice. We will push the boundaries on both piston and turbine engines that are unbelievably affordable!

Does this goal go far enough? You tell us.

Environment:

Right now, our engines are inefficient. They run too loud and too dirty. Communities shut their doors to airports, and even shut down airports!

If our vision is to become a reality airplane engines should produce no more noise or emissions than a car or a truck.

We need to end our dependence on leaded fuel . . . and use generally available, lower cost jet fuel in both the small turbines and piston engines of the future.

Perhaps our goal should be 24 hour per day operations at any public-use airport without noise complaints or curfews.

Is that the right goal? You tell us.

Next area -- Airframes.

Cost:

Today's General Aviation airframes cost about $50 to $100 per pound.

We are already committed to bringing this down to about $30 per pound.

But new car structures cost about $10 per pound. So maybe we can go further.

What about reducing the cost of General Aviation airframes to less than half or about $15 per pound?

And while we do that . . . what about making sure the maintenance costs of airframes also comes down 50 percent?

And what about repair work on new composite airframes being available at any airport and any location?

You tell us.

Airframe Performance:

Airframe structures should be "smart" in the sense that they will contain embedded sensors and communications capabilities for safety and maintenance information.

They can also have embedded micro-devices that control the aerodynamics for more lift and less drag depending on the flight conditions.

Everyone has seen a bird fly; they don't just have control surfaces and flaps on the back of their wing.

They have three-dimensional control that shapes their wing. They're much more efficient aerodynamically than anything we can build today.

Should our goal be to develop smart structures that would not only increase performance of airframes today . . . but also dramatically reduce maintenance costs?

You tell us.

Next -- Avionics:

Simply put . . . we need to bring the revolutionary advances made in computing into the cockpit. We need to get rid of the "steam gages" we use today!

When computational capability goes up . . . as it does exponentially . . . so too must the capability of our avionics. And when the cost of that capability comes down . . . as it does exponentially . . . so too must the cost of our avionics.

Everyone here who has compared a panel mounted GPS system to a hand-held GPS unit knows what I'm talking about. The hand held version cost about 6 times less . . . and often works much better.

There's no excuse for it.

We must also take into account that even the most sophisticated systems that we have today . . . aren't advanced enough to help in decision making and risk management.

And that is the number one safety issue for General Aviation operations.

That is why it is essential that we work to develop the technology that gives a pilot full situational awareness of the vehicle's state of health and the surroundings.

We should make it possible for remote sensing satellites to send signals directly to the vehicle to give the pilot real-time knowledge about weather and traffic and terrain.

GPS navigation systems will give the pilot the aircraft's precise position.

Communication links and onboard sensors will determine where other vehicles and obstacles are . . . and an onboard computer database will tell the pilot where the other vehicles and micro-disturbances in the atmosphere will be.

Together, all of this will allow free flight by giving you real-time, on-board, unprecedented air-traffic control.

Our current investment in avionics -- the AGATE program I mentioned earlier -- has a goal to reduce the cost of avionics by more than 75 percent, while incorporating many of the features I've just talked about.

Should our longer-term goal be to equip General Aviation cockpits with avionics that reduce the cost by half again, to about one-tenth of the cost of today?

When it comes to situational awareness, should our goal be to make IFR flying, day or night, as safe and simpler than VFR flying?

What should be our timeline for developing a vehicle IQ -- a system that is capable of self-diagnosis and self-repair?

And what about upgrading and updating avionics with simple and affordable

software changes?

You tell us.

That's the airplane . . . now let's talk about the **Small Aircraft Transportation System** -- the infrastructure that will support this new generation of GA airplanes.

First -- Airports.

Instead of paving over hundreds of small airports, let's pave the way for thousands of "smart" airports.

A future airport will integrate emerging communication, navigation, and surveillance technologies to produce new levels of utility for the Nation's smaller airport infrastructure.

These airports of the future will support aircraft equipped for self-separation and self-sequencing in free flight, without the use of control towers or radar.

How about a goal to have the same day or night all-weather utility at all of the 18,000 small airports -- the all-weather utility we take for granted at the 500 hub-spoke airports today?

You tell us.

When we have these thousands of small airports and the planes we discussed earlier . . . we will finally have within our reach the very reason we do all these things to begin with:

Mobility.

One of the main reasons the automobile displaced the train was not because the car was cheaper . . . but because the car was faster for doorstep to destination travel. The automobile increased the speed of doorstep to destination travel to over 50-60 mph.

Unfortunately, that's where we've been stuck for the past three decades. In fact, the average speed of interstate highway travel has been slowly decreasing during the past decade.

Now, airlines are slowing down, too.

With the advent of the hub-spoke system, and increasing congestion, the average doorstep to destination speed for trips of less than about 300-400 miles (the range of most trips taken) average about 50-60 mph.

Think about it.

You are flying through the air at 300 to 500 mph during the part of your trip that is in the commercial airplane.

But your average speed from when you left your home to when you arrive at your destination is only 50 or 60 mph!

It's time we start working to change this.

We envision advances in speed for personal transportation so an individuals' average daily radius of action will increase by a factor of ten -- from 30 to 50 miles in the age of the interstate highway and hub-spoke system . . . to 300 to 500 miles in the age of the Small Aircraft Transportation System.

And cost?

Today, the price of speed in new General Aviation airplanes is about $1,000 per mph. For a car it's around $300-400 per mph (*e.g.*, $30,000/80 mph).

Maybe that should be our goal, too.

You tell us.

Pilot Training.

Working with the FAA, we have already taken great strides.

We have reduced pilot training time from more than 7 months to about 3 months. We've reduced cost by over 25 percent. And we've done this by combining the instrument and private pilot training.

Can we go further?

What do you think about the goal of our children receiving pilot training for small aircraft just as they do now for Drivers' Education in High School?

You tell us.

And, finally . . . the most important goal we could have:

Safety.

When we have advances in engine design . . . airframe . . . and avionics . . .

and when we have the air transportation system infrastructure to support it . . .

and when we have the training to use it, support it, and sustain it . . .

we will be able to make General Aviation as safe and reliable as commercial travel of the future. This means future General Aviation safety even better than today's airline safety.

How safe? You tell us.

You tell us what works . . . and what doesn't. You tell us what we need . . . and what we don't. You tell us if these opening bids for what our goals should be go too far . . . or not far enough.

I am here today to ask for your help.

At NASA, we want to work with AOPA . . . FAA . . .SAMA . . . GAMA and others. We want to hold workshops over the next year to finely tune these goals.

And then . . . we want to come back here next year . . . with the goals on paper . . . and plans to make them a shared vision. Then each year, we will meet here at AOPA and measure our progress against these goals and our plans.

So let us know if we're moving in the right direction and if we're moving fast enough.

We can only succeed if we do this together.

And we will succeed. And when we do, the future might look like this:

A husband and wife and their two children board a commercial airline in New York.

It's cold and foggy that evening. But they're not worried about delays. The pilot will be able to see through the fog because of high-definition synthetic vision.

Of course, this capability has been available in GA cockpits for years.

They push away from the gate; it will only be moments until they reach the runway for take-off because they are using advanced taxiway navigation tools developed by NASA and the FAA

They fly to San Francisco.

In San Francisco, they get off the plane . . . and follow the signs to Avis and Hertz.

That's where they pick up the keys to their rental plane.

They have a lot of choices.

There have been choices ever since the FAA type-certified the Lancair Columbia 300 and the Cirrus SR-20 on October 23, 1998 at the AOPA Convention in Palm Springs!

The rental plane is also surprisingly inexpensive.

As a matter of fact, thanks to the advances we spoke about earlier, the price of all airplanes has come down dramatically. Even the 4-place personal jet they are flying in cost about the same as a high-end luxury automobile.

Both the husband and wife can fly . . . because years ago, their employers saw the advantage of personal air transportation to business . . . and were confident that the infrastructure would support it.

Their oldest child . . . is 15. He'll learn to fly next year at school.

The family boards their rental plane . . . comforted by the fact that the days when GA airplanes were a factor of 10 less safe than scheduled airplanes have long past.

In fact, both have surpassed the safety level that long-haul jet transports had back in 1998.

The rental aircraft is equipped with all of the intelligent avionics I mentioned earlier . . . and our pilots cannot even fathom that there was time when people didn't have real-time, on-board assessment of aircraft health, atmospheric conditions, and air traffic.

They fly to a remote area in the Pacific Northwest. That's where the grandparents have retired.

There was once a time when this area was not accessible for approaches. But now, GA airplanes curve through the valley and land there all the time. Their computer has a digital map in its database of the local terrain, with updates broadcast continually from a commercial Litestar spacecraft constellation. The NASA RFP for the Litestar satellites was released back in the fall of 1998.

They drop the kids off and depart back for San Francisco in their rented small aircraft. There, they split up for their respective business meeting.

He boards another commercial airliner that takes him to Singapore. It's a two-hour flight that costs no more than today's subsonic ticket prices.

It's environmentally friendly, too. We solved NOx problem a long, long time ago.

She stays in the rental plane . . . because she wants to visit three separate customers . . . all in California . . . but each about 200 miles apart.

By car . . . the three sites would require a total of 12 road hours to conduct 2 hours of business at each location.

The total travel period could be up to 4 days. She would be away from her family for three nights.

But because of the advances in General Aviation discussed at an AOPA conference at the end of the 20th century . . . she completes the business trip to these three locations in one extended business day.

She picks up her kids and heads home the next morning.

Her husband will meet them back in New York . . . . .

home of the World Champion Yankees.

Some will say that this is impossible (not the Yankees part…). That we don't have what it takes. That this is a vision only for those who refuse to look at the real world.

At NASA, we couldn't disagree more.

We exist to discover what is possible. That is what America is about.

36 years ago, when John Glenn made his first flight into space, there were those who said we'd never get to orbit, much less to the moon.

Almost 100 years ago now . . . when the Wright brothers were preparing for their flight . . . there were those -- reportedly, even their own father . . . who said we would never fly.

But we got to orbit and the moon. And that GA plane in Kitty Hawk . . . made it into the air for 57 seconds.

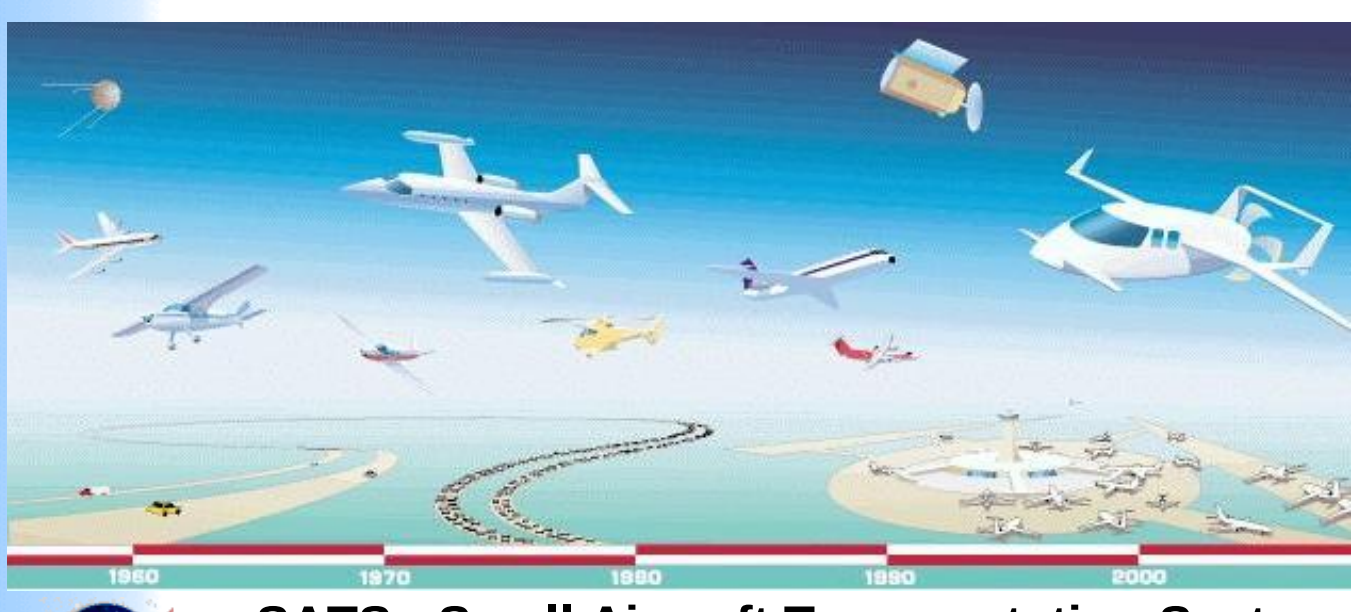
Both changed the world forever.

That is what we can do, too. Because this is more than technology. . . more than airplanes . . . more than the "hundred dollar hamburger."

It's about creating highways in sky that will redefine freedom. Redefine who we are. Redefine what we aspire to be.

It will be some journey. And I don't know what the destination will be. But I do know this:

If NASA, the FAA and AOPA travel together . . . there's no question we'll get there.



SATS - Small Aircraft Transportation System

"The Small Aircraft Transportation System is a safe travel alternative freeing people and products from today's system delays, creating access to more communities in less time"

MISSION MAY LEAD TO MORE PRECISE MAPS
By JEFF LONG
Jan 30, 2000, Daily Press
Copyright `2000 The Daily Press

The Shuttle Radar Topography Mission, scheduled for launch Monday, represents a breakthrough in the science of remote-sensing, according to NASA scientists.

It will produce topographic maps of Earth 30 times as precise as the best global maps in use today. With that information, cartographers will attempt to produce one of the most comprehensive and accurate maps of Earth ever assembled.

The information is key to the database that researchers are developing for the "Small Aircraft Transportation System."

But there are many other uses, including geology, geophysics, earthquake research, volcano monitoring, hydrologic modeling, ecology, atmospheric modeling, flood inundation modeling, urban planning, natural hazard consequence assessments, fire spread models, and transportation/infrastructure planning.

GLOSSARY OF TERMS

GPS. Global Positioning System. Shows your position on Earth anytime, anywhere, in any weather. Twenty-four satellites orbit Earth at 11,000 nautical miles and are continuously monitored by ground stations worldwide. The satellites transmit signals that can be detected by your GPS receiver, with which you can determine your location.

HITS. "Highway in the Sky." A concept of the Small Aircraft Transportation System that will display a pilot's flight path and other information, such as nearby aircraft and the weather, on a computer screen.

Hub-and-spoke. An invention of the airlines to get the most passengers on the least number of flights. A "hub" is a large airport where flights arrive from many outlying, smaller airports or "spokes." Passengers arriving from the spokes transfer to other flights and continue on to their destinations. In other words, the hubs act as switching centers. All of which is fine for travelers who live near a hub, or want to get to one. And it's efficient for the airlines. But if you live in Newport News and want to fly to Milwaukee: "You can't get there from here" - at least, not without flying somewhere else first. (And buying a ticket for that side trip.)

SATS: The "Small Aircraft Transportation System" is a concept being developed by the National Aeronautics and Space Administration, state governments, the U.S. Department of Transportation, the Federal Aviation Administration, the Department of Commerce, private industry and academia. The idea is to make air travel that's faster and safer available in more suburban, rural and remote communities. It's an alternative to highways and the "hub-and-spoke" system of today.

SRTM: The Shuttle Radar Topography Mission aboard the Endeavor is scheduled to launch Monday from Florida's Kennedy Space Center. Information gained during the mission will go into a database that will be part of "Highway in the Sky" technology.

LEARN MORE ONLINE

Here are some Web sites with information about the "Small Aircraft Transportation System:"

* NASA's official SATS Web site: sats.nasa.gov/

* NASA's Web site for the Shuttle Radar Topography Mission, scheduled for launch on Monday: www.jpl.nasa.gov/srtm/

* Web site of Cirrus Design, builder of the SR20 airplane: www.cirrusdesign.com/

MISSION DETAILS

Orbiter: Endeavor

Launch site: Kennedy Space Center, Launch Pad 39-A

Launch window: 2 hours, 2 minutes

Altitude: 126 nautical miles

Duration: 11 days, 4 hours, 5 minutes

Commander: Kevin R. Kregel

Pilot: Dom L. Gorie

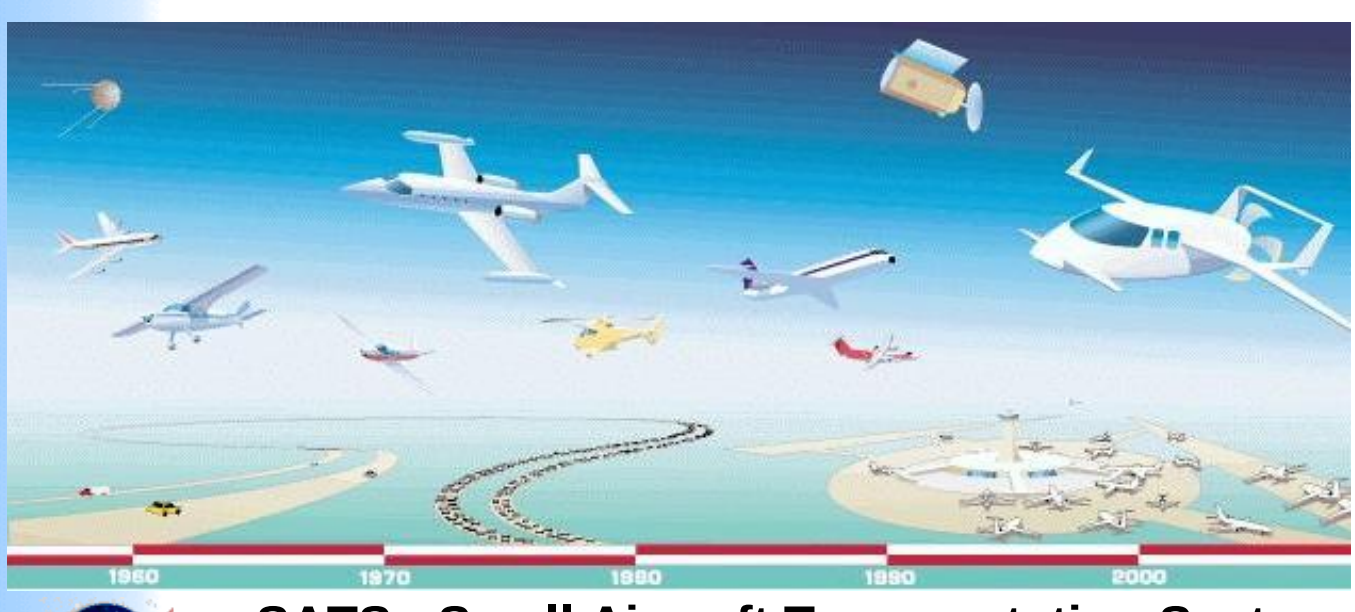
Mission Specialist 1: Gerhard P.J. Thiele

Mission Specialist 2: Janet L. Kavandi

Mission Specialist 3: Janice Voss

Mission Specialist:4: Mamoru Mohri

Jeff Long can be reached at 247-4760 or by e-mail at jlong@dailypress.com



SATS - Small Aircraft Transportation System

"The Small Aircraft Transportation System is a safe travel alternative freeing people and products from today's system delays, creating access to more communities in less time"

"Built-in chute lets pilot float plane to ground"
by Shamus Toomey and Chris Fusco
12/12/99, The Daily Herald (Arlington Heights, Ill.)
© Daily Herald

The controls and interior look more like a BMW's than a small plane's. Computers store virtually every navigational chart a pilot needs to fly around the world. But should the engine quit, the pilot keel over or another disaster occur on this high-tech aircraft, a safety feature aviators have discussed for 70 years is available to save the pilot and passengers.

If there's no other option, the pilot or a passenger can grip a red overhead handle and deploy a parachute that will escort the plane to the ground at 17 mph.

What's more, the company that designed the parachute has received federal grants to bring it to other small planes. If technology keeps moving in the direction it's heading, the chutes some day may be used on commercial jets, according to their manufacturer.

For now, only one plane in the United States, the Cirrus SR20, comes with the parachute as standard equipment.

The only place people can rent or charter the four-seat plane is at Palwaukee Municipal Airport in Wheeling and Prospect Heights.

A member of the Windy City Flyers flying club late last month received one of only eight SR20s to come off the assembly line so far, much to the delight of club president and founder Dean Ellis, who wears a perpetual smile when flying the $179,400 aircraft.

The Cirrus' dashboardlike cockpit, streamlined egglike frame and high-performance engine is making pilots at the airport swoon. In the long run, Ellis hopes its parachute will allay the public's fears about small planes and get people who wouldn't otherwise dream of piloting behind the controls.

"I'm hoping this is going to blaze a trail in the industry," Ellis said while performing a pre-flight check of the plane Wednesday. "This plane has a single engine with fixed gear. Other than that, it's like nothing I've ever flown."

Unlike many modern innovations, the built-in parachute concept has been around for decades and even was tested in the 1920s. The problem, said Cirrus spokes man Chris Maddy, is the technology to make the plane light enough and the chute strong enough to handle the descent has been lacking until recently.

The parachute is the creation of Ballistic Recovery Systems Inc. in St. Paul, Minn. The company's founder, Boris Popov, began pursuing the idea in the late 1970s after a wing on his hang-glider collapsed and he crashed into a lake. Had he had a parachute, he reasoned his injuries would have been less severe.

Popov confirmed that reasoning when one of his first chutes saved a man flying an ultralight (essentially a propeller-powered hang-glider) in August 1983. Since that time, the company has recorded 129 similar "saves" stemming from ultralight and kit-airplane flights - the most recent coming in June.

About 30,000 chutes, including 15,000 sold in Ballistic Recovery's history, are on airplanes through out the globe. The company, U.S. sales manager Gregg Ellsworth said, also sells models that can be retrofitted on Cessna 150 and 152 aircraft for around $15,000.

When it comes to the chutes' future, the company has lofty goals, Ellsworth added. Ballistic Recovery has received NASA grants to develop lighter chutes that some day may be able to handle larger aircraft.

"Can you do an airliner? It could be done," Ellsworth said. "But it's not practical today because of the weight and size of the chutes." To illustrate how far parachutes aboard large jets are from reality, Maddy said at this point it would take 21 parachutes each the size of a football field to safely bring down a typical commercial jet. The space and weight of those chutes make them totally impractical.

Still, the Cirrus and other high-tech small planes are important to the nation's aviation system. In October 2000, NASA plans to launch a program to foster greater use of small aircraft in response, in part, to flight delays at major airports. The agency, spokesman Keith Henry said, expects Congress to approve spending $10 million or more on the so-called Small Aircraft Transportation System annually through 2007.

The long-term goal is to use small aircraft to create an "interstate skyway" for trips of between 150 and 900 miles. Most air traffic is now funneled through 45 hub airports such as O'Hare International, but there are 5,400 public airports in the United States that can accommodate passengers who travel in small planes.

Chicago airport congestion could be eased, for example, by more business travelers using small planes to fly to airports such as Palwaukee, DuPage, Schaumburg Regional and Lake in the Hills. Now, the majority of those passengers fly shorter distances to hub airports and board commercial flights to O'Hare and Midway.

Cirrus is one of three dozen so-called general aviation manufacturers or suppliers to participate in existing NASA programs to make small aircraft safer and more comfortable, Henry said. The SR20's high-tech features- some of which grew out of NASA research - include two satellite-navigation screens that feed in formation to a 14-inch computer monitor that displays the plane's position at all times on a digital map.

Pilots also rave about the plane's speed for its size and the visibility it offers from inside the cockpit.

But clearly the most exotic innovation is the nylon parachute, which is attached to the plane with Kevlar straps.

Cirrus began working on the concept in 1994 and spent $62 million getting the first plane to the market. After a series of successful tests covering a wide range of potential catastrophic scenarios, the first plane was delivered July 20, Maddy said. Of the eight planes produced so far, two are used for demonstrations and the other six were sold to customers. There are 438 on order, and Cirrus hopes to boost its productivity from one a week to one a day by next summer, Maddy said.

The parachute system sits near the top of the plane with its harness imbedded in the plane's outer surface. By pulling the interior handle on the ceiling between the pilot's and co-pilot's seats, a rocket launches the canopy from the plane, much like an ejection seat in a fighter jet, Maddy said. In eight to 12 seconds, the chute deploys, slows the plane and brings its occupants down safely. That doesn't happen for the plane, which will be damaged beyond repair from the landing. Once you deploy the chute, "you've bought the plane," Maddy joked. Cirrus and Ballistic Recovery went through eight tests of the system to get it approved by the Federal Aviation Administration. To guard against accidental deployments, the interior handle includes a safety pin that must be removed, and the pilot must apply between 35 and 40 pounds of pressure. "It's an uncocked system," Ballistic Recovery's Ellsworth said. "Some little kid would have to yank on the thing pretty hard for it to deploy."

Of the SR20s on the market, none has had its chute deployed since delivery.

"You don't just use it when you run into trouble because there are other options available to pilots," Maddy said. "It's basically a last resort. It's to save you and your passengers."

Possible scenarios when the chute would be used are: emergency night landings over unfamiliar terrain, mid-air collisions, running out of fuel with no place to safely land using the normal gear or the pilot becoming incapacitated. During the eight test runs of the parachute - which was cut away on descent to save the plane for its next test - Cirrus practiced spins and stalls. They say it can be deployed at cruising speed (184 mph and slower) and at altitudes as low as 600 feet. Under that, the usefulness is in question, but as Maddy said, "anything is better than nothing at all."

Warren Morningstar, a spokesman for the Aircraft Owners and Pilots Association, a group representing 340,000 aircraft owners and pilots of small planes, said pilots in general aren't fascinated by the parachute but by the Cirrus' technology and other safety features.

"While the Cirrus' parachute has attracted the attention, perhaps even more significant is the amount of attention that was paid to crashworthiness in this aircraft, which may do more to save lives and reduce injuries than the parachute itself," he said.

Morningstar also has heard pilots remark that by the time they went through all options for saving the airplane, it would be too late to use the chute. Others have remarked pilots with less experience would deploy it too quickly. The plane is not designed to reach altitudes where sudden decompression could be a factor, such as in the crash of pro golfer Payne Stewart's jet. But Windy City's Ellis said in the case of this year's other highly publicized small aircraft crash - John F. Kennedy Jr.'s - the chute could have saved lives.

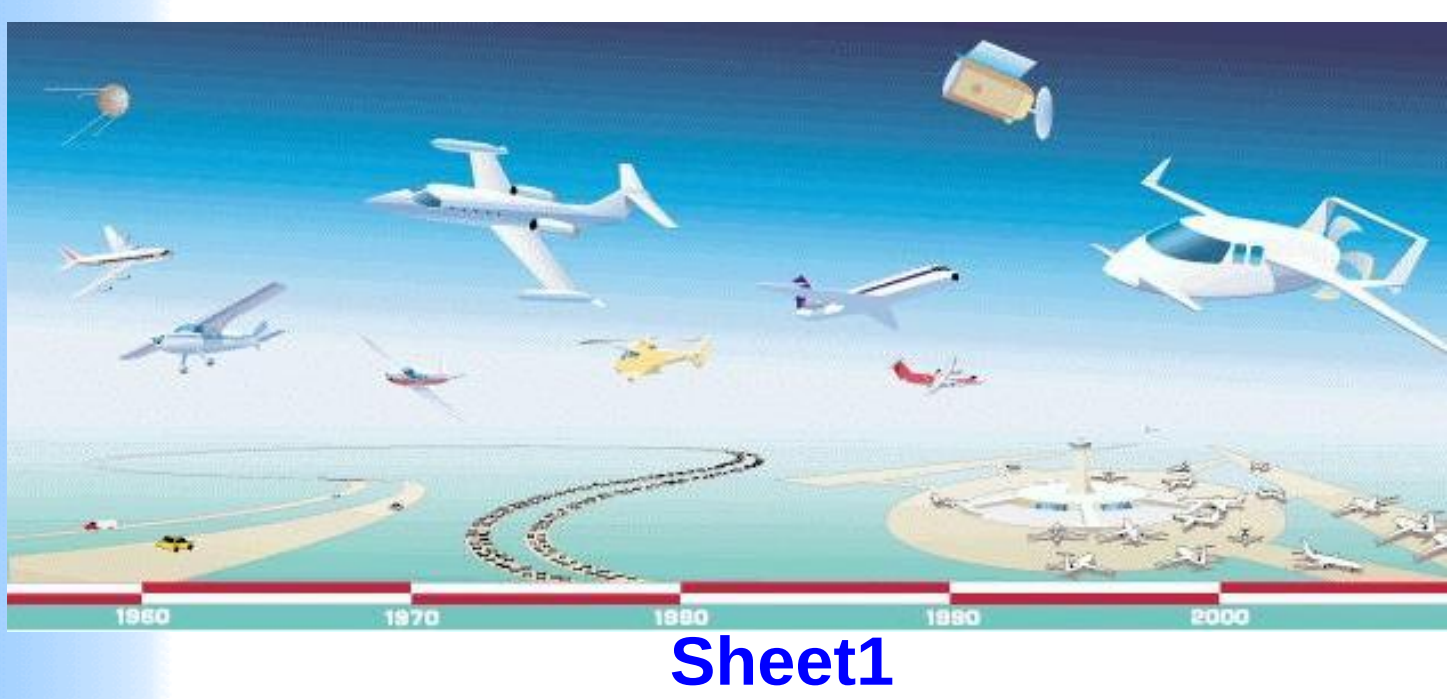
One eager pilot on the waiting list for an SR20 is WGN-720 AM's Bob Collins, a Daily Herald columnist. Collins got on the list about three years ago and recently flew the SR20 based at Palwaukee.

"It's cutting-edge, but it isn't gimmicky at all," said Collins, who now owns stock in Cirrus. "It's well thought-out research."

The plane's price is comparable to others in its class. And although most small aircraft manufacturers have considered the concept, it's not yet clear if others will follow suit by equipping their planes with chutes, said Shelly Snyder Simi, spokeswoman for the General Aviation Manufacturers Association.

"We'll have to wait and see how the safety statistics will shape or change with this over time," she said.

Web Hosting by the AGATE Alliance Association, Inc. (AAAI)
Responsible NASA official: Jim Burley (j.r.burley@larc.nasa.gov)
Curator: Dale B. Castle (dale.b.castle@larc.nasa.gov)
Last Updated: December 30, 1999



Sheet1

Small Aircraft Transportation System Planning Conference Agenda								
	Monday, June 21		**Tuesday, June 22**		**Wednesday, June 23**		**Thursday, June 24**	
8:00 AM	Registration and Continental Breakfast		State-of-the-Art:	*Burkardt*	**Vehicle Tech**	**Infrastructure**	Executive Session for presentation preparation	
8:15 AM			Engines		Airframe	CNS		
8:30 AM					Aerodynamics	Airports		
8:45 AM			State-of-the-Art:	*Asbury*	Propulsion	Airspace/Airway		
9:00 AM			Avionics		Avionics	Procedures	Vehicle Technologies Executive Summary Certification Issues Discussion	*Burley*
9:15 AM					Training			
9:30 AM	Opening Remarks	*Hahne*	State-of-the-Art:	*Freeman*				
9:45 AM	Welcome	*Creedon*	Airframes					
10:00 AM	Conference	*Hahne*	**Break**		**Break**			
10:15 AM	Agenda and Products		State-of-the-Art:	*Breunig*	**Vehicle Tech**	**Infrastructure**		
10:30 AM	Assessing the	*O'Donnell*	NAS Infrastructure		Airframe	CNS	**Break**	
10:45 AM	Feasibility of Innovative				Aerodynamics	Airports	Infrastructure Executive Summary Certification Issues Discussion	*McHugh*
11:00 AM	Transportation Systems		State-of-the-Art:	*Hampton*	Propulsion	Airspace/Airway		
11:15 AM			Training		Avionics	Procedures		
11:30 AM	Market Research	*Hammers*			Training			
11:45 AM			Aviation Safety	*Durham*				
12:00 PM			Program					
12:15 PM	**Lunch**		**Lunch**		**Lunch**		**Lunch**	
1:15 PM								
1:30 PM	GA Roadmap &	*Holmes*	Instructions to Vehicle and Infrastructure Track Breakout Sessions		**Vehicle Tech**	**Infrastructure**	General Discussion	*Hahne*
1:45 PM	SATS Concept				Airframe	CNS		
2:00 PM			Travel to Breakout Rooms		Aerodynamics	Airports		
2:15 PM			**Vehicle Tech**	**Infrastructure**	Propulsion	Airspace/Airway		
2:30 PM	FAA Mission	*Rowlette*	Airframe/Aero./	CNS/Airports/	Avionics	Procedures	SATS Partnerships & Alliances Design Discussion	*Masson*
2:45 PM	Need Statement for SATS		Prop./Avionics/	Airspace,Airway/	Training			
3:00 PM	**Break**		Training	Procedures				
3:15 PM	State-of-the-Art:	*Roskam*	**Break**		**Break**			
3:30 PM	Configuration Aerodynamics		**Vehicle Tech**	**Infrastructure**	**Vehicle Tech**	**Infrastructure**	**Break**	
3:45 PM			Airframe	CNS	Session Report Out to Vehicle Technologies Group	Session Report Out to Infrastructure Group	Summary	*Holmes*
4:00 PM	Partnerships &	*Panel Discuss.*	Aerodynamics	Airports			Next Steps	
4:15 PM	Alliances		Propulsion	Airspace/Airway			Actions	
4:30 PM			Avionics	Procedures			**Adjourn**	
4:45 PM			Training					
5:00 PM	**Social**		**Adjourn**		**Adjourn**			

Last Updated on 6/18/99
By David Hahne

FAA
Mission Needs Statement
(Draft)
for
Small Aircraft Transportation System
(SATS)

June 21, 1999

Jim Rowlette
Mission Analysis Division

Briefing Overview

- Objective
- Background
  - FAA Acquisition Management System
  - Baseline 2001
- Needed Capabilities
  - Aircraft
  - NAS Infrastructure
  - Airports
- Benefits / Impacts
- Next Steps

Objective

Informational Brief

FAA's

Small Aircraft Transportation System

Mission Need Statement.

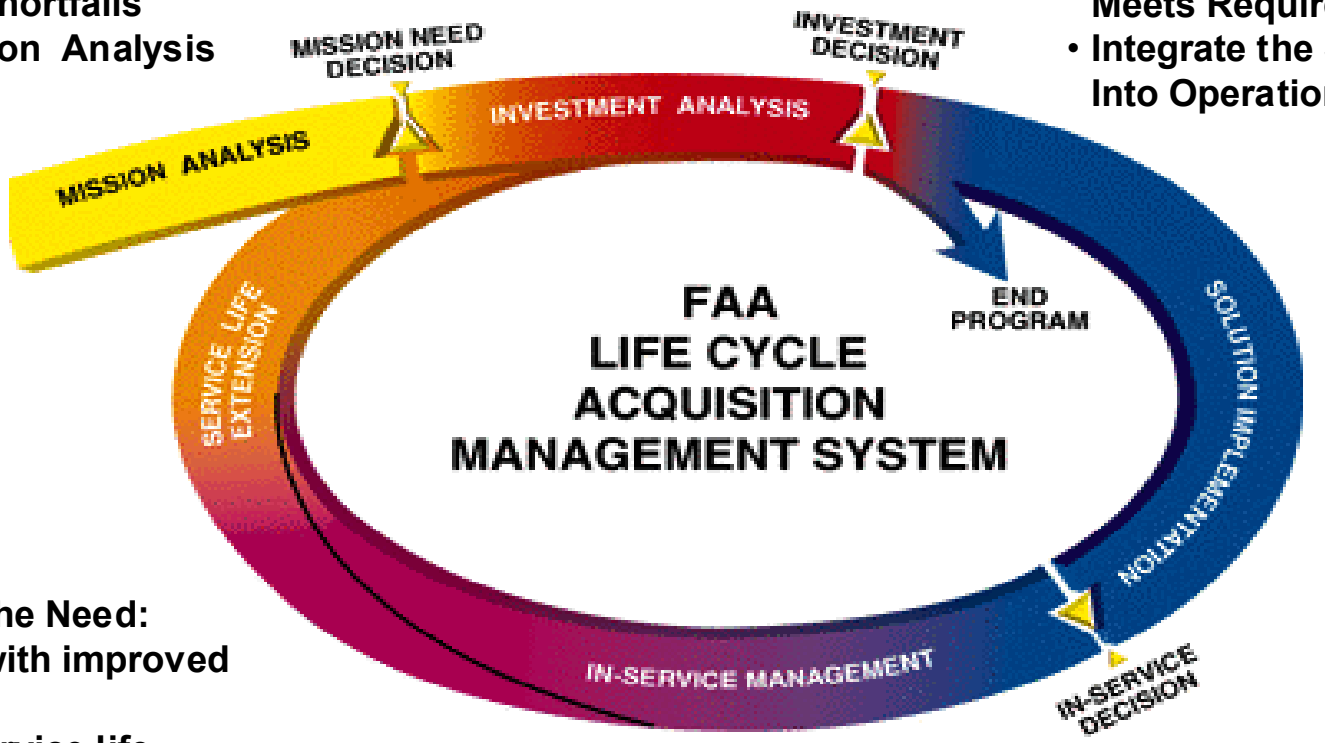
(Draft)

Acquisition Management System

- Identify Service Capabilities Shortfalls
- Conduct Mission Analysis

- Requirements Identification
- Selection of Alternatives
- Affordability Assessment

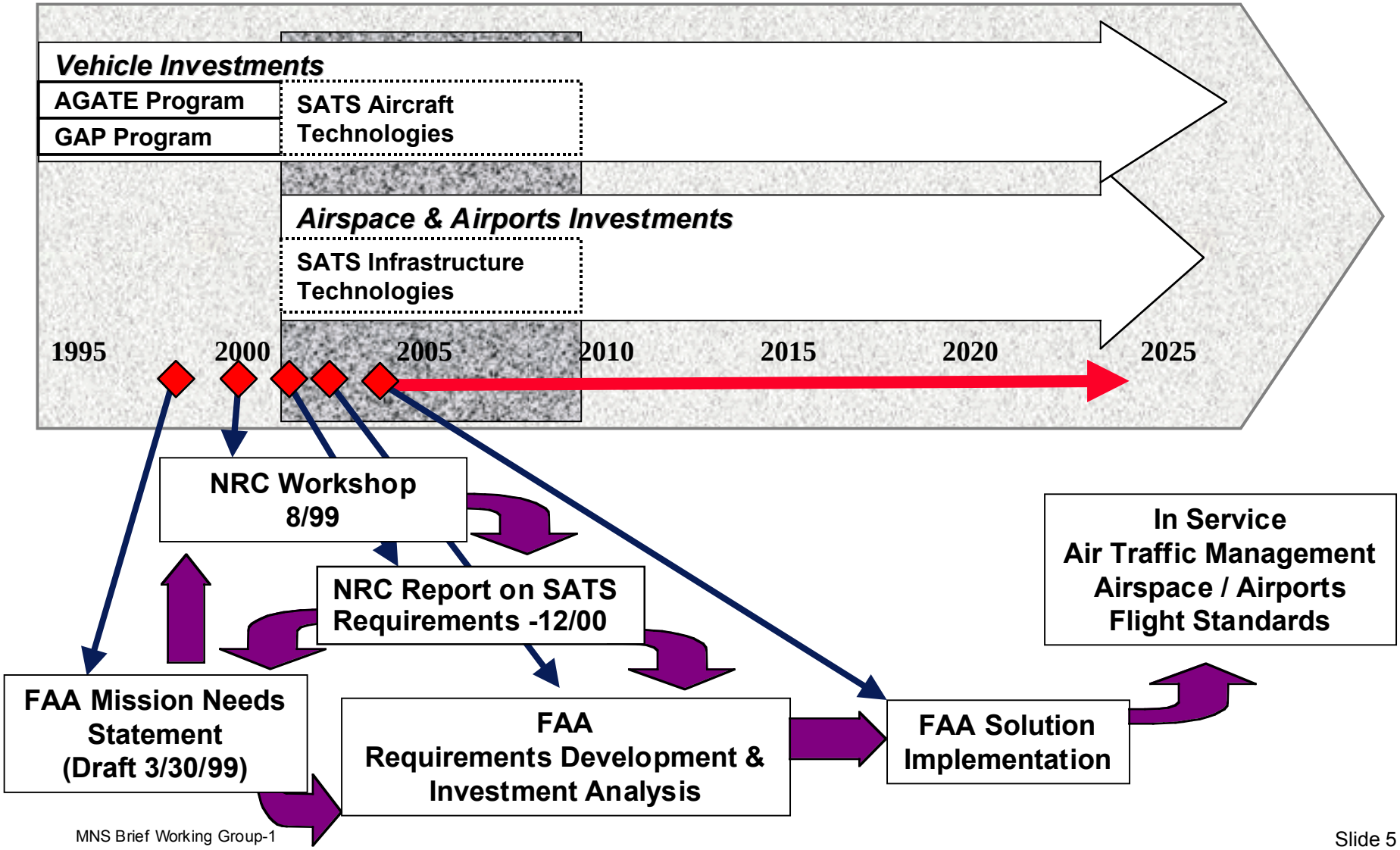
- Plan the Acquisition
- Acquire Solution That Meets Requirements
- Integrate the Solution Into Operations



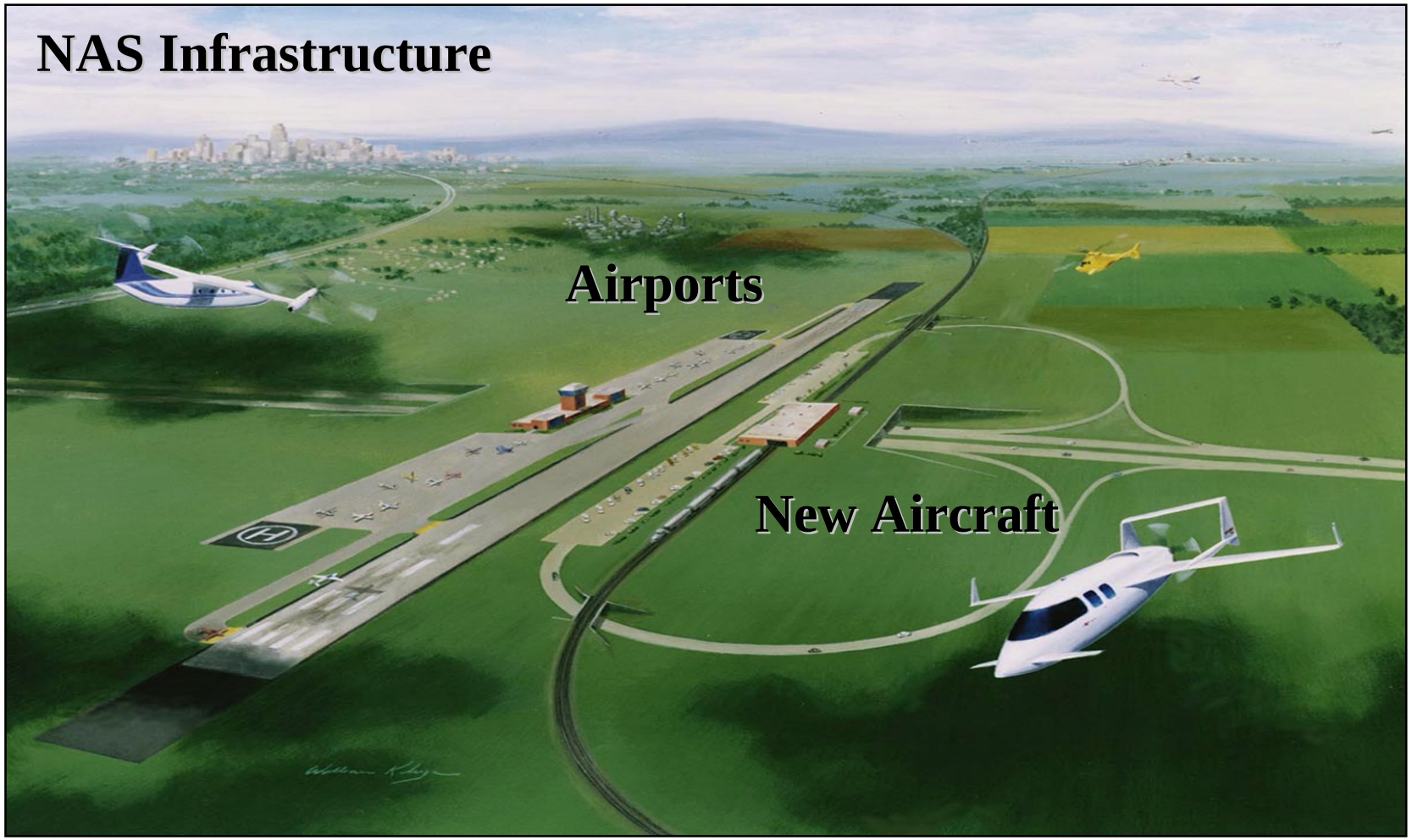
•Revalidate the Need:
- Replace with improved capability
- Extend service life
- Decommission

- Operate and Sustain Solution
- Monitor Performance and Cost, Identify Trends in Capability

SATS Roadmap

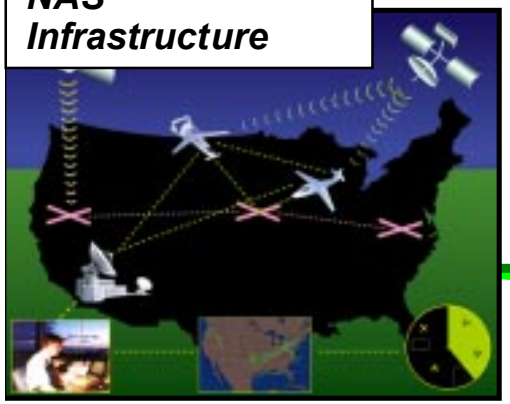


SATS Needed Capability



Technology Areas

NAS Infrastructure



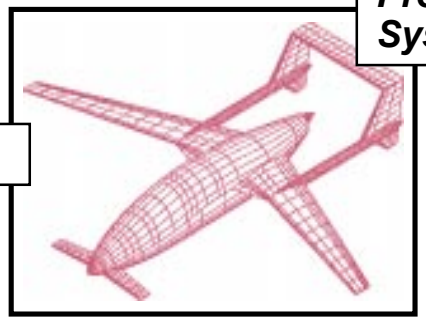
Flight Deck Operations & Avionics

Small Aircraft Transportation System

Pilot Training

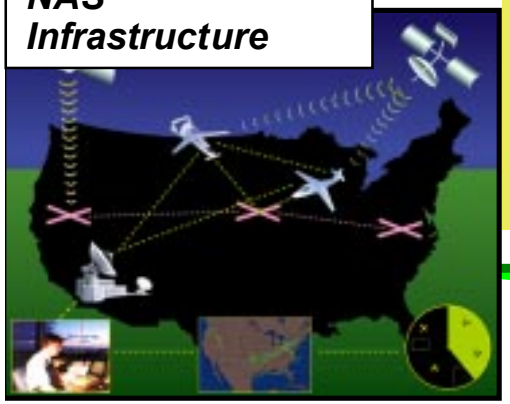
Propulsion Systems

Airframe Systems



Baseline Technology -- 2001

NAS Infrastructure



- Begin WAAS deployment (CAT I approaches)
- Air-to-air surveillance introduced
- Initial FIS provided WX from commercial vendors
- Satellite-based Comm-Nav-Surveillance

Flight Deck Operations & Avionics

- COTS Processors, Operating Sys, Displays
- Solid state Attitude-Heading-Ref-System
- Affordable databus
- PFD, MFD
- Icing "Avoid & Exit"
- Single-lever power control
- VDL Mode 2 data radios
- FAR-JAR Harmonization underway

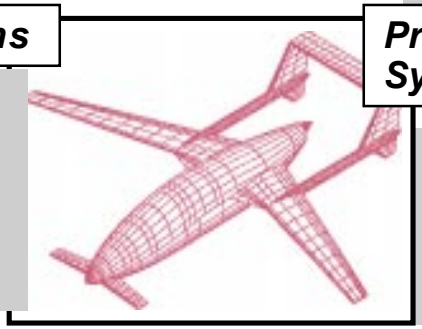
Small Aircraft Transportation System

Pilot Training

- Unified Instrument-private curriculum
- 25% savings in time and cost

Airframe Systems

- Affordable composites
- Crashworthiness
- Affordable ice protection
- Integrated lightning protection

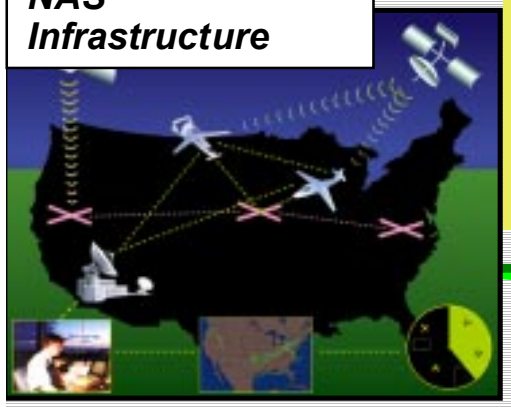


Propulsion Systems

- New Small Turbine
- New Compression-Ignition Engine
- Quiet propellers

Baseline Technology -- 2001

NAS Infrastructure



- **Begin WAAS deployment (CAT I approaches)**
- **Air-to-air surveillance introduced**
- **Initial FIS provided WX from commercial vendors**
- **Satellite-based Comm-Nav-Surveillance**

Flight Deck Operations & Avionics

- COTS Processors, Operating Sys, Displays
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Small Aircraft Transportation System

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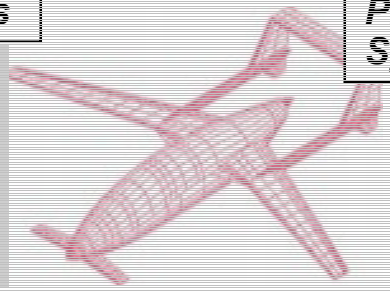
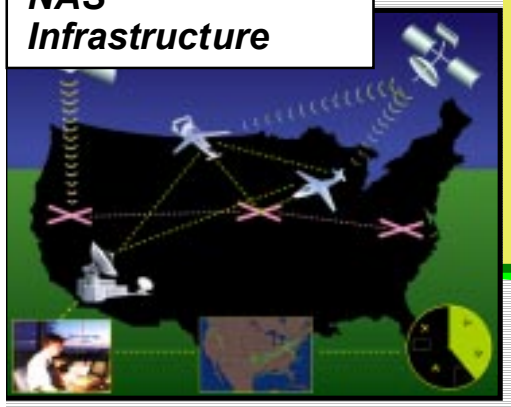


Propulsion Systems

- New Small Turbine
- New Compression-Ignition Engine
- Quiet propellers

State of the Art -- 2007

NAS Infrastructure



- **WAAS completed (Increased CAT I approaches)**
- **LAAS deployed (CAT I/II/III approaches)**
- **ADS-B available for user equipage**
- **Real-time FIS including WX, SUA, & NOTAMS**
- **Deployment of Next generation Comm-Nav-Surveillance equipment**

Single-Crew Flight Deck Systems & Operations

- Decoupled controls
- Envelop protection
- Ride quality
- Affordable software certification
- Affordable HUD/ Enhanced/synthetic vision
- VDL Mode 3 data radios

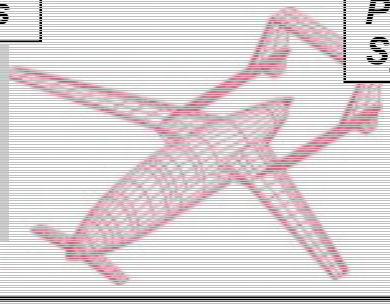
Small Aircraft Transportation System

Pilot Training

- Onboard Cyber-Tutor
- Internet Training
- 50% savings in time and cost

Airframe Systems

- < $30 per lb composites, assembled
- Optimized ice, lightning, & crash protection



Propulsion Systems

- < $50,000 Turbine
- < $15,000 Compression-Ignition Engine
- Quiet propulsion

Needed Capability -- 2007

New Aircraft

•*FAA's responsibilities in the aircraft area involve policy, certification, and the implementation of supportive air traffic procedures and capabilities in the NAS.*

Needed Capability

- Regulation and rule changes to support design, production & certification of new aircraft systems
- Policy & procedures to utilize SATS technology aircraft
- Ability to accurately determine & broadcast current location
- Means to separate from other aircraft in remote areas
- Near all-weather operations
- In-flight re-planning
- Comply with laws, regulations, & policies

Current & Planned Capability

- Address Certification Process & Procedures
- Cooperation as effective service provider
- Participates as a partner in the public-private alliances seeking to advance state-of-the-art.

Shortfalls

- Implementation of SATS supportive air traffic management procedures
- Streamlined aircraft/avionics certification process
- Expedited pilot training & evaluation based on SATS technologies

Needed Capability -- 2007

NAS Infrastructure

•*Accommodate SATS concept of operations by providing communications, navigation, and surveillance procedures and weather capabilities.*

Needed Capability

- Information on traffic flow & system status
- Systems to permit near all-weather operations in remote areas at low altitudes
- Expanded traffic flow management
- Reliable Communications from Surface Up
- Means to Separate Aircraft in Remote Areas
- Near All-Weather Operations
- Accommodate mixed equipage aircraft

Current & Planned Capability

- Flight Standards Service to ensure flight procedures are developed and validated
- New Decision Support Tools to increase capacity & efficiency of NAS

Shortfalls

- Analysis of effect of increased volume of SATS aircraft on traffic flow and ATC system
- Streamlined aircraft/avionics certification process
- ATC system ability to utilization of SATS technology
- SATS operating policy guidance
- Airspace designed to support SATS operating concept

Needed Capability -- 2007

Airports

•*Ensured accessibility to an expanded service area with higher utility in near all weather conditions*

Needed Capability

- Marked & lighted for 24/7 operations
- Systems to permit near all-weather operations
- Instrument approach capability
- Meet all environmental regulations
- Available to all category aircraft
- Lower cost approach lighting systems

Current & Planned Capability

- GA roadmap calls for 1,125 SATS airports by 2007
- FAA conducts approximately 138 airport master planning studies per year
- Approximately 47 infrastructure system planning studies a year

Shortfalls

- Lack of basic infrastructure at most airports
- Limited funding available for airport planning
- NAS Architecture does not highlight transition to SATS airports
- Ability to process environmental requirements in a timely manner
- NPIAS policies & processes may be inadequate for efficient & flexible development of SATS infrastructure

Benefits

- Meet User Demand
- Increases capacity and efficiency of NAS
  - Exploits Underutilized NAS Capacity
  - Augmentation to Hub-and-Spoke
  - Leverages on current NAS Architecture development
- Supports Advances in Engine and Airframe Technology "Technology Push"
- Exploits Safety Enhancements Inherent in SATS
- Enhances Personal / Business travel and development
- Supports the further growth of National productivity and increases overall National quality of life
- Supports ONE DOT strategy for intermodal transportation

Next Steps

- Attain JRC Commitment
- Support NRC/TRB Study
- Establish Research Areas
  - Procedural requirements
  - Airspace needs
  - Infrastructure requirements
  - Certification process
- Reinsert SATS program in FAA AMS process
  - JRC 1 -- Investment analysis
- NAS Architecture Update

SATS Discussion

on

Partnerships and Alliances Design

SATS

- Process
- Status
- Timing
- Scope
- Assessment

P R O C E S S

SATS

- ASSESSMENT- Objectives, Features
- PARTICIPANTS- Who, Role, When
- STRUCTURING- Organize
- NEGOTIATE- Document
- OPERATE- Govern, Manage, Administer
- EXIT OR CONVERT- Envision end

S T A T U S

SATS

- NOTHING FIXED YET...
- DESIGN CONCEPTS- Multi-tiered partnership, individual membership via association
- GUIDING NASA PRINCIPALS
- BEGINNING ASSESSMENT JUNE ‘99

T I M I N G- Projected

SATS

- Assessment/Design - 9/30/99
- Participants - 1/30/00
- Structure - 3/30/00
- Negotiate - 9/30/00
- Operate - Phased
- Exit or Convert - ??????

S C O P E

SATS

- Participants- Federal (3), State (50), local-special jurisdictions (?), industry groups (8), public interest groups (?)

- Working areas- policy, regulatory, technical, financial, operator, traveler, ?

- Coordination & integration- technology, Federal & state policy, investment plans

A S S E S S M E N T

SATS

- Objectives of SATS- functions & features
- Stakeholders- champions & issues
- Due diligence- stakeholders
- Strategic driver- technology driven, market driven, investor driven
- Design options- objectives, strategy, stakeholders
- Apply design-

  - formally solicit participants
  - offer alliance design options- acquisition strategy

A S S E S S M E N T

SATS

- Stakeholders- Who?

- Issues- What?

Available via FTP:
Address: 128.155.43.83
Username: SATS
Password: Public

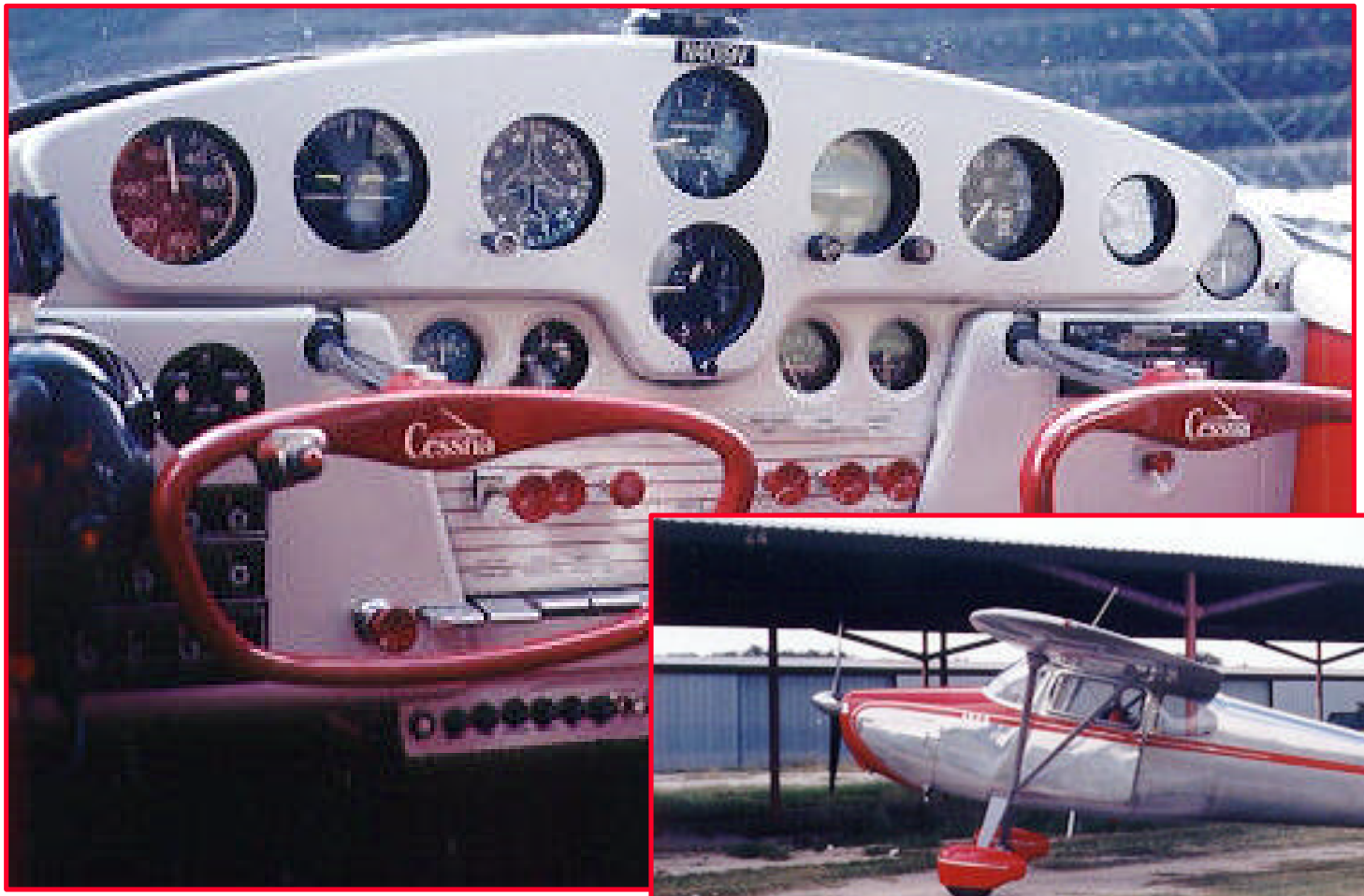
STATE-OF-THE-ART IN GENERAL AVIATION AVIONICS

Scott Asbury
AGATE Flight Systems Avionics Task Leader
NASA Langley Research Center

OUTLINE

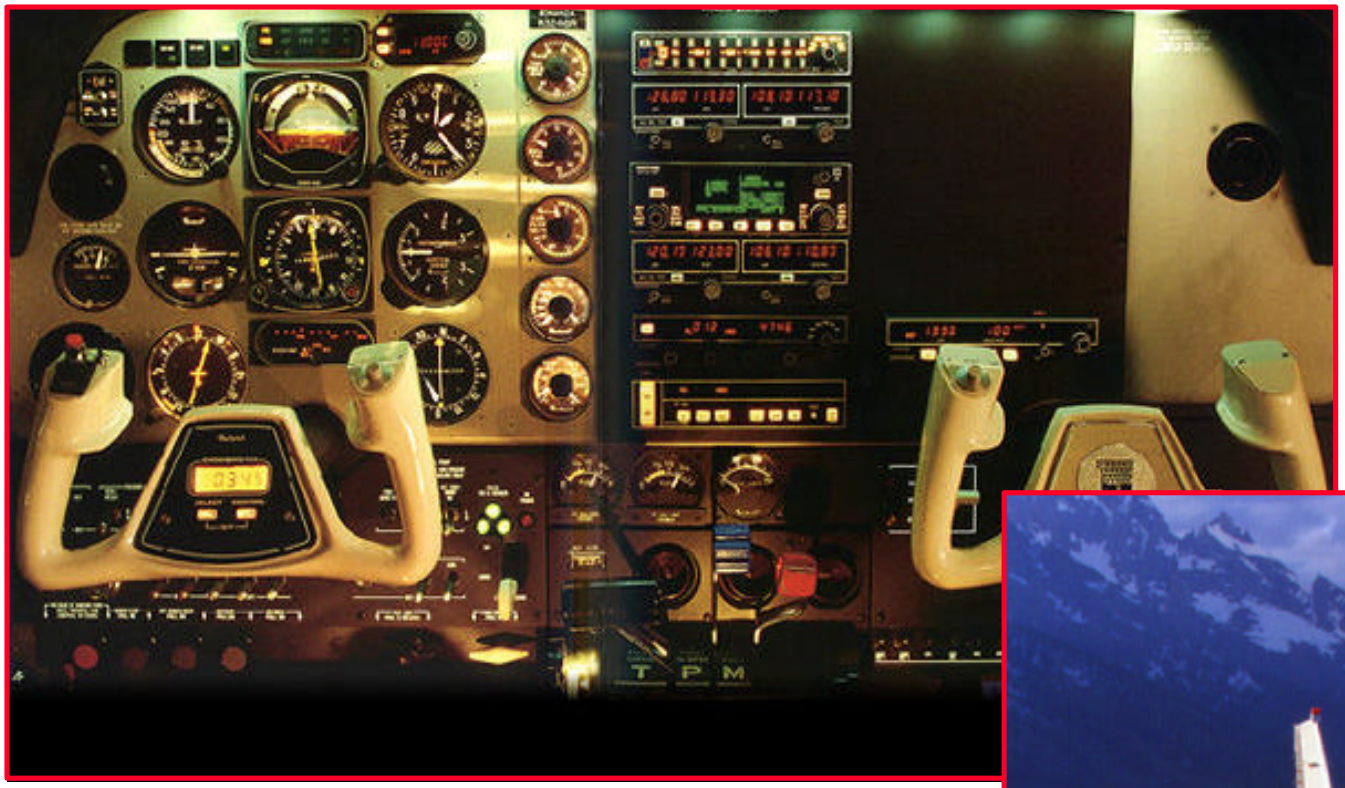
- Background
- Advanced General Aviation Transport Experiments
- General Aviation Revitalization
- SATS Challenges in Avionics

STATE-OF-THE-ART….1948



STATE-OF-THE-ART….1990's

STATE-OF-THE-ART….1990's



THE AGATE PROJECT

- **Consortium of Government, Industry, Universities, and Nonprofit Organizations**
- **Goal: Create the Technological Basis for Revitalization of the U.S. General Aviation (GA) Industry**
  - **Single-Pilot Flight Deck, Single-Engine Light GA Airplane**
  - **Mission of Point-to-Point On-Demand Transportation**
    - » **150 to 700 mile range**
    - » **"Near-all-weather" capability**
      - **CAT 1 ILS at over 5000 public use airports**
      - **Do not fly through thunderstorms**
      - **Do not fly through known ice without protection**
      - **Do not fly through moderate and severe turbulence**

AGATE PRODUCTS

GS&C's

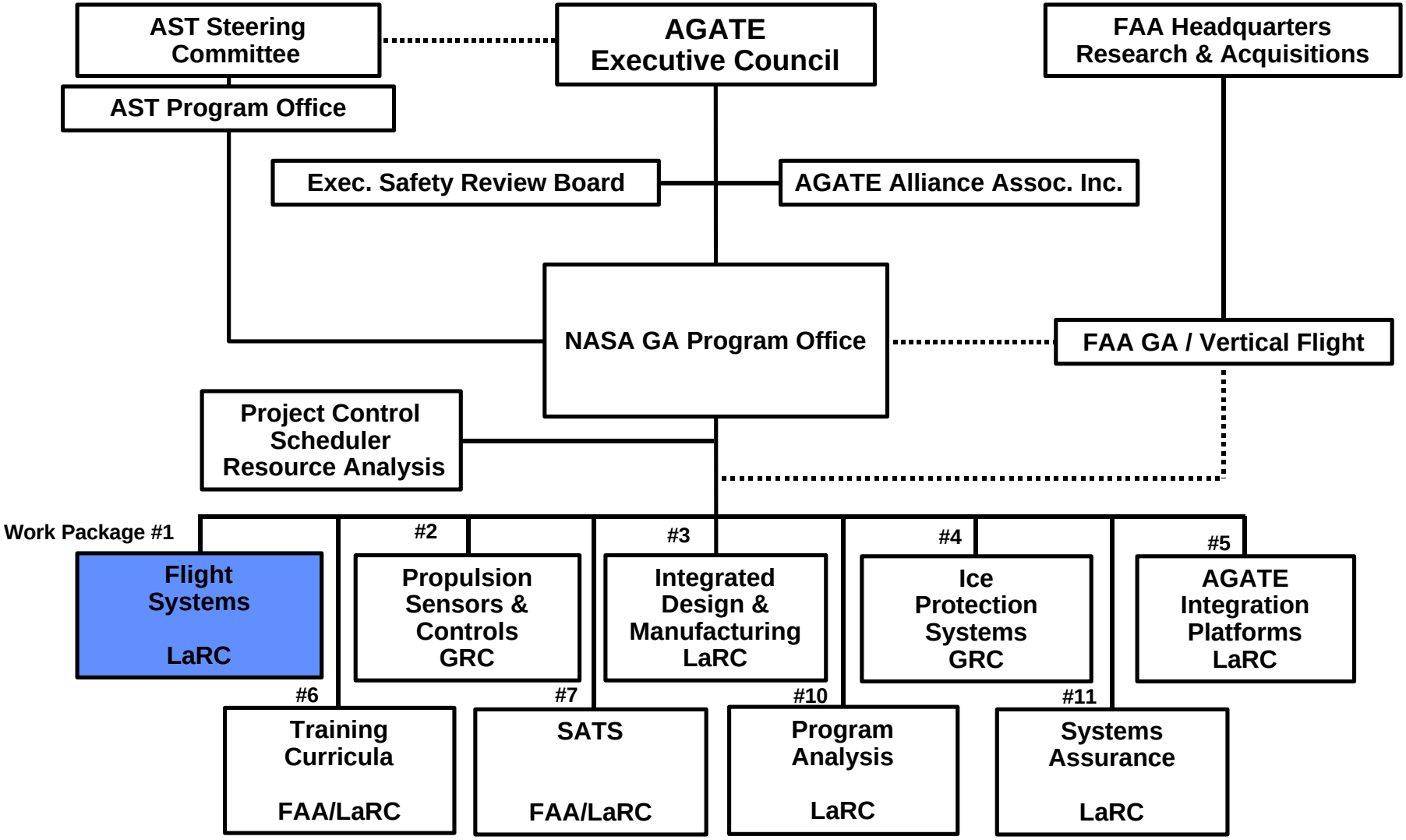
- Design Guidelines
- Systems Standards
- Certification Methods

AGATE TIMELINE

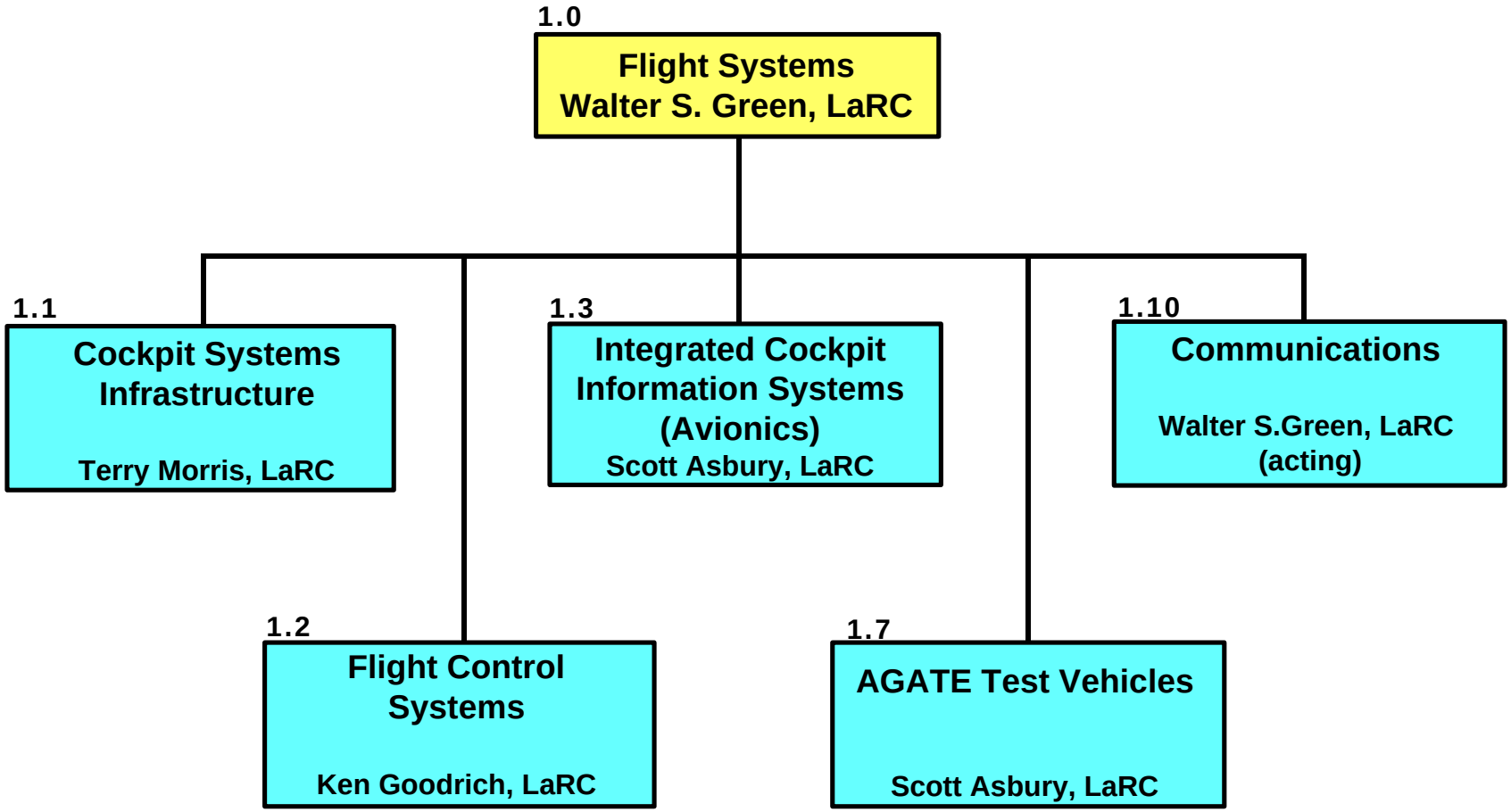
- Create Consortium
- Conduct Market Analysis
- Establish Requirements
- Identify Technology & Systems Options
- Develop & Evaluate Selected Alternatives
- Provide Design Guidelines, System Standards & Certification Methods

1994 — 2001

AGATE ORGANIZATION



FLIGHT SYSTEMS ORGANIZATION



AGATE
FLIGHT SYSTEMS OBJECTIVES

- **Develop <u>Affordable, Integrated</u> Controls and Displays to:**
  - **Improve pilot situational awareness**
  - **Reduce pilot work load**
  - **Reduce requirement for voice communication**
  - **Reduce time and cost to obtain and maintain safe "near-all-weather" flying skills**
- **Establish Standards and Certification Methods for New Technology Applications in GA Airplanes**
  - **Provide analytical and human factors support for regulatory changes and FAA Advisory Circulars**
  - **Provide technical analysis input to the RTCA and other standards bodies**

FLIGHT SYSTEMS AREAS OF EMPHASIS

- **Infrastructure**
  - Databus
  - Avionics computer resource
- **Flight Controls**
  - Attitude and Heading Reference System (AHRS)
  - Auto-pilot display format
  - De-coupled flight controls
- **Cockpit Information Systems**
  - Integrated primary and multi-function displays
  - Highway-in-the-Sky (HITS) development
  - Nav, traffic, weather, flight plan, and system status standards
- **Communication**
  - Interoperable data link

FLIGHT SYSTEMS AREAS OF EMPHASIS

- **AGATE Test Vehicles**
  - **AGATE architecture implementation**
    - » **De-coupled flight controls**
    - » **HITS display**
    - » **Emergency auto-land capability**
    - » **Data link communications**

THE AGATE COCKPIT

AGATE COCKPIT CHARACTERISTICS

- **Certifiable Advanced Technology Architecture**
  - **Computer-driven, flat-panel displays**
    - » **Electronic primary flight display (PFD) with HITS flight path depiction**
    - » **Integrated, graphical multi-function display (MFD) of navigation, weather, traffic, flight plan, and system status information**
  - **De-coupled flight controls**
  - **Databus with plug and play capability**
  - **GPS-based navigation**
  - **Information transfers via data link**
  - **Emergency auto-land capability**
  - **Electronic, single-lever power control**

AGATE COCKPIT ADVANTAGES

- **Increased Situational Awareness for Improved Safety**
  - **Flight plan, position, weather, traffic, terrain, airspace, and systems status information provided via:**
    - » **HITS graphical PFD depiction with terrain**
    - » **Integrated MFD with decision aiding**
  - **Minimum recoding of information**
  - **Less demand on short-term memory for operations**
- **Less Demand on Long-Term Memory for Proficiency**
- **Minimum Training Time and Cost**
- **Simplified Emergency Procedures**
- **Emergency Auto-Land Capability**

FLIGHT SYSTEMS PRODUCTS

- **AGATE GS&Cs for:**
  - Databus
  - Computer resource
  - De-coupled flight controls
  - Low-cost GPS-based AHRS
  - Integrated displays with navigation, weather, traffic, flight planning, and systems status
  - Highway-in-the-Sky
  - Data link communications
  - Emergency auto-land capability
- **Revised FAA Advisory Circulars**
  - AC 23.1309
  - AC 23.1311

REVISED AC 23.1309

- **EQUIPMENT, SYSTEMS, AND INSTALLATIONS IN PART 23 AIRPLANES, <u>REVISED MARCH 1999</u>**
  - **Previous certification standard was unrealistic for GA**
    - » **Based on standards developed for transport category aircraft**
    - » **Required 10^9 reliability regardless of safety implications**
  - **New standard allows <u>affordable</u> certification (under Title 14 CFR Part 23) of new technologies that:**
    - » **Improve pilot situational awareness (attitude/position/weather/traffic)**
    - » **Address terrain, traffic, and weather related accidents**
  - **Accomplished by AIR AGATE (FAA Small Airplane Directorate) and AGATE Flight Systems Team**

REVISED AC 23.1311

- **INSTALLATION OF ELECTRONIC DISPLAYS IN PART 23 AIRPLANES, <u>REVISED MARCH 1999</u>**
  - **Allows affordable certification of the installation of electronic displays in Part 23 airplanes**
  - **Allows approval of new type design or a change in type design through TC, ATC, or STC**
  - **Accomplished by AIR AGATE (FAA Small Airplane Directorate) and AGATE Flight Systems Team**

GA REVITALIZED

- **The Evidence is Everywhere!**
  - **2 New GA aircraft Type Certificates in 1999 (first in 15 years)**
    - » **Cirrus SR-20**
    - » **Lancair Columbia 300**
  - **Increased R&D expenditures in GA**
  - **Increased sales**
  - **Advanced avionics introduced to the market**
  - **Increased student pilot starts**
  - **Increased public awareness of GA as a transportation solution**

CIRRUS SR-20

- Single-lever power control
- Multi-function display
- Ballistic airframe parachute
- Data link capability
- Improved crashworthiness

LANCAIR COLUMBIA 300

- Multi-function display
- Data link capability
- Improved crashworthiness

COMPANIES DEVELOPING STATE-OF-THE-ART GA AVIONICS

GARMIN

AVROTEC

UPS Aviation Technologies SM
A subsidiary of United Parcel Service

Archangel SYSTEMS INC

AlliedSignal AEROSPACE

AVIDYNE

NORTHSTAR TECHNOLOGIES • A Division of CMC Electronics, Inc.

SANDEL AVIONICS

Seagull Technology

KING

JEPPESEN

ORBCOMM GLOBAL DATA & MESSAGING

MAGELLAN

BFGoodrich

echo FLIGHT

ARNAV

SIERRA FLIGHT SYSTEMS

NavRadio

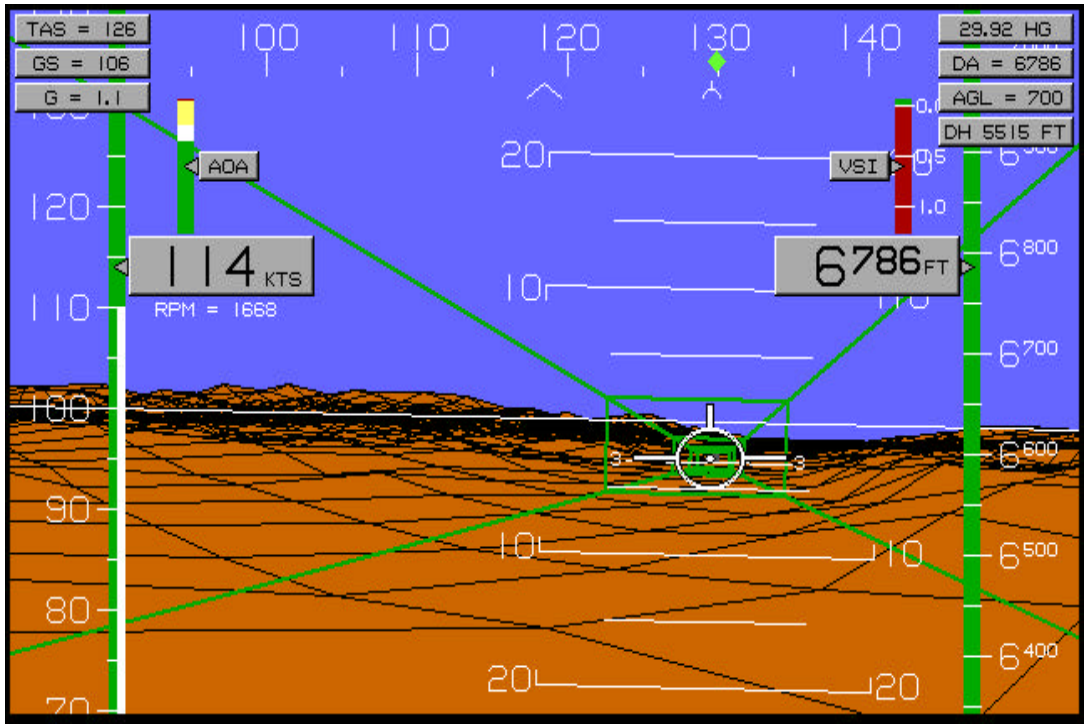
ULTIMATE SITUATIONAL AWARENESS

JPI J.P INSTRUMENTS

PRIMARY FLIGHT DISPLAYS

- **Sierra Flight Systems EFIS PFD**
  - 5x8-inch color display
  - Ruggedized Pentium II 233MHz CPU
  - Moving map display
  - Engine display
  - Air data computer
  - Solid-state gyro
  - GPS receiver
- **Experimental**

SIERRA FLIGHT SYSTEMS



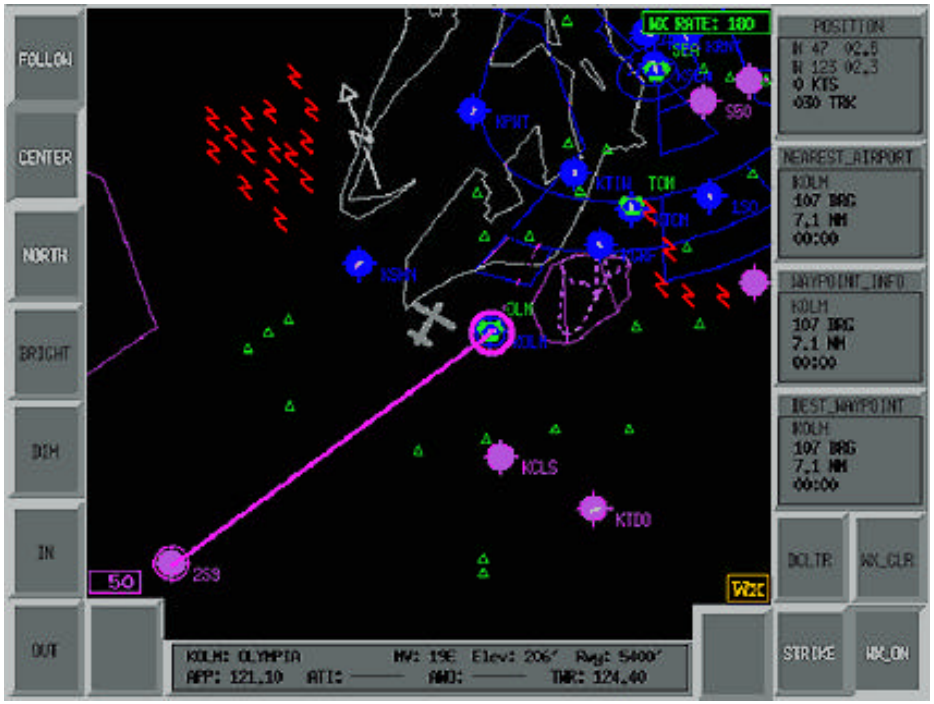
PRIMARY FLIGHT DISPLAYS

- **Archangel Systems, Inc. EFIS PFD**
  - 8.5x11.25-inch touch-screen 640x480 LCD
  - Engine Indicating and Crew Alerting Systems (EICAS)
  - Solid-state AHRS
  - Air data system
  - Engine data system
  - Fuel data system
  - GPS receiver
- **Experimental**

Archangel SYSTEMS INC

MULTI-FUNCTION DISPLAYS

- **Archangel Systems, Inc. Cockpit Display System**
  - 8.5x11.25-inch touch-screen 640x480 LCD
  - GPS moving map display
  - ARNAV data link weather
  - Stormscope compatible
  - Ryan TCAD traffic
  - Flight planning
- **FAA Certified**



MULTI-FUNCTION DISPLAYS

- **Garmin GNS-430 MFD**
  - 2x4-inch 128x240 LCD display
  - IFR approved GPS navigation
  - VOR navigation
  - VHF communication
  - ILS localizer and glideslope
  - Moving map color graphics
  - Jeppesen aviation database
  - Internal land data
- **FAA Certified**

MULTI-FUNCTION DISPLAYS

- **Avidyne Flight Situation Display**
  - 5-inch diagonal 320x234 LCD display
  - GPS moving map
  - IFR enroute and VFR charts
  - Traffic (TCAS 1/ Ryan TCAD) interface
  - Stormscope interface
  - Weather radar interface
  - Weather data link
- **FAA Certified**

MULTI-FUNCTION DISPLAYS

- **ARNAV MFD-5200**
  - 5-inch diagonal LCD display
  - GPS VFR/IFR moving map
  - Terrain obstruction proximity system (look around/look ahead)
  - Geographic database
  - Flight planning
  - Electronic checklist
  - Stormscope interface
  - Weather data link
  - EICAS
- **FAA Certified**

MULTI-FUNCTION DISPLAYS

UPS Aviation Technologies SM
A subsidiary of United Parcel Service

- **Apollo MX-20 MFD**
  - 6-inch 640x480 LCD display
  - Terrain database coupled with GPS position and baro altitude inputs
  - VFR/IFR vector based moving map
  - Terrain awareness charting/alerting
  - Stormscope interface
  - Pilot-selectable custom displays
  - Flight planning
  - Future upgrades for data link
- **Certification by October 1999**

PORTABLE AVIONICS

- **EchoFlight EchoMap Windows Software**
  - GPS moving map navigation
  - ORBCOMM LEO satellite data link
  - In-flight weather
  - 2-way e-mail
  - Position reporting

ORBCOMM
GLOBAL DATA & MESSAGING

ECHO FLIGHT

PORTABLE AVIONICS

- **AvroTec Flight Monitor**
  - 10.4-inch diagonal 640x480 LCD display w/touchscreen
  - Pentium CPU w/Windows 95 or NT
  - GPS moving map
  - Flight planning
  - Approach plates
  - Electronic checklists
  - Weather data link
- **Certified Panel Mount Available**

AVROTEC

PORTABLE AVIONICS

- **Northstar CT-1000 Cockpit Organizer**
  - 6.4-inch 800x600 LCD display w/mouse, remote keyboard
  - Pentium II CPU w/Windows 95 or 98
  - GPS moving map
  - Terrain avoidance
  - Approach plates
  - Charts
  - Internet access

NORTHSTAR TECHNOLOGIES • A Division of CMC Electronics, Inc.

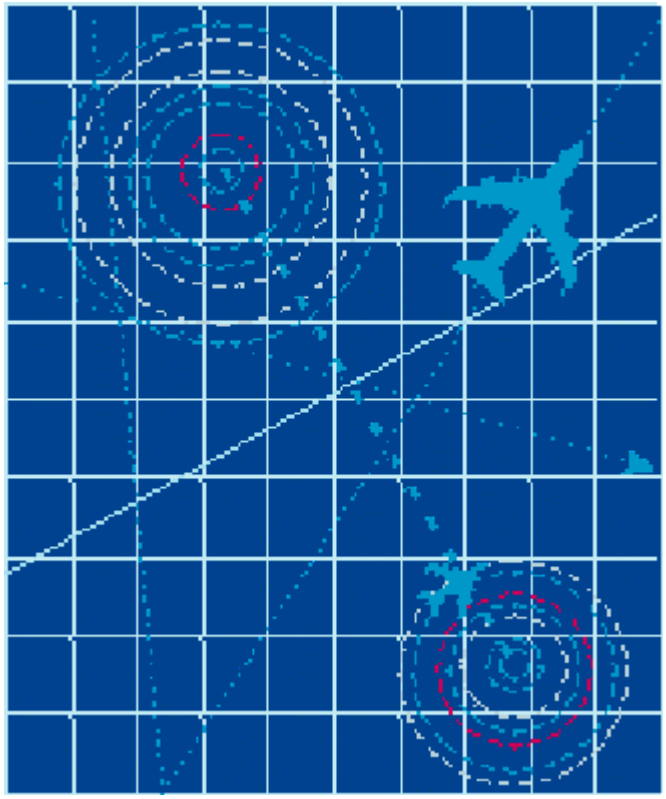
GA FLIGHT DECK CHALLENGES

- **Safety: Certifiable State-of-the Art Technologies**
  - Integrated displays with synthetic vision
  - De-coupled flight controls
  - Ride quality
- **Affordability: Produced for Volume Consumption**
  - Sensors and and processors
  - Databus
  - Heads-up displays
  - Software certification
  - Data link communication (VDL Mode 3)
- **Ease of Use: Intuitive, Integrated Cockpit Systems**
  - Minimization of training/retraining time and cost
  - Human factors considerations

STATE-OF-THE-ART….2007

- Safe
- Affordable
- Convenient
- Reliable
- Quiet
- Comfortable

- 200 to 300 knots
- 700 - 1200 n. mile range
- Easy to learn



NAS Architecture Support of Small Aircraft Transportation System Concept

June 22, 1999

Jeff Breunig

Briefing Overview

- Objective
- Background
  - National Airspace System
- Needed Capabilities
  - Air Traffic Management
  - Communications
  - Navigation
  - Surveillance
  - Flight Information Service
  - Airports / Approaches
- Next Steps

Objective

Informational Brief

The National Airspace System Architecture in relation to the Small Aircraft Transportation System Requirements.

The National Airspace System

The NAS is a complex collection of systems, procedures, facilities, aircraft, and people. These components work together as one system to ensure safe and efficient operations.

Towers
- 264 Level I and II
- 155 Level III, IV, and V

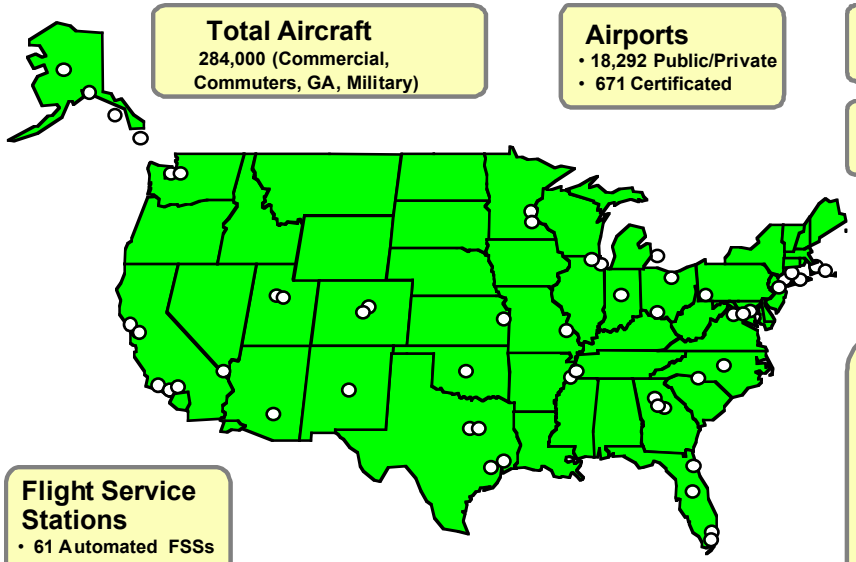
Total Aircraft
284,000 (Commercial, Commuters, GA, Military)

Airports
- 18,292 Public/Private
- 671 Certificated

Passengers per Year
- 546.2 Million

Military Ops per Year
- 990,000 IFR Operations

Radio Sites
- 25,000 VHF Radios
- 15,000 UHF Radios
- 1,285 RTR
- 701 RCAG



Commercial Aircraft Ops per Year
- 25,000,000

Other TMU Sites and Data Feeds
Alaska, Honolulu, San Juan, Canada (8), Great Britain, Scotland, Contractor Analysis (13), Airlines (24), and DOD (3)

Flight Service Stations
- 61 Automated FSSs
- 14 Alaskan FSSs

Weather Sites
- 61 AFSS
- 23 WARP
- 46 TDWR
- 594 ASOS
- 198 AWOS
- 25 ADAS
- 2 WMSCR
- 235 DASI
- 20 FSDPS

Terminals
- 171 TRACONs
- 3 Offshore Sites

TFM Sites*
- ATCSCC – Herndon
- TFM Hub – Boston
- TMUs at:
  - 21 ARTCC
  - 28 TRACON
  - 9 Regional Offices

* Denoted Cy

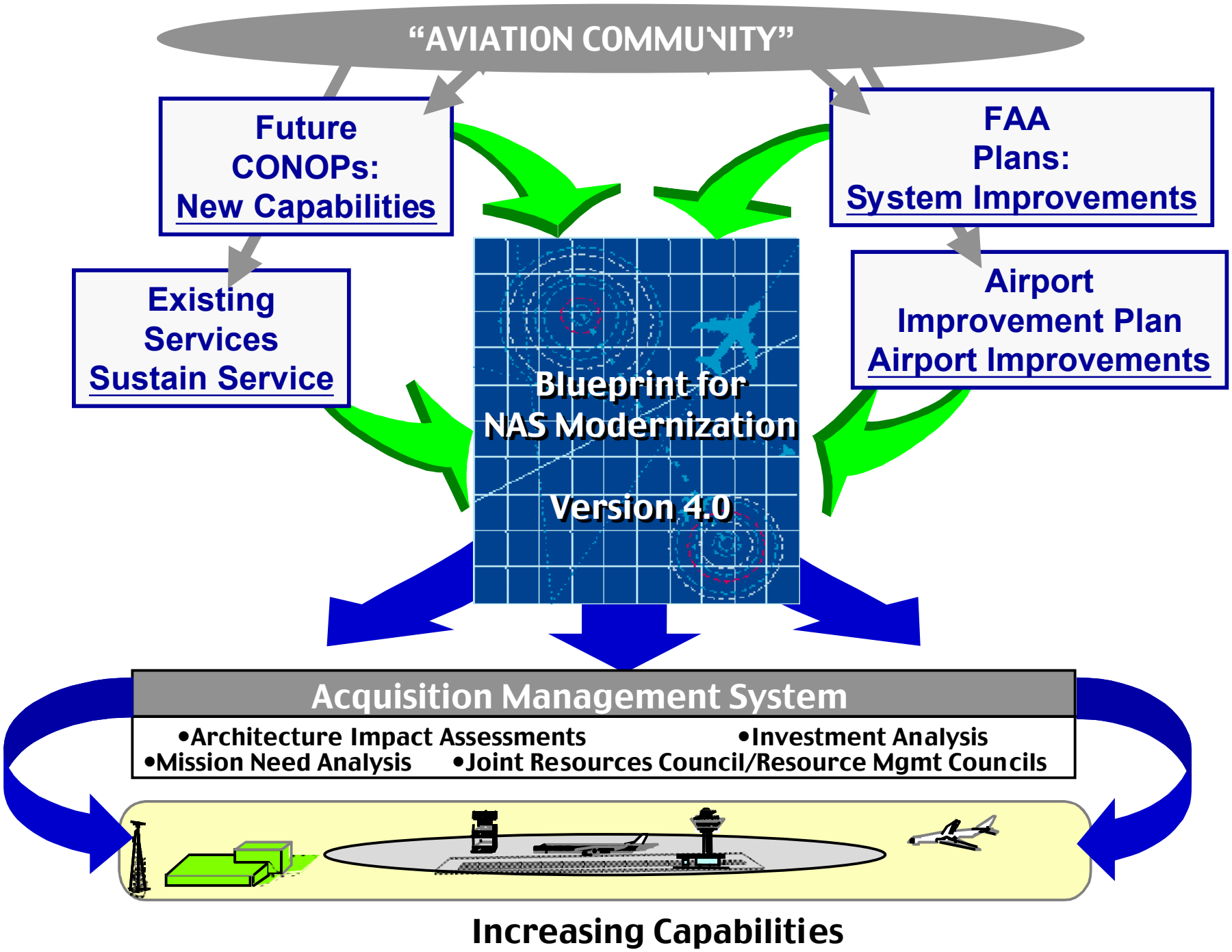
Radar Sites
- 116 LRR
- 220 ASR
- 40 ASDE

Personnel
- FAA OPERATIONS PERSONNEL
  - 17,000 Operational Controllers
  - 3,500 Flight Service Personnel
  - 8,000 Field Maintenance Personnel
- USERS
  - 665,000 Pilots
  - 2,000 Manufacturers

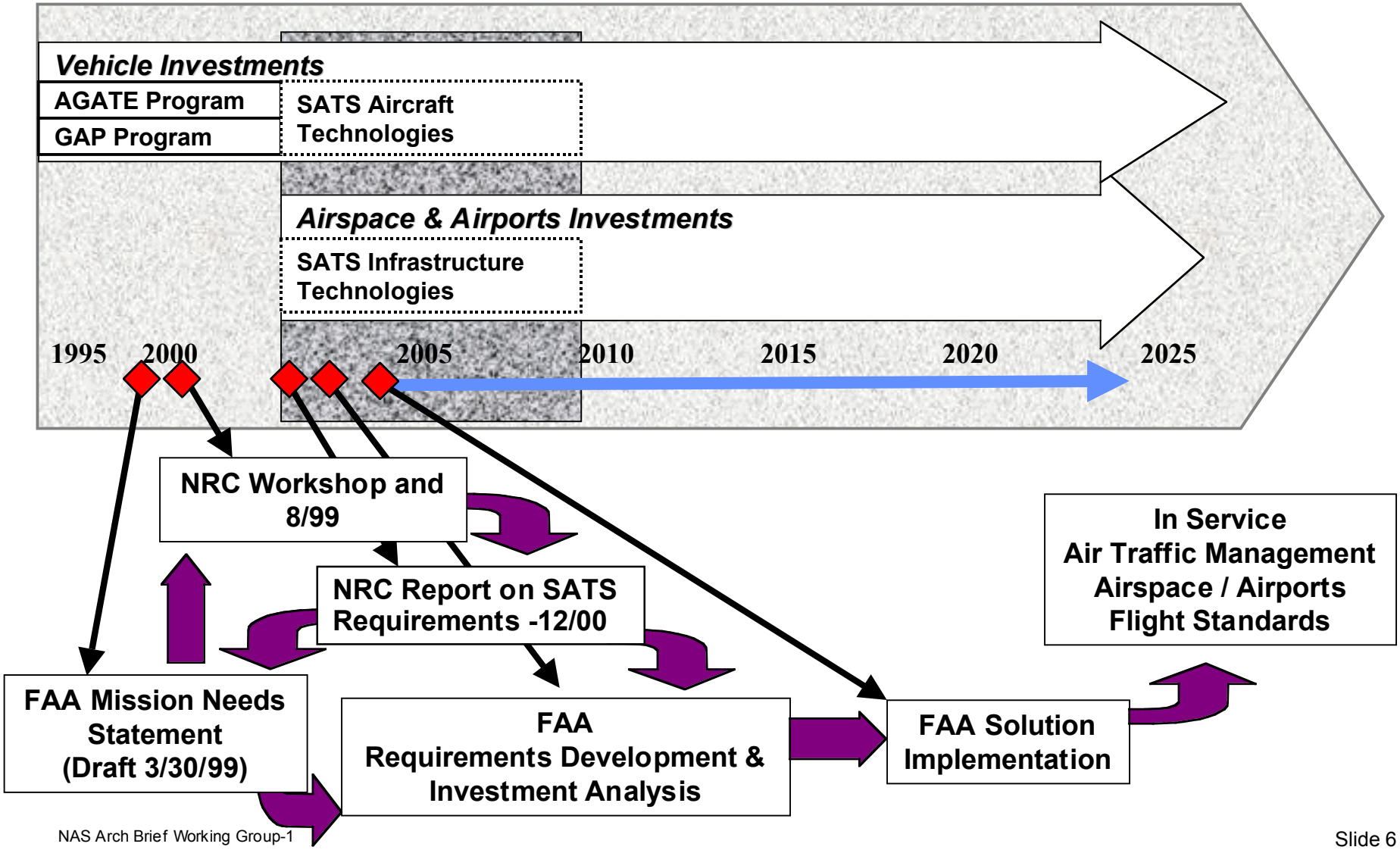
Navigation Sites
- 1,016 VOR
- 1,028 ILS – CAT I
- 85 ILS – CAT II/III

En Route Sites
- 20 ARTCC

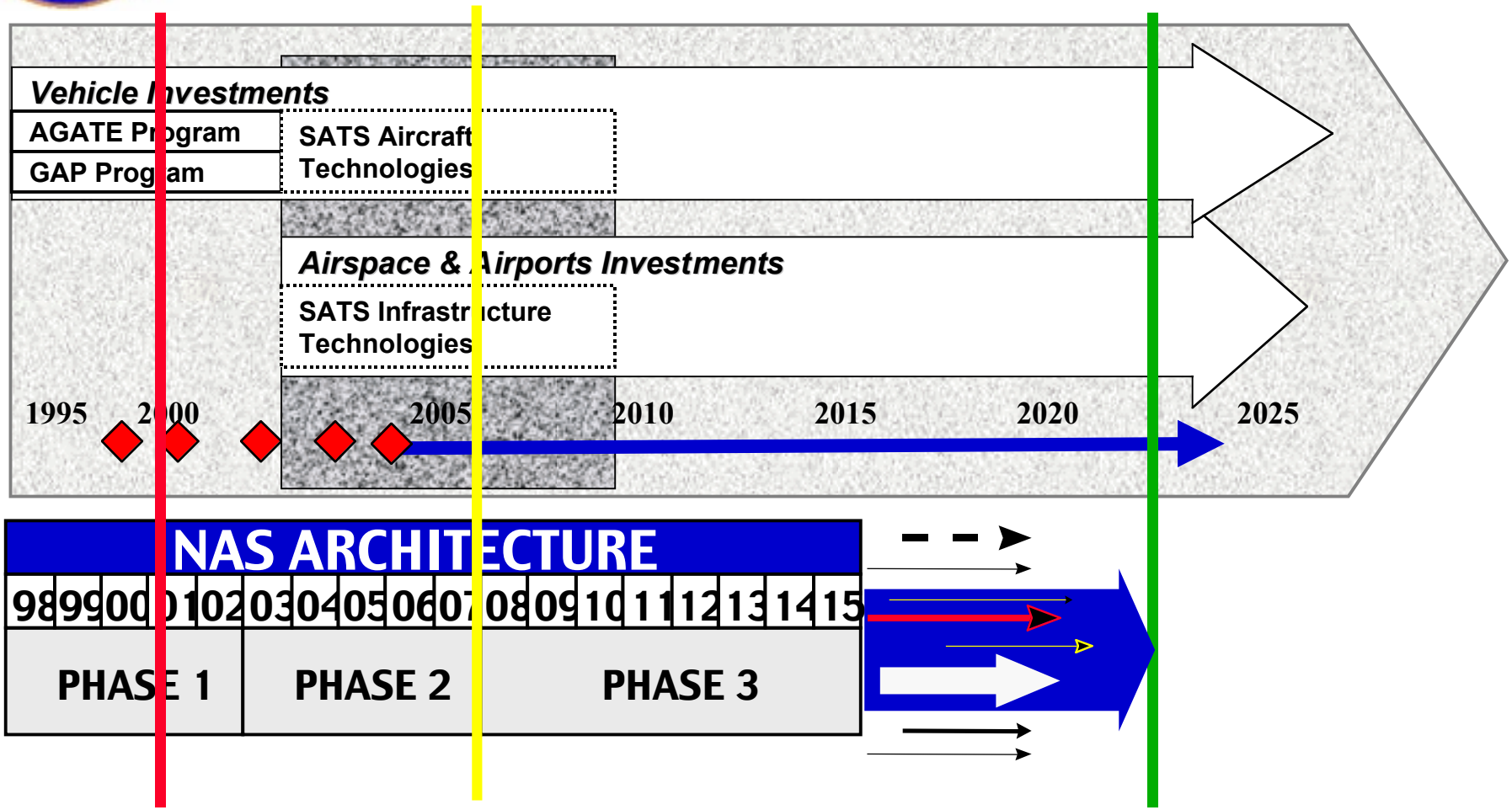
Oceanic Sites
- 3 Centers


"AVIATION COMMUNITY"
Future CONOPs: New Capabilities
FAA Plans: System Improvements
Existing Services Sustain Service
Airport Improvement Plan Airport Improvements
Blueprint for NAS Modernization
Version 4.0
Acquisition Management System
•Architecture Impact Assessments
•Investment Analysis
•Mission Need Analysis
•Joint Resources Council/Resource Mgmt Councils
Increasing Capabilities

SATS Roadmap



SATS Roadmap



Today

State-of-the Art
2007
25% Goal

90% Goal
2022

SATS Needed Capability

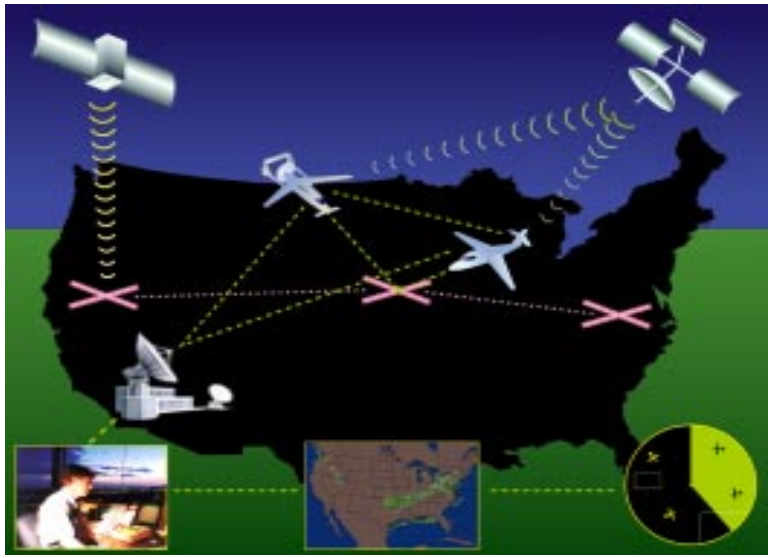
Needed Capability -- 2007

Air Traffic Management

•Provide users with information on traffic flows and system status to permit knowledgeable flight operations.

Needed Capability

- Greater operating efficiencies through more direct routing and user route selection
- Change in airspace design & structure to to capitalize on emerging SATS capabilities
- Optimize advanced technology decision support tools
- Minimized delays and congestion
- Maximizing NAS throughput & flexibility
- Accommodate mixed equipage aircraft
- In-flight re-planning capability



Current & Planned Capability

- FFP1 limited deployment of five core capabilities
- Enhanced Traffic Management System (ETMS) to assist in strategic flow decisions
- Enroute - Display System Replacement (DSR) to aid controllers
- Terminal - Std Terminal Automation Replacement System (STARS)

Watch Items & Shortfalls

- Analysis of SATS aircraft & their capabilities on NAS & ATC system
- Determine procedural requirements to effectively support SATS
- Determine airspace needs for SATS operations
- Implementation of SATS supportive air traffic management procedures

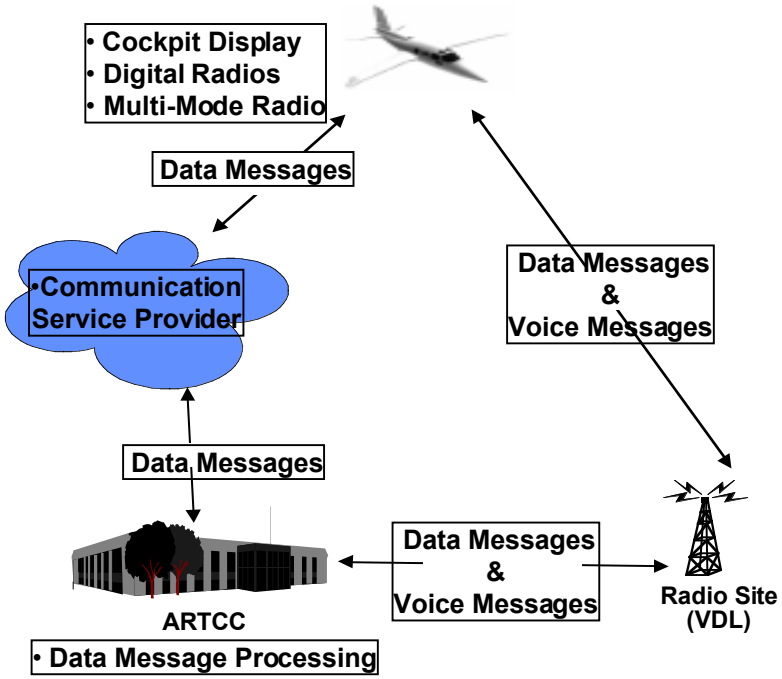
Needed Capability -- 2007

Communications

•Reliable, accurate, timely and cost efficient communications capabilities to include operations information, position and surveillance information and weather data .

Needed Capability

- **Reliable comm from surface up in all areas of operation**
- **In-flight re-planning capability**
- **Clearances through Special Use Airspace**



Current & Planned Capability

- **Deployment of Next Generation CNS Systems**
- **Introduction of digital radios & data link services**
- **Cooperation as effective service provider**
- **Participates as a partner in the public-private alliances seeking to advance state-of-the-art.**

Watch Items & Shortfalls

- **Streamlined avionics certification process**
- **Transition to Next-Generation Air Ground Comm System - fully integrated digital comm not completed until 2015**
- **Minimum equipage required for en route and terminal area operation**
- **Spectrum availability**
- **Cost of data link services**

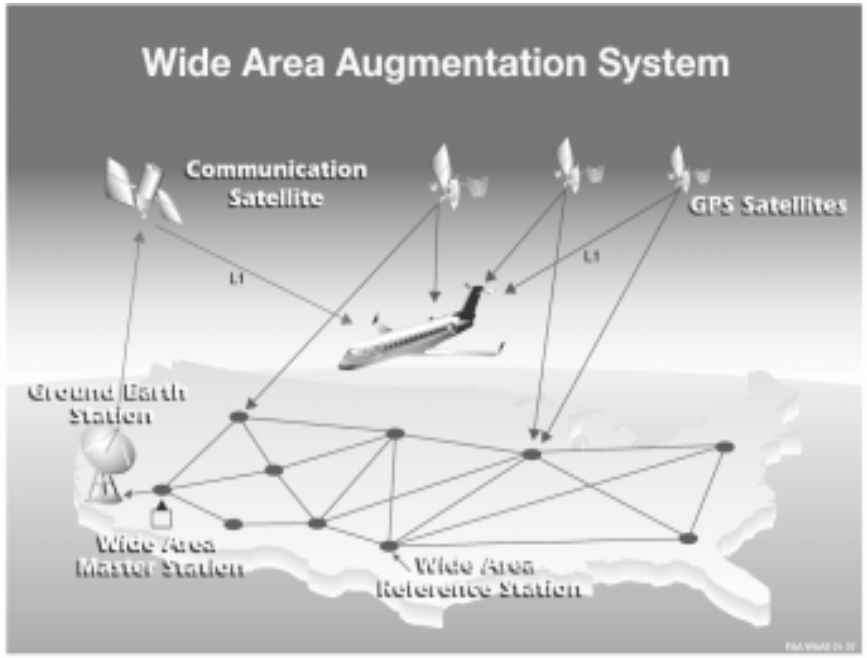
Needed Capability -- 2007

Navigation

•*Navigation support must provide reliable, improved position location resolution in all flight modes, from surface upward and in all weather conditions.*

Needed Capability

- **Ability to accurately determine & broadcast current location in all areas of operation**
- **Means to separate from other aircraft in remote areas**
- **Near all-weather operations**
- **In-flight re-planning capability**



Current & Planned Capability

- **Enroute Navigation via GPS/WAAS**
- **WAAS achieves full operating capability**
- **Deployment of Next Generation CNS Systems**

Watch Items & Shortfalls

- **Streamlined avionics certification process**
- **Affordable avionics**
- **Transition schedule for reduction of ground based navigation systems**
- **Policies on carrying redundant equipage**
- **WAAS performance and funding**

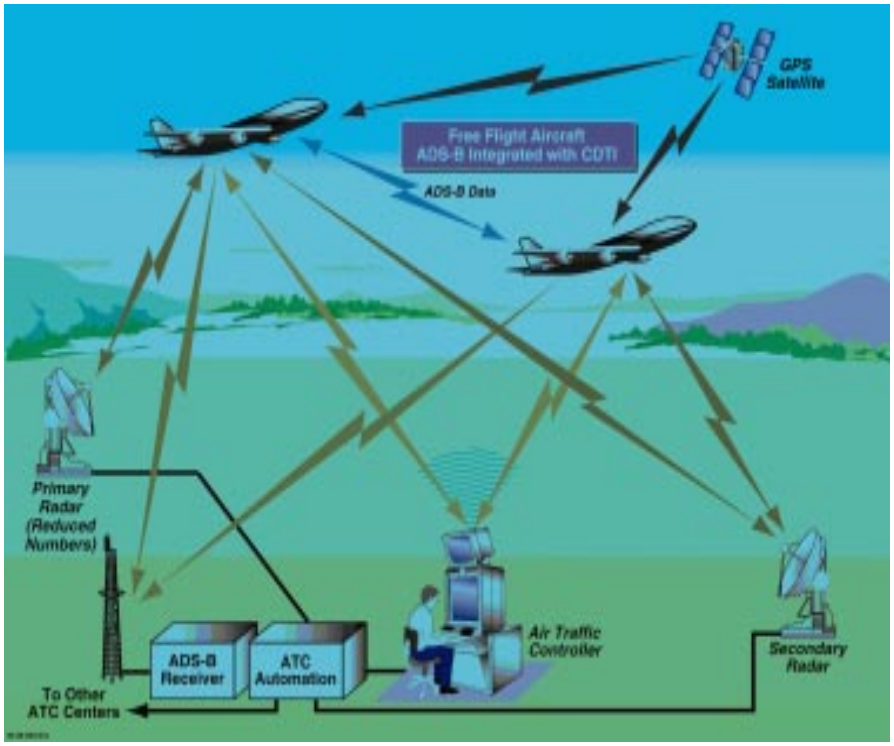
Needed Capability -- 2007

Surveillance

•*Reliable,accurate, timely, and cost efficient position information to and from all aircraft from surface up, in all terrain and all airspace areas.*

Needed Capability

- **Means to separate from other aircraft in all areas of operation and all terrain**
- **Means to self separate in non-surveillance areas**
- **Near all-weather operations**



Current & Planned Capability

- **Safe Flight 21 Demonstration**
- **ADS-B becomes available for air-to-air surveillance and self separation**
- **Deployment of Next Generation CNS Systems**

Watch Items & Shortfalls

- **Streamlined avionics certification process**
- **Affordable avionics**
- **Ability to separate aircraft in all areas of anticipated operation**
- **Development & evaluation of ADS-B**
- **ADS-B ground infrastructure dependant on user demand**
- **ADS-B ground system installed 2008-2015**

Needed Capability -- 2007

Flight Information Service (FIS)

•Provide reliable,accurate, timely, and cost efficient flight information to include weather, NOTAMS, and special use airspace information.

Needed Capability

- **High resolution, accurate weather data for all areas of operation**
- **Suitable means to disseminate weather in the cockpit data**
- **Ability to avoid & negotiate Special Use Airspace (SUA)**
- **In-flight re-planning capability**

Current & Planned Capability

- **Capstone Demonstration**
- **FIS broadcast of wx data thru commercial vender data link**
- **Cooperation as effective service provider**
- **Participates as a partner in the public-private alliances seeking to advance state-of-the-art.**

Watch Items & Shortfalls

- **Streamlined avionics certification process**
- **Affordable avionics**
- **Policy regarding content, process, & display of weather products & electronic PIREPS**
- **Ability to receive and display FIS data (SUA, NOTAMS, etc)**
- **NAS wide information sharing/data link 2008-2015**

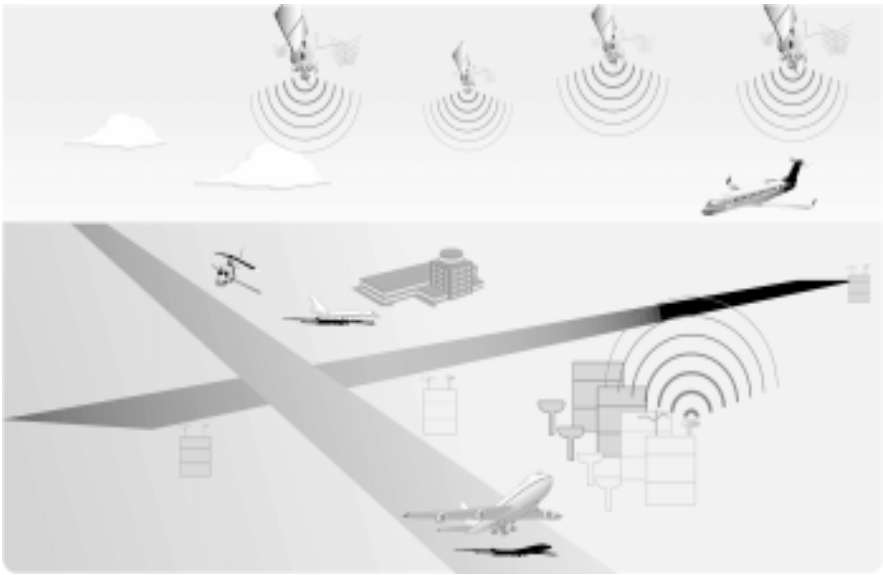
Needed Capability -- 2007

Approaches / Airports

•*Facilitate precision instrument approaches, departures, and ground operations to all SATS designated airports.*

Needed Capability

- Precision Approach Capability
- Near all-weather utility
- Airports available to SATS & non SATS aircraft
- Paved, marked, lighted for 24/7 operations
- Low cost approach lighting/guidance systems
- Meet all airport / environmental regulations



Current & Planned Capability

- WAAS provide CAT I approach capability
- LAAS deployment (CAT I/II/III) approaches available outside WAAS coverage
- Capable of completing Airport / Environmental master planning for 75 airports/year

Watch Items & Shortfalls

- New GPS satellites with second civil frequency
- LAAS deployment scheduled for 150 airports
- Certified, affordable avionics
- Development of LAAS standards
- Estimate 200 airport/environmental master plans/year must be processed
- Airport Lighting to support LAAS approaches

Next Steps

- Attain FAA JRC Commitment
- Establish Research Areas
- Identify Infrastructure Shortfalls
  - Establish criteria for a "SATS" airport infrastructure requirements
    - SATS requirements 2007
    - SATS requirements 2025
- Reinsert SATS program in FAA AMS process
  - JRC 1 -- Investment analysis
- NAS Architecture Update to reflect SATS Requirements

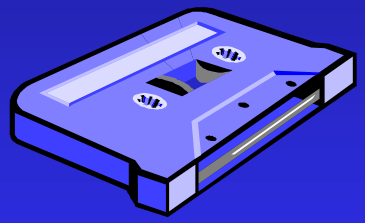
State of the Art of Aviation Training

SATS Planning Conference

15 July, 1999

Historical Perspective

- Based on age old technologies
- Classroom
  - Manuals
  - Video clips
  - Cassette tapes
  - 30/40 year old learning theories
  - Limited support materials

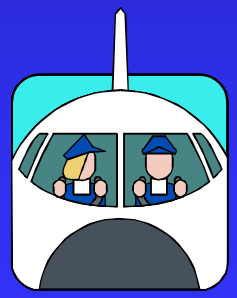


Historical

- Simulation
  - GAT link
  - Desk top trainers
- Aircraft
  - Technology base 30 – 40 years old
  - Avionics
    - Radios
    - Navigation

Historical

- Instructional systems
  - Requirements are hours based
  - Limited support
  - Human factors / ADM / CRM ?



Current State (Normal)

- Classroom materials
  - Paper
  - Video tapes
  - Presentation materials
    - Electronic slides
    - Overheads
  - Support materials available

Current State (Normal)

- Simulation
  - Flight training devices
    - Expensive
  - PCATDs
    - Low cost alternative

Current State (Normal)

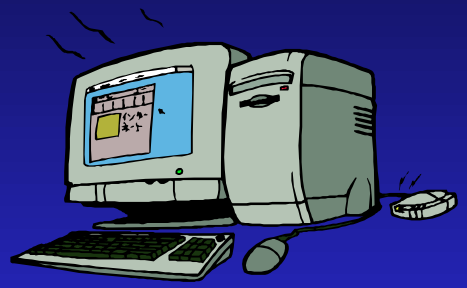
- Airplane
  - Technology base 30 – 40 years old
  - Avionics
    - Radios
    - Navigation
      - Two VOR's, ADF
    - Limited auto-pilot

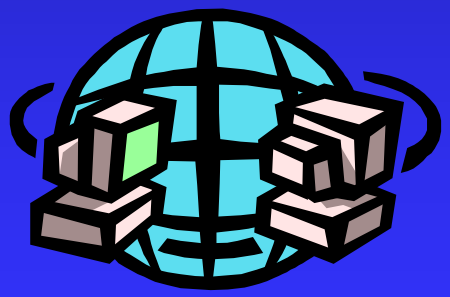
Current State (Normal)

- Instructional systems
  - Requirements are hours based
  - Limited support
    - NAFI and supporting organizations
  - Limited human factors / ADM / CRM

“State of the Art” - AGATE

- Classroom
  - Computer based
    - Multi-media CBT
    - Test preparation
  - Electronic presentations
  - Web-based
  - Multiple support systems





“State of the Art”

- Simulation
  - Flight training devices
  - Flight simulation
  - PCATDs
    - Instructional
    - Debriefing tools

“State of the Art”

- Airplane
  - Technology base 30 – 40 years old
  - Avionics
    - Radios
    - Simplified navigation
      - Global positioning system
    - Auto-flight

“State of the Art”

- Instructional systems
  - Requirements are hours proficiency based
  - Instructional support provided
    - Institutional training
    - NAFI and supporting organizations
  - Modern learning theories
  - Human factors
    - ADM / CRM an integral element

SATS Issues

- Vehicle technologies
  - HITS
  - Embedded training systems
  - Fliers education
  - Web-based training
  - Low cost integrated curriculum
    - 50 - 75% lower than today!!!

SATS Issues

- Infrastructure
  - Free flight
  - Data link
  - Smart airports
    - Seamless movement
  - Flight Information Service
  - Traffic Information Service

Background and Instructions For Breakout Sessions

Small **A**ircraft **T**ransportation **S**ystem
Planning Conference
NASA Langley Research Center
June 21-24, 1999

Project Management

"Planning is an unnatural process - it is much more fun to get on with it.

The real benefit of not planning is that failure comes as a complete surprise and is not preceded by months of worry."

Sir John Harvey-Jones

Breakout Session Objectives

- Validate/change current baseline assumptions
  - Roadmap strawman goals and objectives
  - State-of-the-Art technologies
  - Identify other technologies needed to achieve SATS vision
- Define your technology area's goals and objectives
  - Does your technology area have the "right" scope
  - Identify other technology areas needed to achieve these goals and objectives
  - Note any potential obstacles or roadblocks to achieve goals and objectives
- Define key "milestones" for achieving goals and objectives
  - Initial SATS plan will go through FY07
  - Technologies should be at least state-of-the-art
- Prioritize technologies (see next chart)
- Identify the certification issues associated with this technology area
- Don't create a detailed implementation plan

Prioritization Methodology

- Prioritize technologies into one of three categories:
  - Critical for SATS to achieve the National Roadmap goals
  - Highly desirable but not a roadblock to achieving the SATS goal
  - Would truly make SATS state-of-the-art but not necessary to achieving the Roadmap goals
- In addition, rank the SATS technologies in order of impact time frame.Technologies should be at least state-of-the-art. Impact should be considered in terms of the following time frames for payoff:
  - Near Term: 2001-2004
  - Mid Term: 2004-2007
  - Far Term: Beyond 2007
- And finally, identify the specific "Public Good" metric(s) that each technology addresses:
  - Mobility/Accessibility (the ability to go where you want, when you want, fast)
  - Capacity (Utility and efficiency of the National Airspace System including General Aviation airports)
  - Environment (Noise and emissions)
  - Safety (Real and perceived)
  - Land Use
  - Energy Use

Technology Readiness Levels

NASA Office of Aero-Space Technology

9	Actual system "flight proven" on operational flight	Product Refinement
8	Actual system completed and "flight qualified" through test and demonstration	
		Typical End of NASA Involvement
7	System prototype demonstrated in flight	Focused Program
6	System/subsystem model or prototype demonstrated in a relevant environment	
5	Component (or breadboard) validation in a relevant environment	
4	Component and/or breadboard validation in a laboratory environment	
3	Analytical & experimental critical function and/or characteristic proof-of-concept	Base R&T
2	Technology concept and/or application formulated	
1	Basic principles observed and reported	

Definitions

- State-of-the-Art
  - Cutting edge but mature technologies
  - Typically TRL 6-7
- State-of-Practice
  - Technologies that are in current, widespread use
  - Typically TRL > 9

Vehicle Technologies - Airframe
Low-Cost Manufacturing Technology

Example Output

Goal - This is a goal statement that is specific to the subject topic. An example might be, "Reduce the SAT vehicle airframe cost by an order of magnitude from $xx/lb to $yy/lb by 2008". This may come directly from the strawman SATS roadmap or the breakout session could choose to modify or completely change the strawman goals. If so, a good rationale for why should be included.

1999 Baseline - Refers specifically to today's state-of-the-art (SOA) (TRL 6-7) and state-of-practice (SOP) (TRL 9-10) in the subject breakout session topic. For example, today's aluminum manufacturing technology used in the automotive industry is certainly low cost and perhaps at a TRL of 9-10 however, the tolerances required for laminar flow may require new manufacturing processes that are today only TRL 3-4 or are very expensive. Composites are certainly new and allow nearly unlimited design freedom but what about cost? (Remember the goal). This paragraph is intended to capture the current level of maturity in both technology development (SOA) and commercial off-the-shelf products (SOP) in the subject topic area.

Objectives - This is a statement of purpose or intent and is generally more specific than a goal in that it more clearly says 'what' and 'how' the goal will be achieved for this particular breakout session topic; in this case 'airframe'. An example might be to "develop and demonstrate low cost high-volume aluminum maufacturing techniques & processes which meet stringent tolerances requirements necessary to achieve designed levels of laminar flow".

Approach - This paragraph is a general description of how the objectives will be accomplished. For example, "bring together industry automotive manufacturing designers and aerospace university faculty and students to collaborate on a SATS airframe manfacturing concept which utilizes industrial virtual design tools to simulate the manufacturing processes. The processes designed will be prototyped and used to build (in low volume) full-scale SATS vehicle parts for the flight demonstration vehicle.

Milestones - The milestones shown here are the necessary steps leading to the accomplishment of the objectives and ultimately the goal. They should be stated as deliverables and a timeframe (qtr/yr) should be estimated with perhaps one milestone per year or every two-years as a guideline.

2Q/02	Complete manufacturing processes design and simulations
4Q/03	Prototype manufacturing process assembled
3Q/04	First full-scale airframe completed using prototype manufacturing processes

Issues - During the breakout sessions, many issues will arise that cannot be resolved in the time available. The purpose of this paragraph is to capture those issues for future workshops or planning teams to discuss and resolve.

Breakout Sessions

NASA Office of
Aero-Space Technology

Topic Area	Lead	Location
Airframe	Tom Freeman	PYT, Curtis Room
Aerodynamics & Control	Harry Morgan	PYT, Shuttle Room
Propulsion	Leo Burkardt	PYT, Bell Room
Avionics	Dan DiCarlo	RCC, Main Auditorium
Training	Tom Glista	RCC, Main Lounge
CNS Technologies	Dean Resch	RCC, Hampton Room
Landing Facilities	Ken Stackpoole	RCC, Wythe Room
Airspace/Procedures/ATM	Jim Rowlette	RCC, Langley Room

PYT - Pearl Young Theater

RCC - Reid Conference Center

Understanding the Advantages and Limitations of a Government-Industry Partnership

To do together, that which we can not achieve alone….

- The trend in american business culture is toward an increased utilization of alliances
- Alliances should be utilized to:
  - Achieve strategic goals
  - Reduce Risks while increasing rewards
  - Leverage precious resources

“ Anything that won’t sell, I don’t want to invent” -Thomas Edison

- The worst trap in technology development is not in the technology but in the customers acceptance.
- SATS is a multi-faceted alliance where market acceptance requires the tiered concept (ie Gov’t, user and technology developer)

Panel

- Mr. Paul Mason- PMC and Company , San Francisco, CA
- Mr. Steve Hanvey, The Hanvey Corporation, Anderson, SC
- Mr. Jack Sheehan, Executive Director,AGATE Alliance Association

AGATE Experience

- Largest member alliance
  - Multi-disipline
  - Win-Win based
  - Outcome oriented
- Established Governance
  - Issue tested

Small Aircraft Propulsion for Personal Air Transportation

The Challenge

SATS Planning Conference

June 21-25, 1999

Leo A. Burkardt

Glenn Research Center

SATS 2001

Small Aircraft Propulsion
Technologies For The Future

2003

100 knot

250 knot

Personal VTOL
"Doorstep to Destination"
Ultra-Safe All-Weather

2010

~$25,000

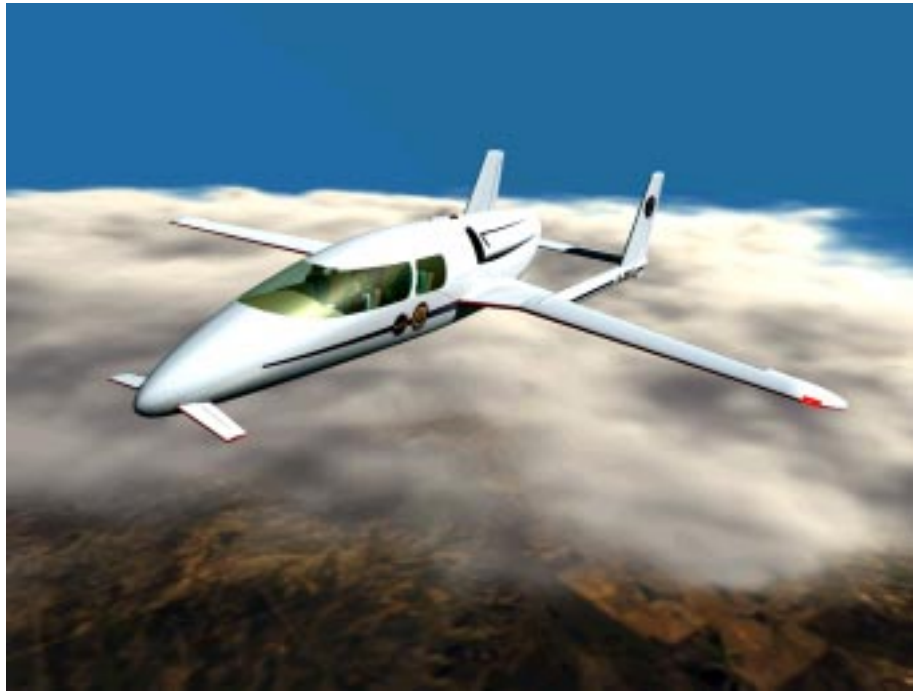
400 knot

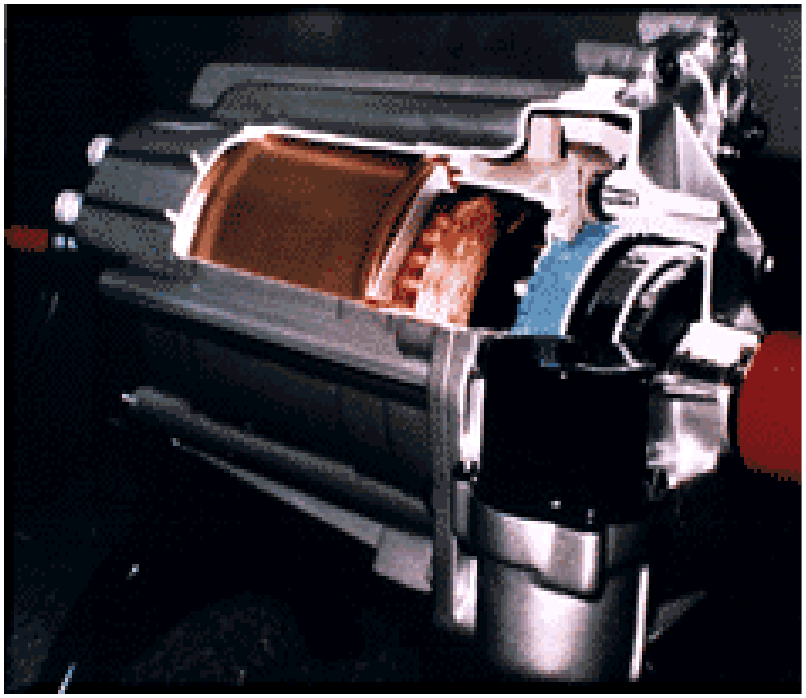
~$5,000

200 knot

- Whisper-quiet, ultra-light, low-cost propulsion systems
  - Engines
  - Propellers & Rotors
  - Transmissions with high reduction ratio gearing
- Low-cost ultra-low emissions
- Failsafe, affordable flight/propulsion Supervisor
  - Intelligent - configures & controls aircraft/propulsion system
    - = Pilot guides vehicle, supervisor flies and controls it
    - = Reconfigures systems & advises pilot when malfunction occurs
- Failsafe, low-cost composite structures

Electric Propulsion





Electric Aircraft

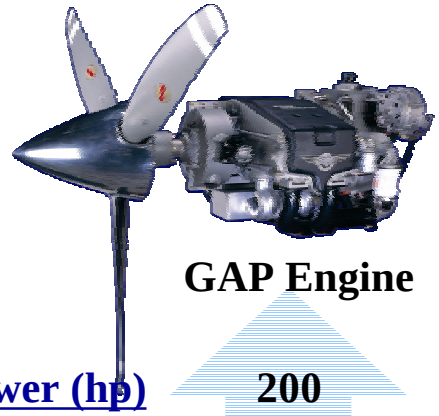
Ultra-reliable, Decoupled, Integrated
Propulsion/Flight Controls
Hydrogen Fueled
All Electric Subsystems
Proactive Health Management System

Electric Propulsion

Light Weight
Efficient
Hydrogen/Air Fuel Cell
No TBO
Ex Noise, foot print within airport
Cab Noise, like auto
Emission, “0”

Trend Setting Revolutionary Engines

(Technology Readiness Level = 6 to 7: Technology Demonstrated In 2000)



GAP Engine

FJX-2

210	Power (hp)	200		Thrust (lb)	700
350	Weight (lb)	~350	420	Power (hp)	~500
Gasoline	Fuel	Jet	195	Weight (lb)	<100
Air	Cooling	Liquid	0.66	bsfc	<0.5
0.45	bsfc	0.36	$230K (+$30K)	Cost	~$65K
$30K	Cost	~$15K	3500	TBO (hr)	5000
1800	TBO (hr)	3000	1750	Hot Sec. (hr)	2500
Noisy & Harsh	Comfort	~ -5db (external) Smooth	Noisy	Comfort	> - 5 db (external) Very Smooth

IO 360 ES

Allison 250-B17C Turboprop

Materials

Ceramics

- 2001 SOA (typical material - AS800 (Si_3N_4)
  - 2000 to 2100˚F gas temp. (With long life)
  - Fairly blunt leading and trailing edges
  - Susceptible to oxidation and FOD (foreign object damage)
  - Expensive to manufacture

- 2007 Desired SOA
  - 2200 to 2300˚F gas temp. (With long life)
  - Aerodynamically efficient shape
  - Oxidation/erosion and FOD proof
  - Low-cost manufacturing

- Challenges
  - Life prediction tools
  - NDE for small parts with complex shapes
  - Design airfoil to prevent oxidation, erosion and FOD from causing unacceptable damage while maintaining efficient aerodynamics
  - Rapid prototyping and low-cost manufacturing methods

Materials

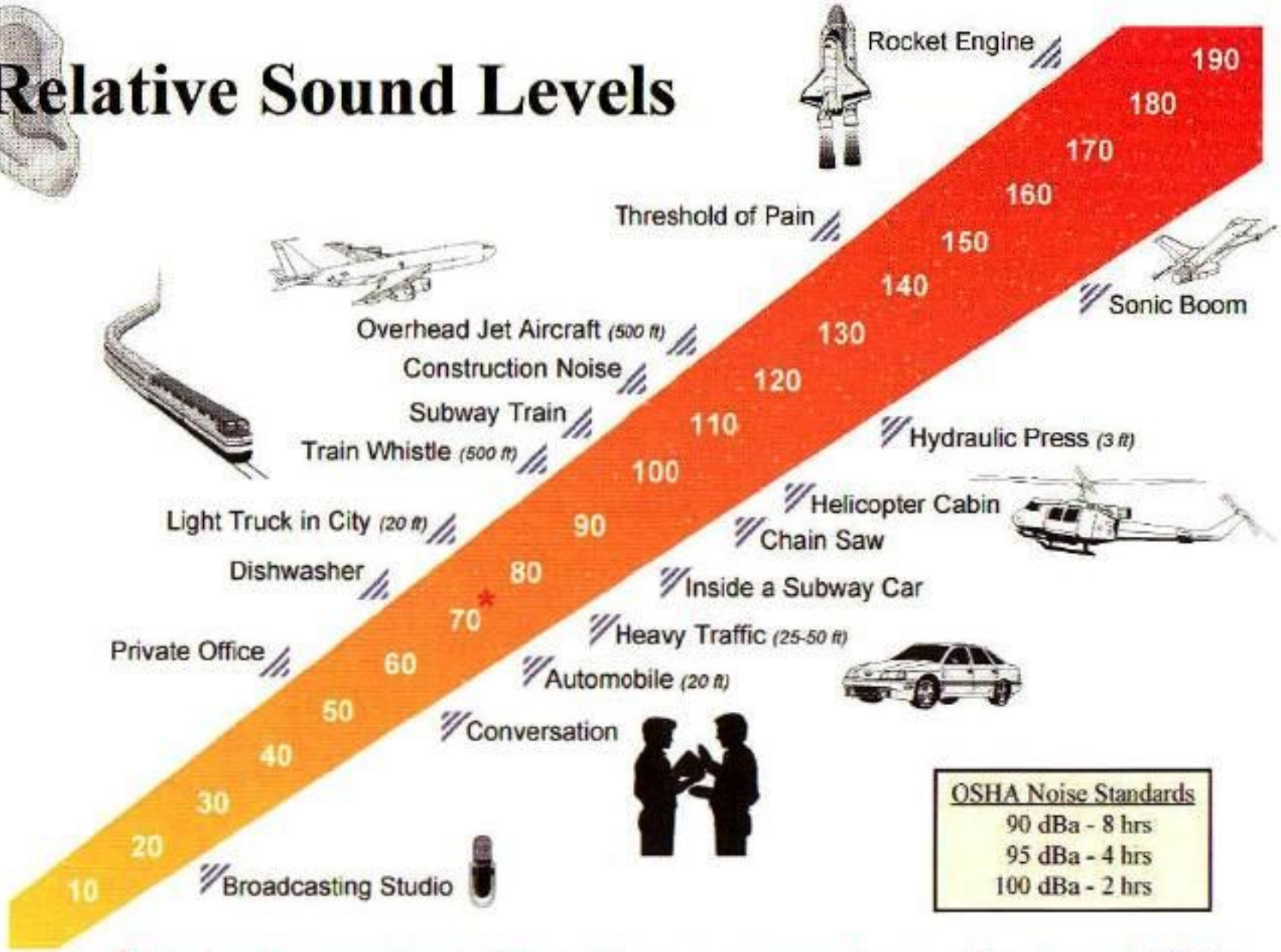
Polymer Matrix Composites

- 2001 SOA (typical material - PMR-15)
  - 500˚F material temp. (long life)
  - Very expensive, especially manufacture of complex shapes
  - Moisture absorption may be a problem for some applications and effect durability and decrease upper use temperature
  - Toxicity of some starting materials can pose health risks in manufacturing and repair
  - FOD tolerance

- 2007 Desired SOA
  - 650 ˚F material temp. (long life)
  - Low-cost materials and manufacturing methods
  - Non-toxic starting materials
  - Low cost, reliable repair techniques
  - Reliable, efficient life prediction tools
  - FOD proof

- Challenges
  - Life prediction tools
  - NDE for small parts with complex shapes
  - Coatings and chemistry for long term stability
  - Protection from and/or robustness to FOD
  - Repair methods
  - Low-cost manufacturing methods

Relative Sound Levels



OSHA Noise Standards
90 dBa - 8 hrs
95 dBa - 4 hrs
100 dBa - 2 hrs

*** Hearing loss may begin with continuous exposure to sound levels over 75 dBa**

Noise

- 2001 SOA
  - Fixed Wing GA (4 to 6 PAX Light Aircraft)
    - = Exterior fly over - 70 to 75 dbA
    - = Interior - 90 to 100 dbA
  - Helicopter
    - = Exterior take off - 90 dbA
    - = Interior - > 100dbA

- 2001 SOA
  - Fixed Wing GA (4 to 6 PAX Light Aircraft)
    - = Exterior fly over - 65 to 70 dbA
    - = Interior - 60 to 65 dbA
  - VTOL
    - = Exterior take off - 65 to 70 dbA
    - = Interior - 60 - 65 dbA

- Challenges
  - Efficient low tip speed propellers and rotors
  - Low-noise fan and duct/nozzle technology
    - = Blade shapes, spacing, etc.
    - = Noise absorption technology
    - = Active noise control technology
  - Low noise gears
  - Propulsion structural noise and vibration isolation from cabin
  - Low-cost interior active noise control methods

Bearings, Gears and Transmissions

Bearings

- 2001 SOA
  - Turbine Engines
    - = Oil lubricated roller element bearings
  - Piston Engines
    - = Oil lubricated journal and roller element bearings
  - Transmissions/Gearboxes
    - = Oil lubricated journal and roller element bearings
- 2007 Desired SOA
  - Turbine Engines
    - = Air bearings (e.g., foil bearings)
  - Piston Engines
    - = Low Oil bearing systems
  - Transmissions/Gearboxes
    - = Low Oil bearing systems
- Challenges
  - Incorporating foil bearings in to complex shaft systems
  - Scaling foil bearings upward in size
  - Reducing weight, cost and power consumption of magnetic bearings
  - Advanced journal bearing technologies
  - Fluid management optimization

Bearings, Gears and Transmissions

Transmissions/Gearboxes

- 2001 SOA
  - Power output
    - = ~20 hp/lb (inline)
    - = ~15 hp/lb (offset)
  - ~$21/hp cost

- 2007 Desired SOA
  - 50% weight reduction in lube sys.
  - 20% weight reduction gearbox
  - 50% cost reduction

- Challenges
  - Fluid management optimization - minimize lube system requirements for packaging and weight reduction
  - High-ratio gear components and configuration technologies - component and system arrangements that permit very high gear ratio capability
  - Lightweight materials
  - Alternate mechanisms (e.g., belt drive, toroidal drive, etc.)

Small Turbomachinery

- 2001 SOA
  - Axial Compressor
    (~2 lb./sec. flow rate, 5:1 pressure ratio)
    = 79% adiabatic efficiency
  - Centrifugal Compressor
    (~2 lb./sec. flow rate, 8:1 pressure ratio)
    = 80% adiabatic efficiency
    (~2 lb./sec. flow rate, 4:1 pressure ratio)
    = 83% adiabatic efficiency

- 2001 SOA
  - Axial Compressor
    (~2 lb./sec. flow rate, 5:1 pressure ratio)
    = 81% adiabatic efficiency
  - Centrifugal Compressor
    (~2 lb./sec. flow rate, 8:1 pressure ratio)
    = 81% adiabatic efficiency
    (~2 lb./sec. flow rate, 4:1 pressure ratio)
    = 84% adiabatic efficiency

- Challenges
  - Manufacturing of small components
    = Small clearances
    = Surface finish
    = Part thickness
    = Low cost
  - Turbines
    = Increased loading
    = Low Reynold's number in aft stages

Controls and Health Monitoring

- 2001 SOA
  - Single lever power control
    - = Engine protected from misuse
  - Simplified/integrate cockpit readouts
    - = Can drive multifunction flat panel
  - Diagnostic system readout to ground computer after flight
    - = Fault isolation
    - = Trend analysis
  - ~$10,000 for full system (FADEC, displays, diagnostic system)

- 2001 SOA
  - Integrated Aircraft/Propulsion Supervisor
    - = Pilot inputs direction and speed (could be point-to-point flight plan)
    - = Supervisor controls and reconfigures aircraft/propulsion
    - = Supervisor advises pilot of abnormal aircraft/propulsion operation, reconfigures as necessary and recommends pilot action
    - = Supervisor advises pilot of external situation issues (weather, traffic, obstacles, etc.) at minimum
  - Order of magnitude cost reduction

- Challenges
  - Certification of COTS components
  - Order of magnitude reduction in sensor and actuator cost (Sensors are major cost driver)
  - Development of, and incorporation of Fault-Tolerant Control technology and fast, robust, “intelligent” controls and diagnostics
  - Bulletproof software and automated software development processes
  - Development of natural, intuitive human machine interfaces

Electric Propulsion

Fuel Cells

- 2001 SOA
  - Cost ~$500 per kw
  - Power output
    - = ~1 kw/kg
    - = ~1 kw/liter
  - 3000 hr life

- 2007 Desired SOA
  - Cost ~$50 per kw
  - Power output
    - = ~2 kw/kg
    - = ~2 kw/liter
  - 3000 hr life at high power density

- Challenges
  - Low cost materials and manufacturing methods for electrodes, electrode catalyst, membrane and bipolar plates
  - Lightweight materials
  - Certification

Electric Propulsion

Motors & Actuators

- 2001 SOA
  - Heavy

- Challenges
  - Lightweight materials
  - Efficient heat dissipation
  - Certification

- 2007 Desired SOA
  - Light weight

VEHICLE TECHNOLOGIES SUMMARY & DISCUSSION

James R. Burley II
SATS Planning Lead for Vehicle Technologies
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Small Aircraft Transportation System (SATS) Planning Conference
NASA Langley Research Center
Hampton, Virginia
June 21-24, 1999

Vehicle Technologies
Outline

- **Summary ~ 45 min**
  - General Comments & Observations
  - Vehicle Technologies
  - Issues & Obstacles
  - Back-up charts (goals, objectives, milestones, etc. “one-pagers” for each technology)
- **Discussion ~ 45 min**
  - Vehicle Technology Leads form “Panel of Experts”
  - Prepared questions to start discussion
  - Opportunity for ‘Infrastructure Technologies’ participants to query ‘Vehicle Technologies’ Panel

Vehicle Technologies
General Comments & Observations

- Common themes/concepts
  - "Operator-centric" goals…ease-of-use, cost, utility …lots of automotive analogies
  - AGATE-like approach (i.e. partnerships & alliances)
  - Issues are primarily cost/legislative/regulatory in nature, with some technological challenges (ex. liability, certification)
  - No vehicle technology obstacles!
- Differences
  - Fixed-wing vs. fixed-wing and/or rotorcraft(VTOL)
  - Flight Deck Automation - from "commercial-transport-like" to "take me to Atlanta, Ga."

"Non-pilot operators" of the future will be to SATS …what today's pilots are to AGATE

Airframe Technologies

- Low Cost Manufacturing Technologies
  - Automation
- Material & Component Certification
- Center of Design & Manufacturing Excellence
- Virtual Design & Manufacturing (Tools)
- Ice Protection
- Cabin Noise

Airframe Issues & Obstacles

- Customer Travel reliability requirements vs. cost
- Probability of planned departure/arrival at destination considering aircraft icing
- Cost of ice-protection system
  - Certification
  - Manufacturing
  - Maintenance

Propulsion Technologies

- Materials
  - Ceramics
  - PMCs
  - Metal & MMCs
- Noise
- Bearings, Gears, and Transmissions
- Fuels & Combustors
- Small Turbomachinery Manufacturing & Design
- Controls & Health Monitoring
- Electric Propulsion

Propulsion Issues & Obstacles

- Low-Cost Manufacturing Methods
- Long-life, High Temp. Materials
- Interior & Exterior Noise & Emissions
- Low-cost, “Bullet-proof”, Intuitive Automation Software/hardware
- Liability & Certification

Flight Controls Technologies

- No Aerodynamic Technology Development needed (Fixed-wing Only)
- Man/Machine Interface
- Fly-by-wire digital flight controls
- Decoupled Controls (no direct connection between control “stick” and control surface)
- Software Verification & Validation

Flight Controls Issues & Obstacles

- Risk that focus may be technologies and airplanes instead of operator's ease of use and accessibility to SATS
- The level of simplification required for acceptable operation with low training requires full time, full authority, fly by wire. This will require a substantial paradigm shift.
- The threat of litigation to new technologies that enhance safety in unfamiliar ways is significant and may block implementation.

Avionics Technologies

- Simplified controls for operation
- Intuitive operator interfaces
- Sensors
- Flight management
- Conflict detection and resolution
- Collision avoidance
- Avionics Open Architecture
- Virtual VFR
- Active noise reduction
- Communication (2-way)
- Smart airplane

Avionics Issues & Obstacles

- What does affordable mean? What is the pricing model (individual SATS airplane purchase vs. shuttle service)?
- Certification – low-cost, timely certification of software and hardware
- Data link – international spectrum issues, single data-link platform to perform all functions?

Training Technologies

- Web based training systems
- Embedded training
- Virtual Reality
- Integrated PCATD
- High School “Flyer’s Education”
- Immersion training

Training Issues & Obstacles

- Aircraft configurations/operating systems not consistent
- Technologies (vehicle, CNS/ATM, airport, and/or training) will not be developed in a timely manner.
- Required certification change processes takes too long
- Over dependency on automation
- Insufficient flow of information between technology development teams
- Transition from current operations to SATS environment
- Current regulations do not allow for:
  - The reduction in training time
  - Proficiency based training
  - Use of simulators/flight training devices/ PCATDs to a level required to meet the SATS goals
  - Electronic evaluation of proficiency

Questions & Discussion

Vehicle Technologies
Prepared Questions

- Should rotorcraft/VTOL be considered as part of the SATS vehicle model?
- What is the proper level of automation that SATS should strive to achieve by 2008?

Back-up Charts

Vehicle Technologies - Aerodynamics and Control

Intuitive Control of the SATS Aircraft

Goal - Increase attractiveness of personal air travel by reducing accidents, life-cycle costs through reduction of training requirements and operator workload by developing intuitive flight control systems. Intuitive and automatic flight controls, along with cockpit design, support a goal of one week's training to make aircraft operations as approachable as any business skill. In this way the capacity of the nation's transportation system is expanded.

1999 Baseline - Operation of today's aircraft is nonintuitive and generally requires at least 200 hours and two years of specialized training. Continuing proficiency training requires about six dedicated annual flights. The flight controls in today's state-of-practice aircraft do not prevent stall and spin entry or structural overloading. Current state of the art includes the basic technologies required to meet our goal. Implementation of these technologies is currently blocked by significant cost and regulatory barriers. These technologies are at a TRL of 4 or 5.

Objectives - Develop decoupled control systems, envelope protection, and auto land capability to increase safety and enhance ease of operability. Develop handling qualities and reliability GS&Cs (design guidelines, standards and certification requirements) for flight controls systems.

Approach - Current accident data will be used to determined flight control and workload related accident rates. The results will be used to predict accident rates associated with intuitive flight controls systems, quantifying the potential to save lives. If the accident data studies demonstrate significant safety potential, human factors will be investigated using flight and ground based simulation experiments to establish improved situational awareness, lower workload, and lower training requirements. A POC/research vehicle will be developed for validation of technologies and marketability. A government industry task force will be convened to write appropriate FAA regulations to support implementation of advanced intuitive flight controls systems.

Milestones - The following milestones are required for implementation

Q4/00	Begin SATS program
Q2/01	Accident data investigation
Q2/01	First flight of POC/research vehicle
Q4/02	completion of ground based simulation of human factors
Q2/04	Completion of flight based human factors study
Q3/06	Completion of the regulatory task force work
Q2/07	GS&C completed

Issues/Obstacles - No hard technical or time constraints restrict completion of this goal. There is a risk that the focus may settle on technologies and airplanes instead of focusing on the operator's ease of use and accessibility to the SATS.

- The level of simplification required for acceptable operation with low training requires full time, full authority, fly by wire. This will require a substantial paradigm shift.
- The threat of litigation to new technologies that enhance safety in unfamiliar ways is significant and may block implementation.

Design for Manufacturing & Assembly

Small Aircraft Transportation System
Planning Conference
June 21-24,1999 Hampton, Virginia

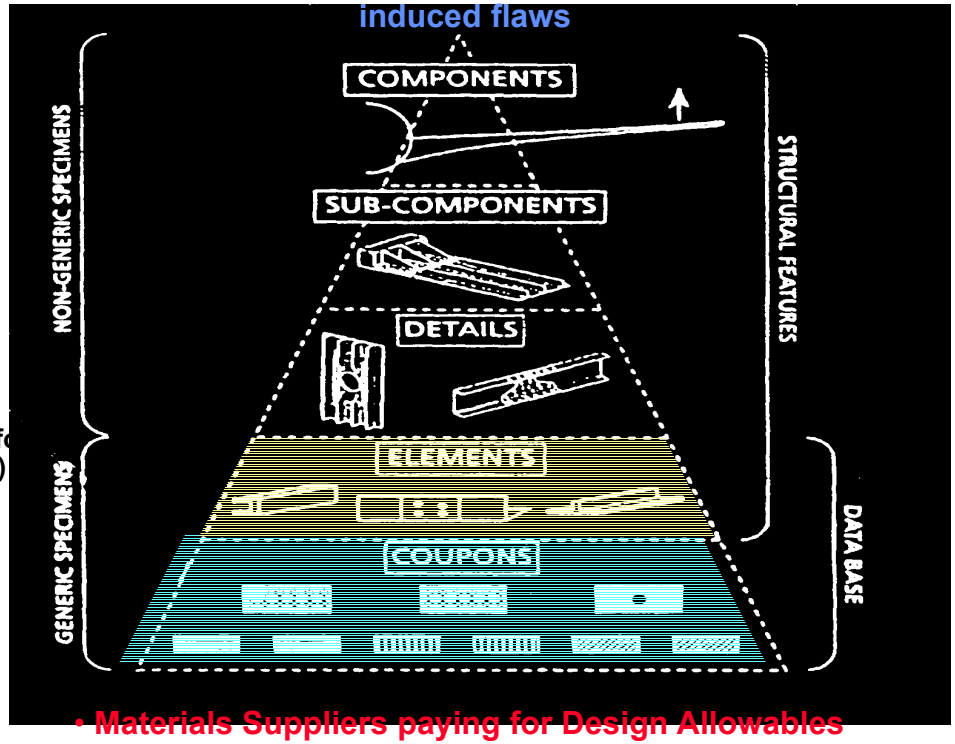
W. Tom Freeman

State of The Art (SOTA) - Materials Research

Building Block Substantiation for Adv. Mtl. Forms, Mfg. Processes & Design Concepts

- **Why Building Blocks?**
  - Material & process control
  - Analysis validation
  - Risk mitigation for design-specific detail
  - Variability & environmental factors for full-scale test substantiation
- **What is the right scale to start?**
  - Most efficient path
  - Variability vs. scale
- **Proposed engineering approach**
  - Start at the product rather than material level
  - Breakthrough savings (mfg. tech. &/or low-cost mtl.)
  - Adv. analysis based on strain softening & dissipated energy to generate failure envelopes in forms suitable f engineering analysis (VMT shell & beam analysis or FE)

Design Imperfections
Manufacturing
induced flaws



No AGATE Research
Start FY 2000
Complete

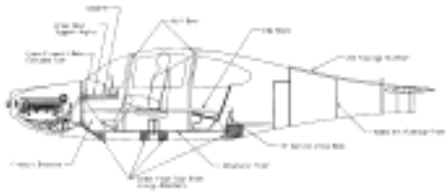
RITA notched data

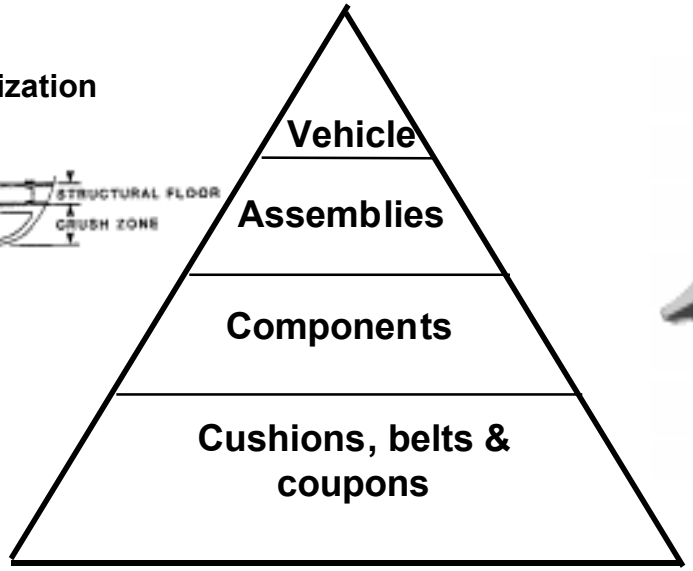
- Materials Suppliers paying for Design Allowables
- Materials Equivalence
- Reduce vendor "monopoly" with respect to a particular aircraft model - Airframer may switch suppliers based upon price, supply schedule, etc.

SOTA - Crashworthiness Research

Building Block Substantiation for Crashworthiness Certification

- **Why Building Blocks?**
  - Analysis validation
  - Risk mitigation for design-specific detail
  - Variability factors for full-scale test substantiation
- **Proposed engineering approach**
  - Start at the product rather than material level
  - Breakthrough savings (cert. &/or flow-time)
  - Adv. analysis based on component characterization
  - A true Systems Approach

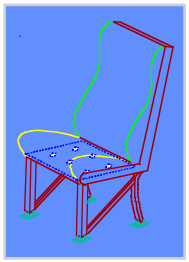


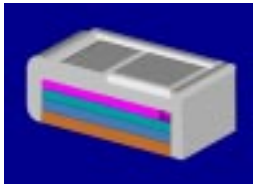


SOTA 2001

Low-cost fuselage design featuring:

- Impenetrable Occupant Volume Capsule
- Energy absorbing structure below cabin floor
- Non-scooping firewall
- Crashworthy engine mount & nacelle
- Delethalization interior with airbags & restraints





SOTA - Ongoing Certification Programs

Cirrus Design Corporation SR20

- FAR Part 23
- 184 mph
- 4 place
- unpressurized
- foam sandwich construction
- hand layup - prepreg
- vacuum bag / oven cure

State Of The Art - Kit

LANCAIR IV-P KIT COMPLETE AIRFRAME $100,800.00

Lancair 4P

- Kit - Experimental
- 335 mph cruise speed @ 24,000 ft
- 4 place
- pressurized
- honeycomb sandwich construction
- hand layup - prepreg
- vacuum bag / oven cure

Continental TSIO-550E1B 6 cylinder, 350 hp @ 2700 rpm $54,900.00

<u>Props</u>
Hartzell aluminum or MT composite constant speed props are recommended. Spinner, backup plate and mounting plate included. MTV-14-D 4-blade for TSIO-550, 75“ $11,240.00

SOTA -2001

- Order of Magnitude of Airplane Sales
  - Used - 30,000/ yr
  - New kits - 1 to 2X Certified
  - New certified - 1500 to 2000
    - »Everybody that can afford a Rolls Royce has one
    - »Pilots license cost = chauffer cost
    - »Fractional ownership of a Rolls
- Technology today
  - Emphasis on product design with limited number of low volume suppliers
  - All Technology adequate for the enthusiast
  - 5 Years of AGATE -
    - »Outstanding Technical Achievements
    - »Perceived increase in safety
    - »Cost more?

SOTA - 2008?

- Pillar II - Revolutionary Leaps?
  - Turbine
    - » "Turbines will do for GA what they did for Commercial Aircraft"
  - Computer Hardware & Software
    - » Intel 5 ghz processor

SATS Investment - Bold Cost Reductions

  - Compelling Vehicle Price
    - » Henry Ford of GA
  - Regulatory Revitalization Partnership

- SAE Aerospace Manufacturing Technology Conference & Exposition
  - Building the 21st Century Global Aerospace Manufacturing Enterprise

Personal Transportation by Design

SATS

- **Manufacturing Progress**

  Craft - Automated - Lean - Just in time - Kaizen

- **Product Design Focus**
  - » Silos of engineering, manufacturing, cost estimation, etc
  - » Serial Process
    - – When aero is done - structures starts - manufacturing & cost estimation last
  - » Craft production assembly of a collection of handmade parts from low volume suppliers
  - » Sequential manufacturing processes - bottlenecks throttle the whole factory

- **System Design Focus**
  - » Lean design and manufacturing principles with value chain and supplier initiatives.
  - » Parallel Process
    - – CAD 3D model shared with all suppliers and modified real time
  - » Best supplier from high volume industries

Outcome by Design

- **Design for**
  - Improved Safety
    - » Crashworthiness
  - Automation
  - Supportability & Repair
  - Reliability
  - Lean Manufacturing & Assembly - minimum waste
    - Min parts, processes, tools, and assemblies, parts are self-aligning and self-fixturing, no threaded fasteners, less inventory, less QA, best suppliers selected (internal vs external)
  - Lean design - Lean engineering - Lean thinking
    - » - quest for ruthless simplicity
  - Lean suppliers - Supply chain management
  - Value chain - Value mapping
- **Benefit**
  - » Maximize Margin
    - » Fertilizer for growth & catalyst for new products
  - » Affordable Products

Chrysler VP of Manufacturing- Dennis Pawley

- **From govt. bailout to highest margin in the industry**
- **Managed 90,000 people in 54 plants**
- **Chrysler Operating System - Bridges Philosophy and Reality**
  - » **No product is technically successful unless it's financially successful**
  - » **Culture change - the battle for peoples minds**
    - **Lean manufacturing pulls the rest of the corporation**
  - » **Manufacturing *push org* to a pull org.**
    - ***Stage 1 Necessary evil to make stuff***
    - ***Stage 2 Competent - adhere to industry standards***
    - **Stage 3 Potential competitive asset**
    - **Stage 4 Strategic weapon - delivers competitive advantage**
  - » **Design must select robust, capable and in-control processes**
  - » **Everything contributes to bottom line**
- **Retired from Chrysler - President of Performance Learning**
- **Interested to assist with SATS**

Ford Corporate Coordinator for DFM- Sandy Munro

- **"The design process is the only step in the product cycle where value and profit can be created"**
- **"Product design, which accounts for only 5% of a product's total cost, actually dictates 70% of the products total manufacturing cost and 90% of it's life cycle cost."**
- **"Design Engineering has much more leverage to reduce labor costs at the beginning of the design process than industrial engineering has at the end of the process"**
- **"Material, tooling and overhead savings from eliminating parts dwarfs the savings in assembly labor"**
- **"Design determines not only product manufacturability and quality, but reliability and serviceability as well"**

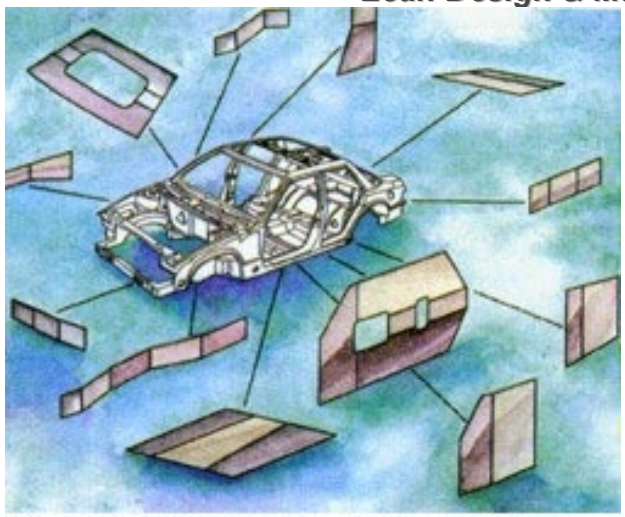
Sandy Munro- De$ign Prophet - De$ign Profit

- **"Designs are a life sentence to the factory floor"**
- **"To leap-frog ahead of your competition, you must break the *what worked for us before will work again* syndrome."**
- **"The team must be multi-functional and include profound knowledge from people outside the normal pool" Time and time again the best ideas come from outsiders who couldn't possibly know anything that would help.**
- **"The Learning Curve is a crutch for a bad design" "Cars used to take 6 months to get to line speed - new designs get to line speed in one day."**
- **"Honor the competition to find out how you can leapfrog them."**
- **Interested to assist with SATS**

ALCOA & Audi A8

SATS

Lean Design & Manufacturing



The use of tailor welded blanks results in weight and cost reductions by enabling engineers and designers to put strength or thickness only where it is needed.

Selling Price =$70K =$19/lb

Automotive Research

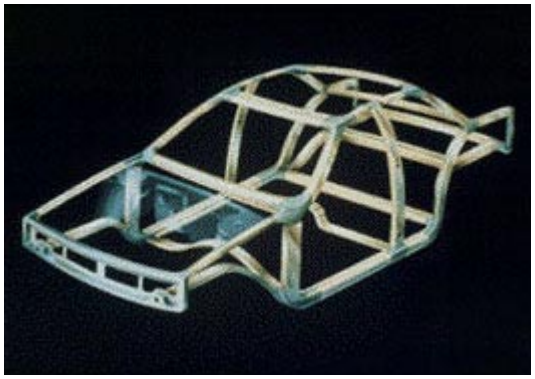
SATS

Lean Design & Manufacturing

Consortium of 30 steel companies invested $20M to "prove steel's preeminence" ULSAB

Steel $989/451lbs = $2.20/lb

Made entirely from carbon fiber composites, General Motors' Ultralite body structure weighs only 420 pounds. The carbon fiber material is half the weight of aluminum -- yet has two times the stiffness. It also has one-quarter the density of steel with slightly better stiffness. However, the material cost alone for the Ultralite structure was approximately $13,000 -- several times the cost of aluminum, steel or fiberglass.



Aluminum

2 Piece (50+Parts)
Material / Labor cost
235 lb (ALCOA?)

Orders of Magnitude

SATS

• Car Body	≈ $650 STEEL	≈$5000 Alum	≈$25,000 Gr Comp
• GA Fuselage	≈ $24,000 Alum	≈$50,000 GI Comp	
• Car Assembly Labor	< 20 mh Steel		
• GA Assembly Labor	≈ 500 mh Alum	≈1500 mh Comp	
• Car Total Labor	≈ 150 mh Steel		
• GA Total Labor	≈ 1200 mh Alum	≈2,500 mh Comp	

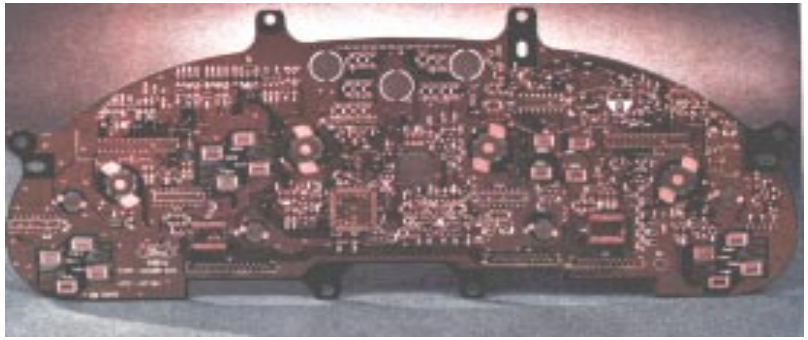
• Minivan	Steel	Price/lb ≈ $5	≈ 250,000/year volume
• Prowler	Alum	Price/lb ≈ $15	≈ 1,500/year volume
• Audi A8	Alum	Price/lb ≈ $19	≈ 10,000 year volume
• Viper	Comp	Price/lb ≈ $20	≈ 1,500/year volume
• GA	Alum	Price/lb ≈ $100	≈ 200/year volume

- Automotive Research must meet severe cost restraints.
- High Value GA parts offer profit potential that's higher than sports cars.
- Would automotive suppliers produce to GA specifications?
- GA outlet until experience, tooling amortization, and volume reduce cost.
- GA companies should participate in PNGV, SAE, etc. - Near Term customer for auto research products

Automotive Research - Lean Assembly

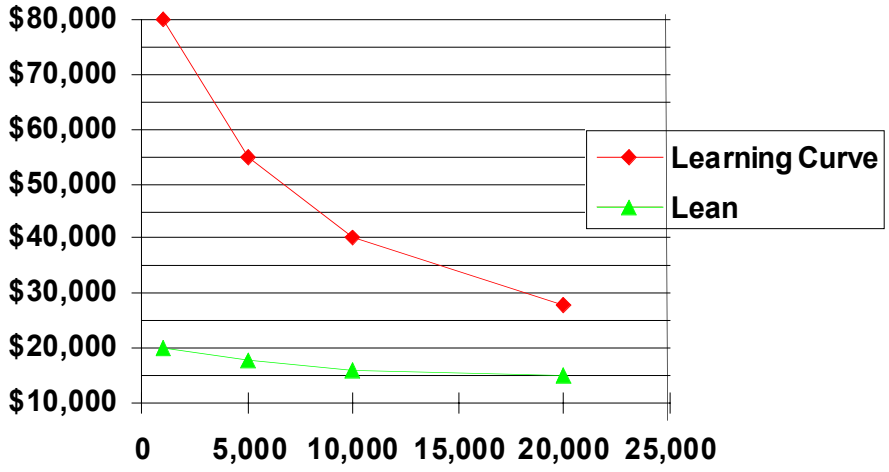
SOTA

Thermoplastic Instrument Panel
Circuit Boards



Digital Dashboard - "Motherboard"

Standards



Learning Curve vs Lean Thinking

Supply Chain in the Internet Era

- **Paradigm Shift from Cost to Profitable Growth**
  - **Internal Efficiency extends to External Trading Effectiveness**
- **Velocity increases as Internet compresses Planning and Execution cycles**
- **Trading Relationships become critical**
- **Information replaces Inventory**
- **Solutions eclipse Products**

Summary

- Foster environment for continual safety improvement & focused funding for increased safety
- Individual company serial learning vs multi-industry lessons learned collaboration
  - Must facilitate tech transfer - travel- consultants- touring facilities, etc.
- Design & Simulation center @ a university to provide expert training for fractional ownership of world class lean design capability
  - System Design Incubator & Lean Lessons Learned Repository for cumulative knowledge, simulation tools, etc.
    - » Convert 4 year education into an internship for students
- CATIA Knowledgeware

Summary Cont.

- Multidisciplinary design optimization tools with lean thinking - ISE Integrated Synthesis Environment tools
- Airbus Service Company President & COO
  - "Objective of lean enterprise plan is to transform the organization into a world class design & manufacturing facility that produces high quality affordable products maximizing the principles of flow, density, & velocity."
- COSTRAN

- Manufacturing technology funding for automation and machine tool development for composite processes
- GA optimum testbed for cost effective prototyping new technology

- Technology Incubation - "When the Markets Ready"
  - Design SATS Vehicle as an integrated system with lean principles
  - Economic Leapfrogging
  - Bankrolling Change - Travel, Suppliers, auto conventions, PNGV, etc.

OCT 24 '98
AM 11:25

OCT 24 '98
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AOPA
OCT 24 '98
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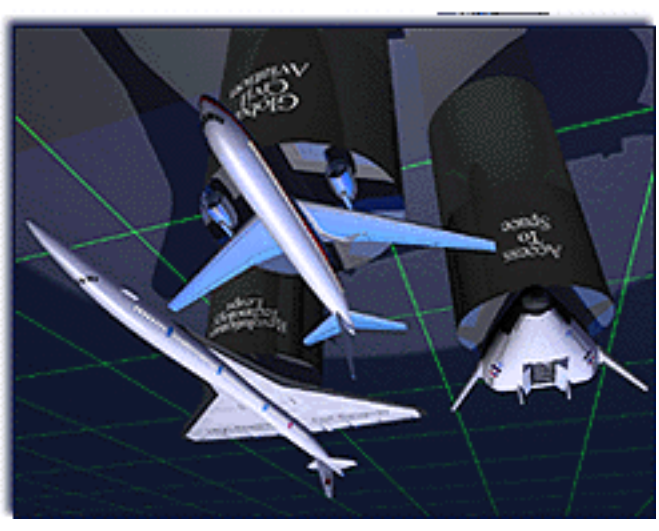
AGATE

NASA INDUSTRY FAA

ADVANCED GENERAL AVIATION TRANSPORT EXPERIMENTS


Access to Space
Global Civil Aviation

Global Civil Aviation

Revolutionary
Technology Leaps

Access to Space

OCT 23 '98
AM 11:14

100 kts
ATIS

AOPA
OCT 23 '98
AM 11:28

OCT 23 '98
AM 11:32

Demographics

Survey

Demographics

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Survey Address

If you have not taken the AGATE survey, please do so now so your views may be heard by those designing a Safe Small Airplane Transportation System. The web address of the site and survey is:

http://apats.org

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Introduction

Preliminary Observations from Survey Data

(http://apats.org)

Current To:

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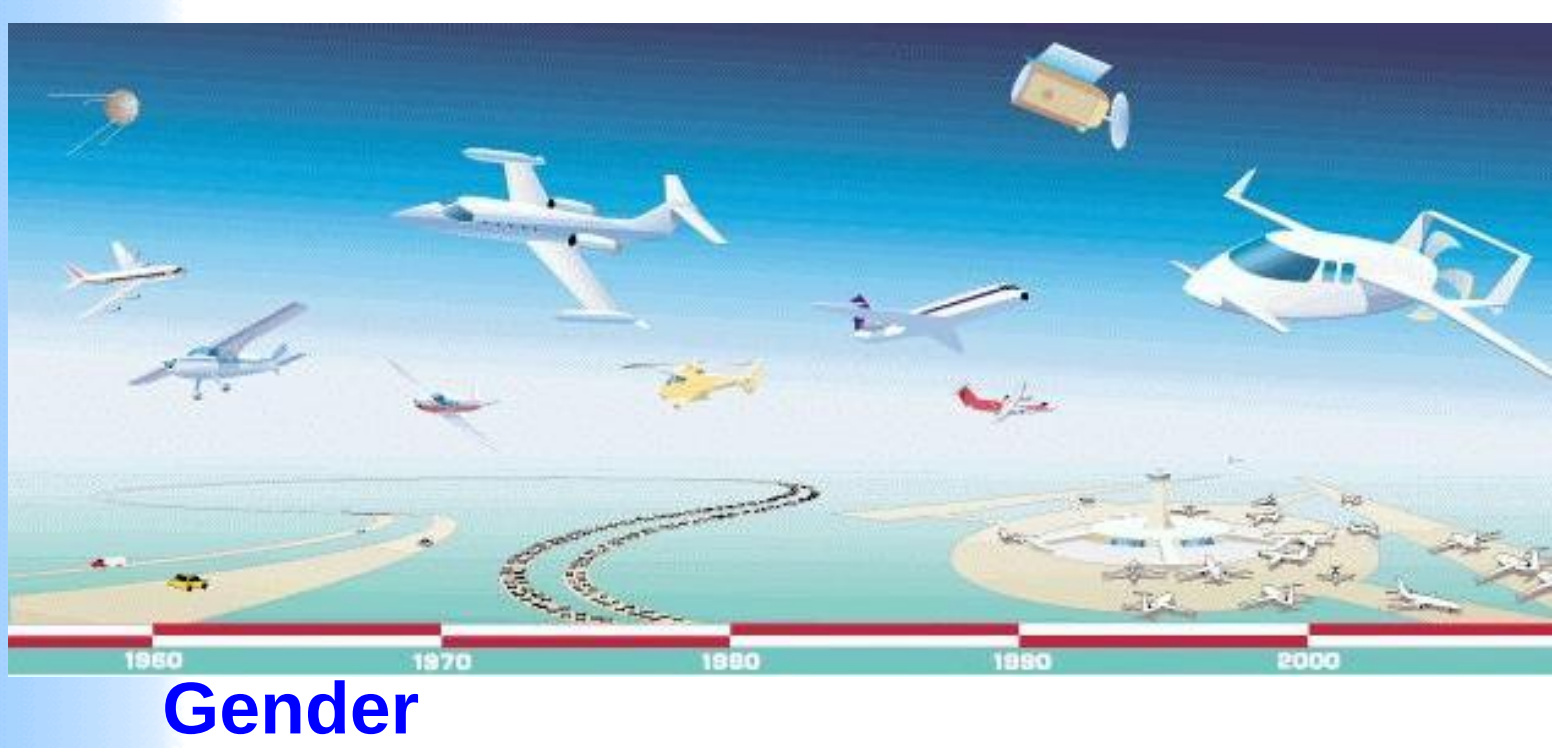

Gender

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Age

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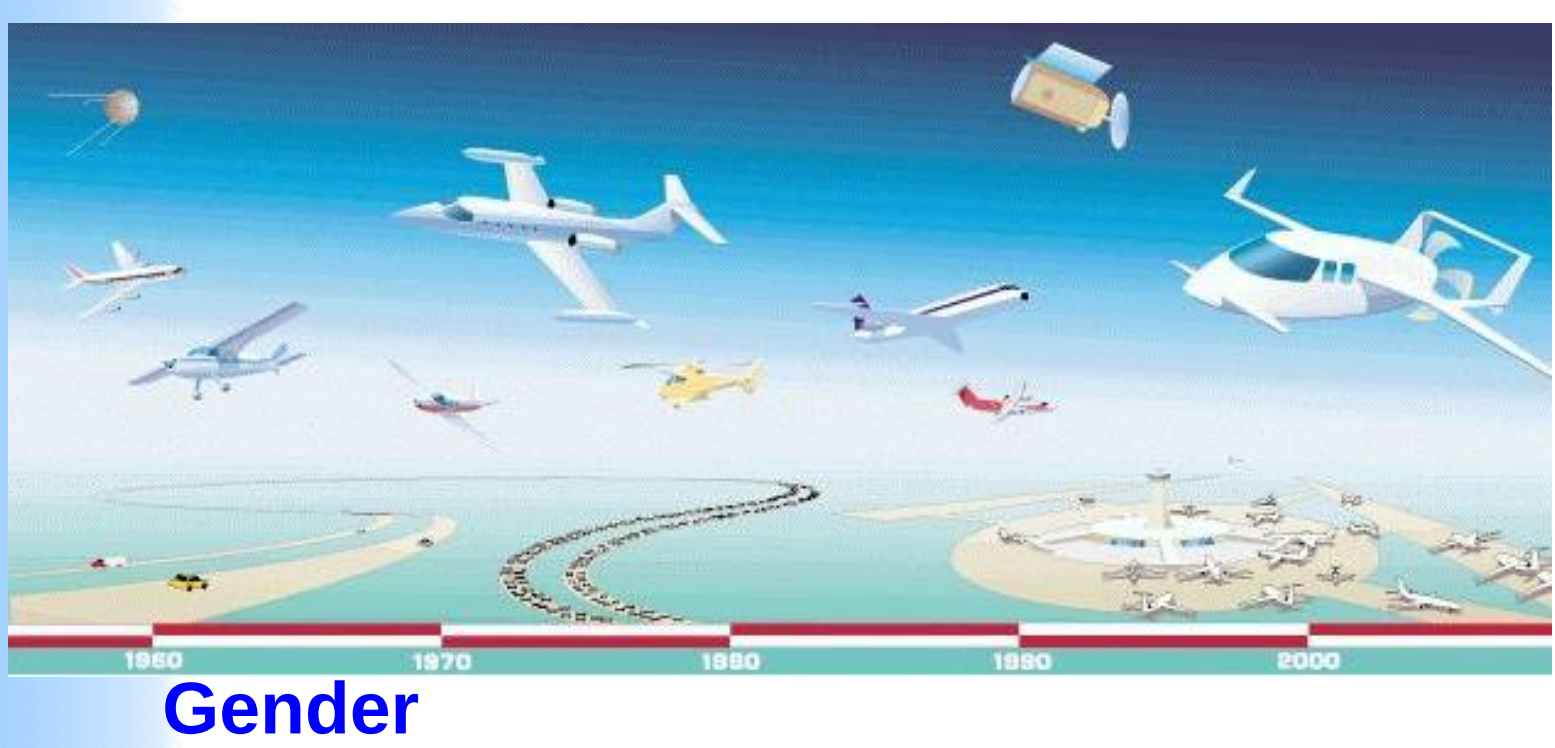

Gender

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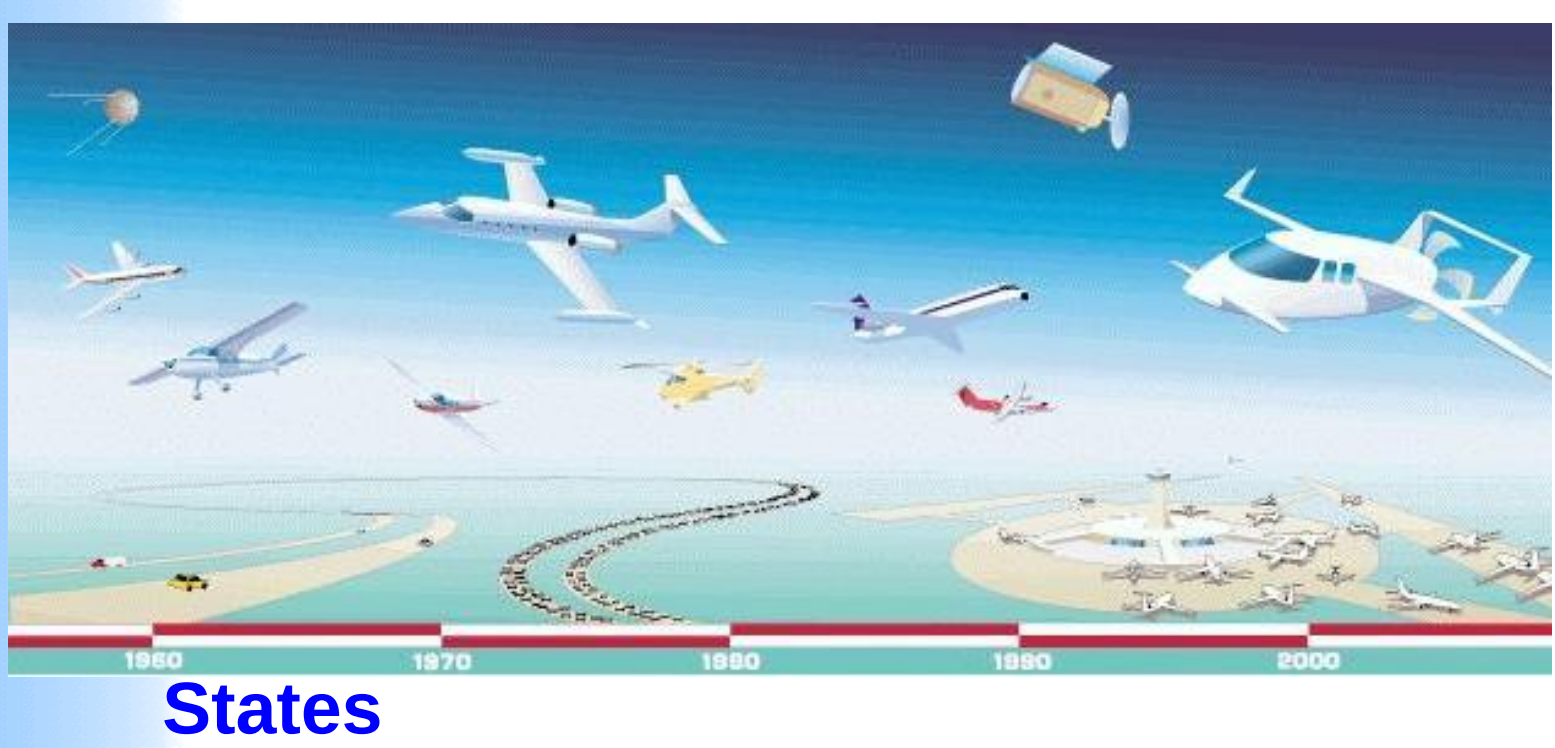

States

Survey

Respondent

Distribution

by

State

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Country

Survey Respondent Distribution by Country

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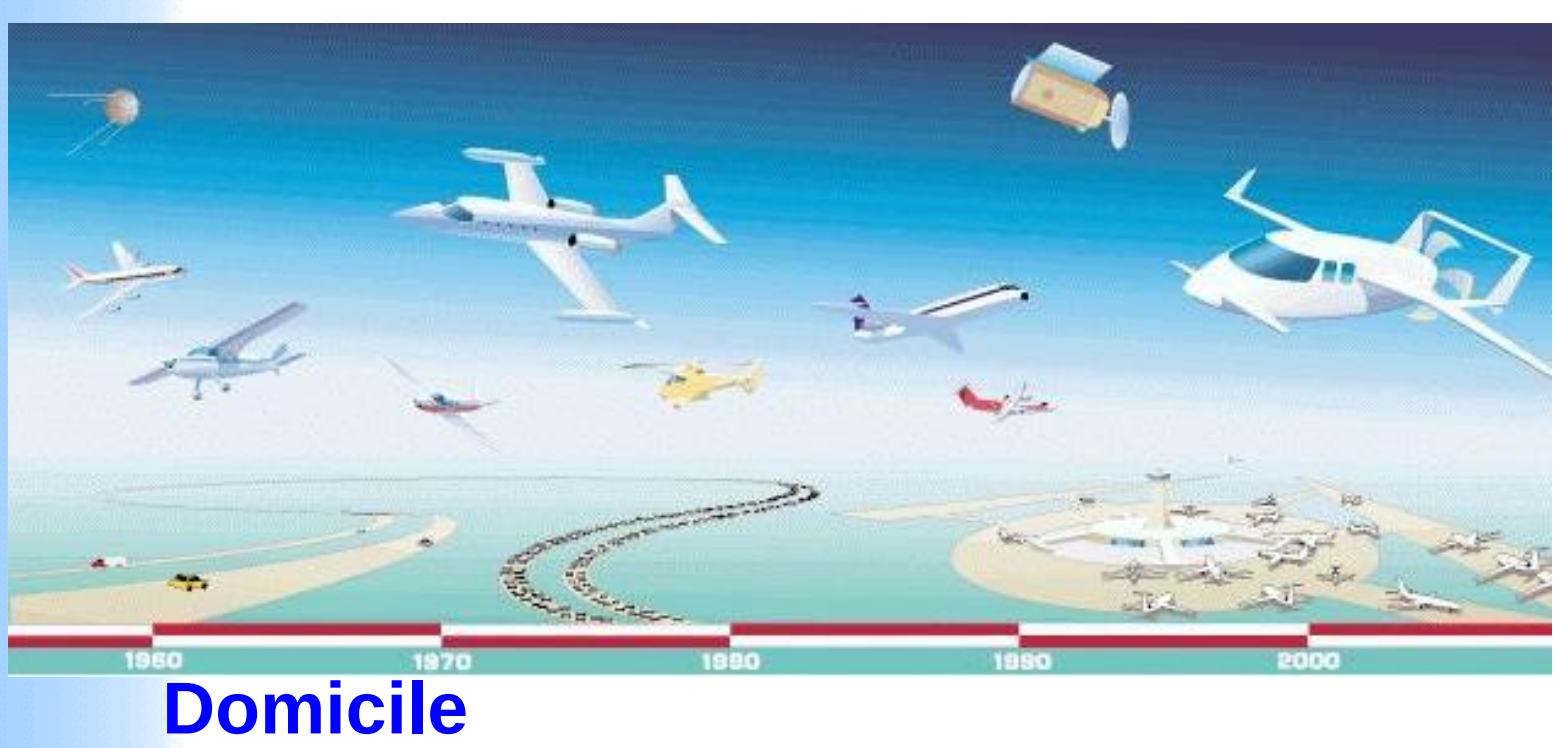

Domicile

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Location

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Living Arrangement

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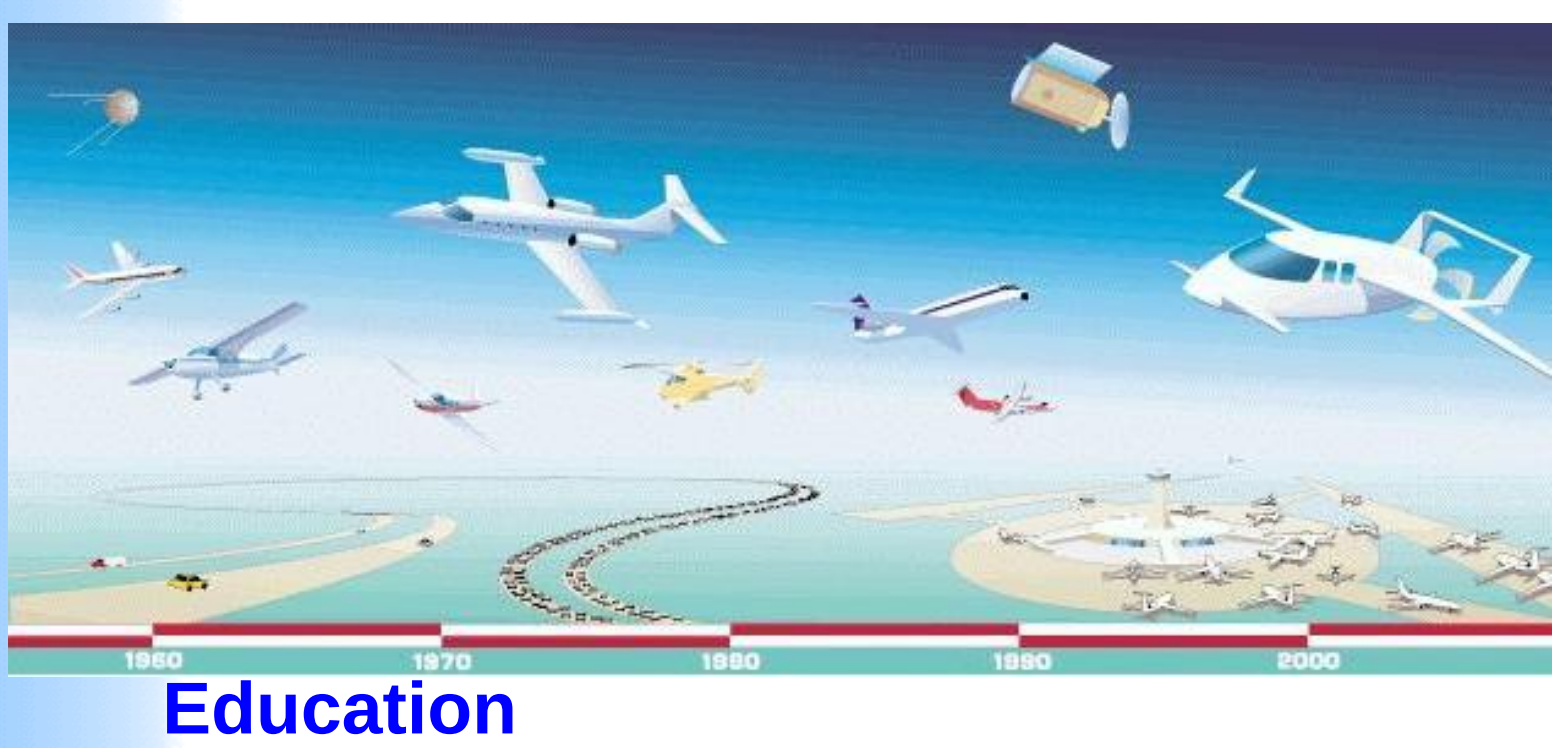

Education

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Occupation

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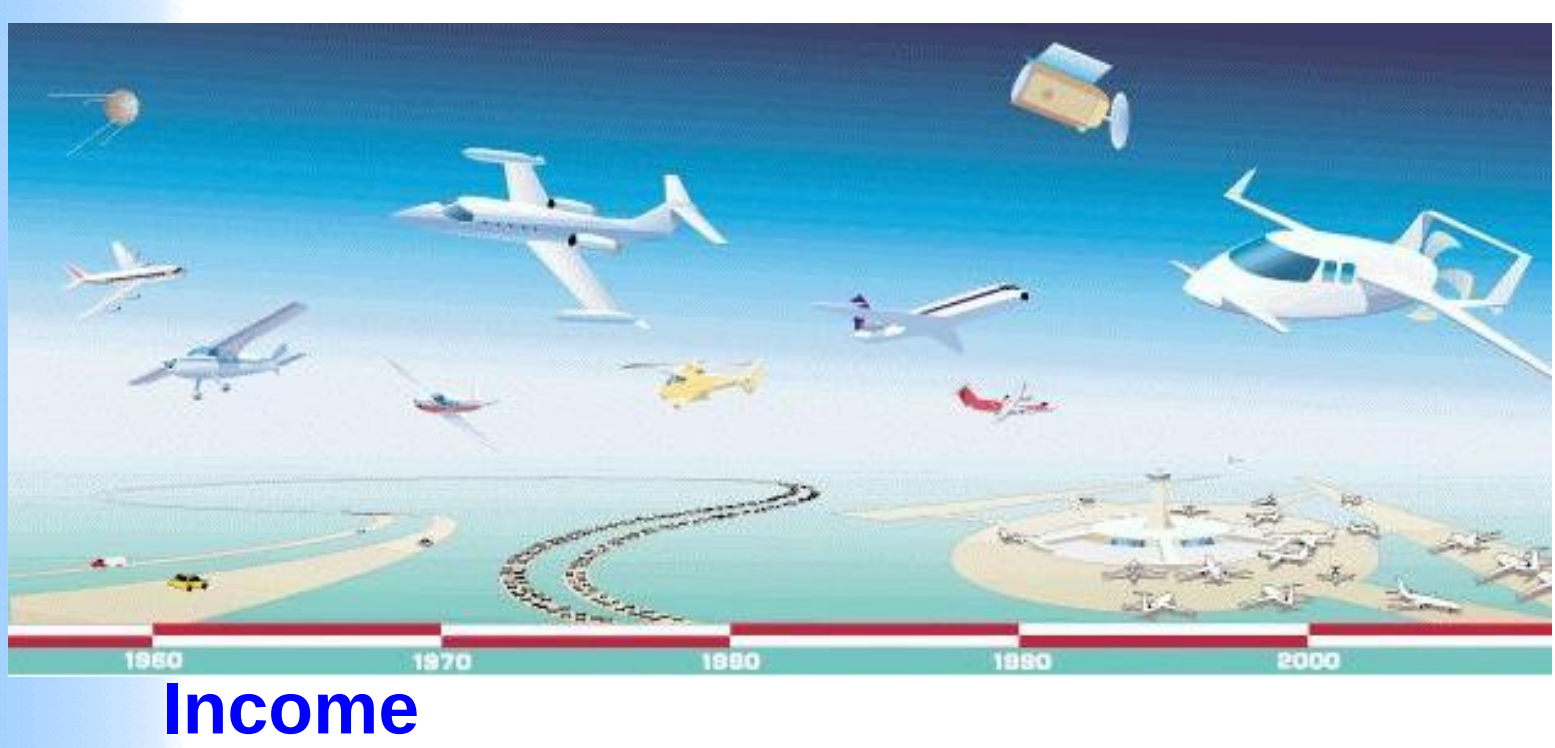

Income

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Income Expectations

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Learning How to Fly

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Information on Purchasing

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eMail Address Response

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Travel Information

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Number of Trips

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Type of Travel

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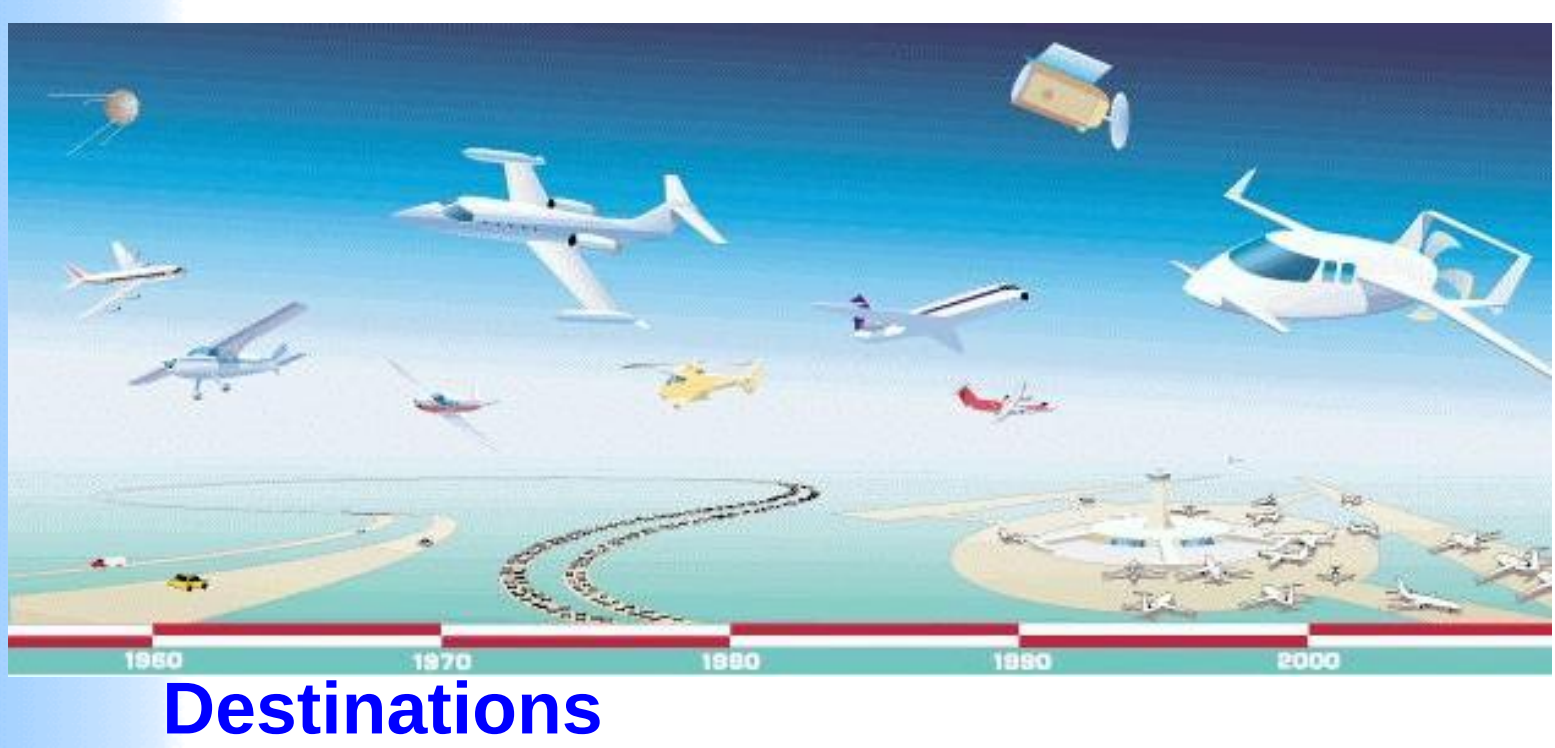

Destinations

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Days Away

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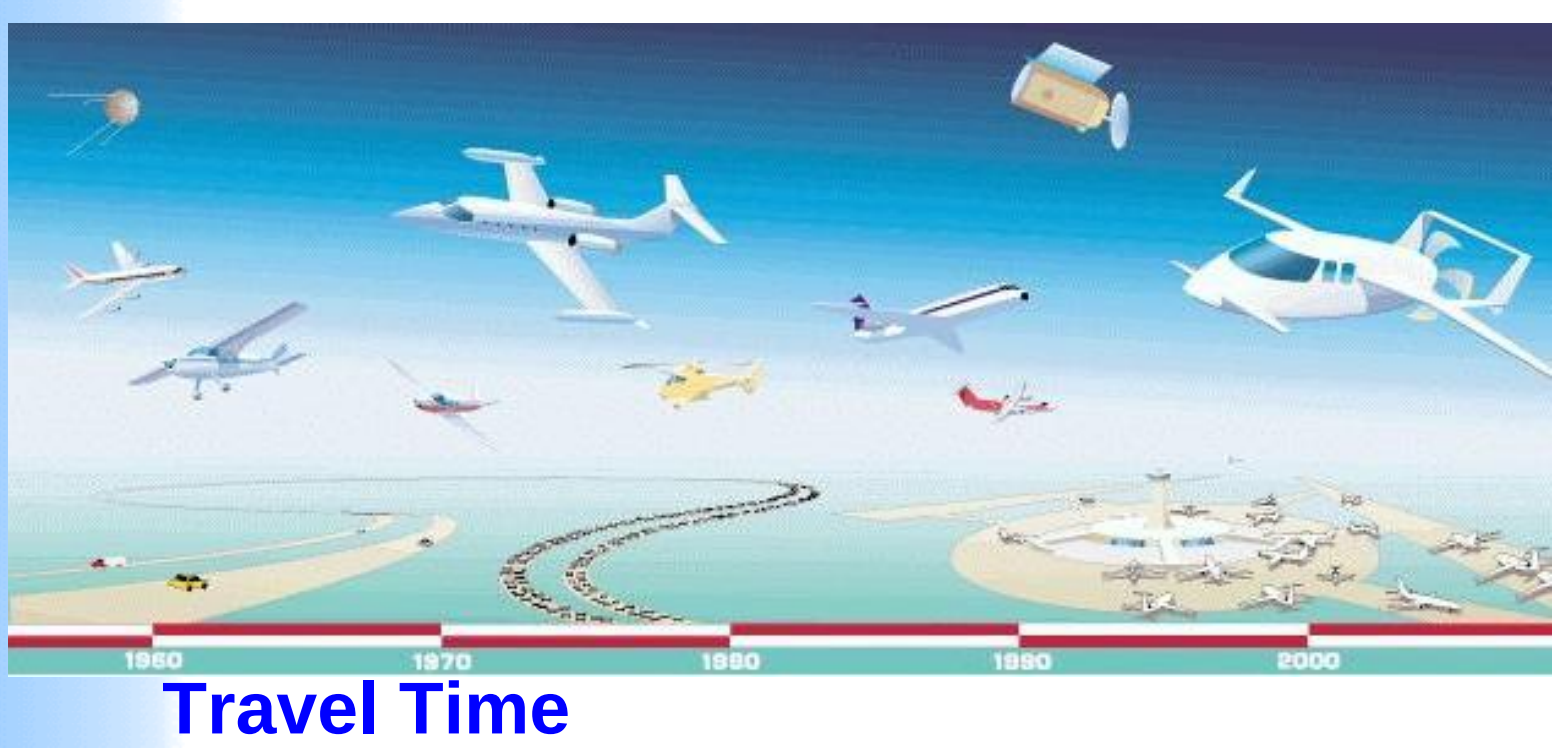

Travel Time

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Number of Destinations

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Automobile Trips

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Business Travel Frequency

People who travel frequently (Question 1o) and travel often on business (Question2o)

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Business Auto Travel

Previous slide Next slide Back to first slide View graphic version

Number of Business Travelers

People who travel frequently (Question 1o) and travel often on business (Question2o)

Previous slide Next slide Back to first slide View graphic version

Business Travel Expense

People who travel frequently (Question 1o) and travel often on business (Question2o)

Previous slide Next slide Back to first slide View graphic version

Personal Travel Frequency

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Number of Personal Travelers

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Personal Travel Expense

People who travel frequently (Question 1o) and DON’T travel often on business (Question2\)

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Commercial Air Travel Information

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Service Rating

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Travel to Airport

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Commercial Air Destinations

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Time to Final Destination

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Advanced Light Plane (ALP) Travel Information

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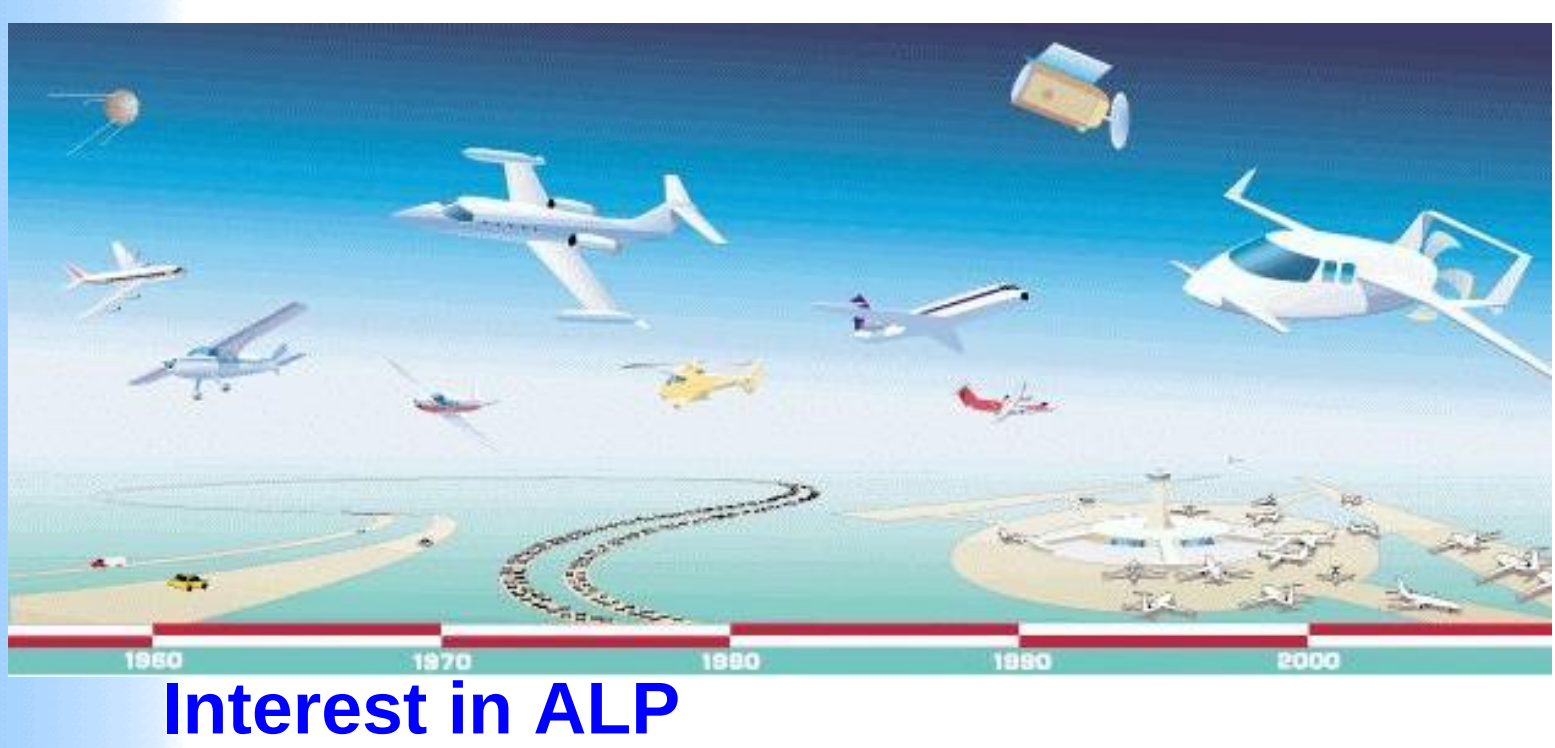

Interest in ALP

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Willingness to Travel in ALP

People who travel frequently (Q1 > 3) and are not current or former pilots

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Extra Trips / Cheaper

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Extra Trips / Faster

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Extra Trips / Cheaper and Faster

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Reasons not to Travel in ALP

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Potential Pilot Information

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Benefits

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Purchase Plans

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Pilot and Owner Information

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Owner Status

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Number of Owners

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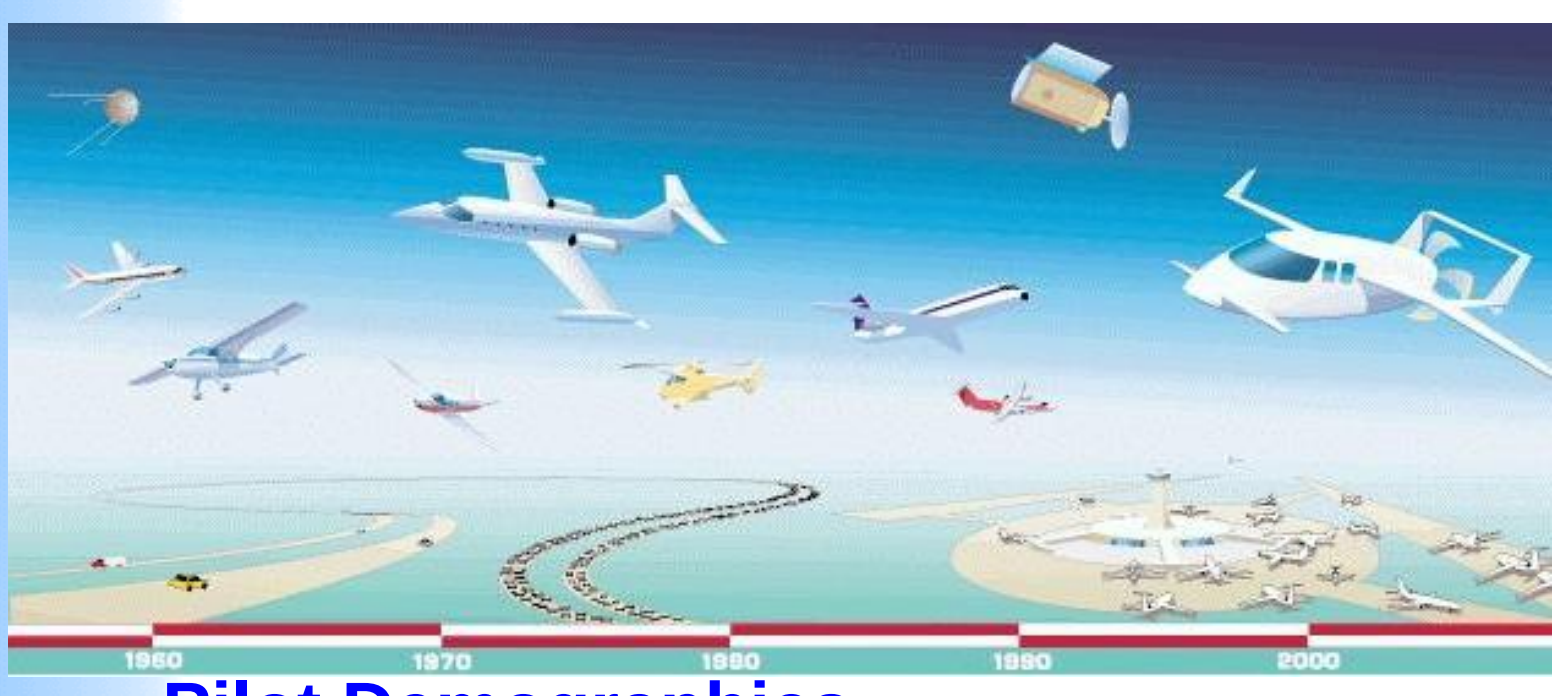

Pilot Demographics

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Flight Hours

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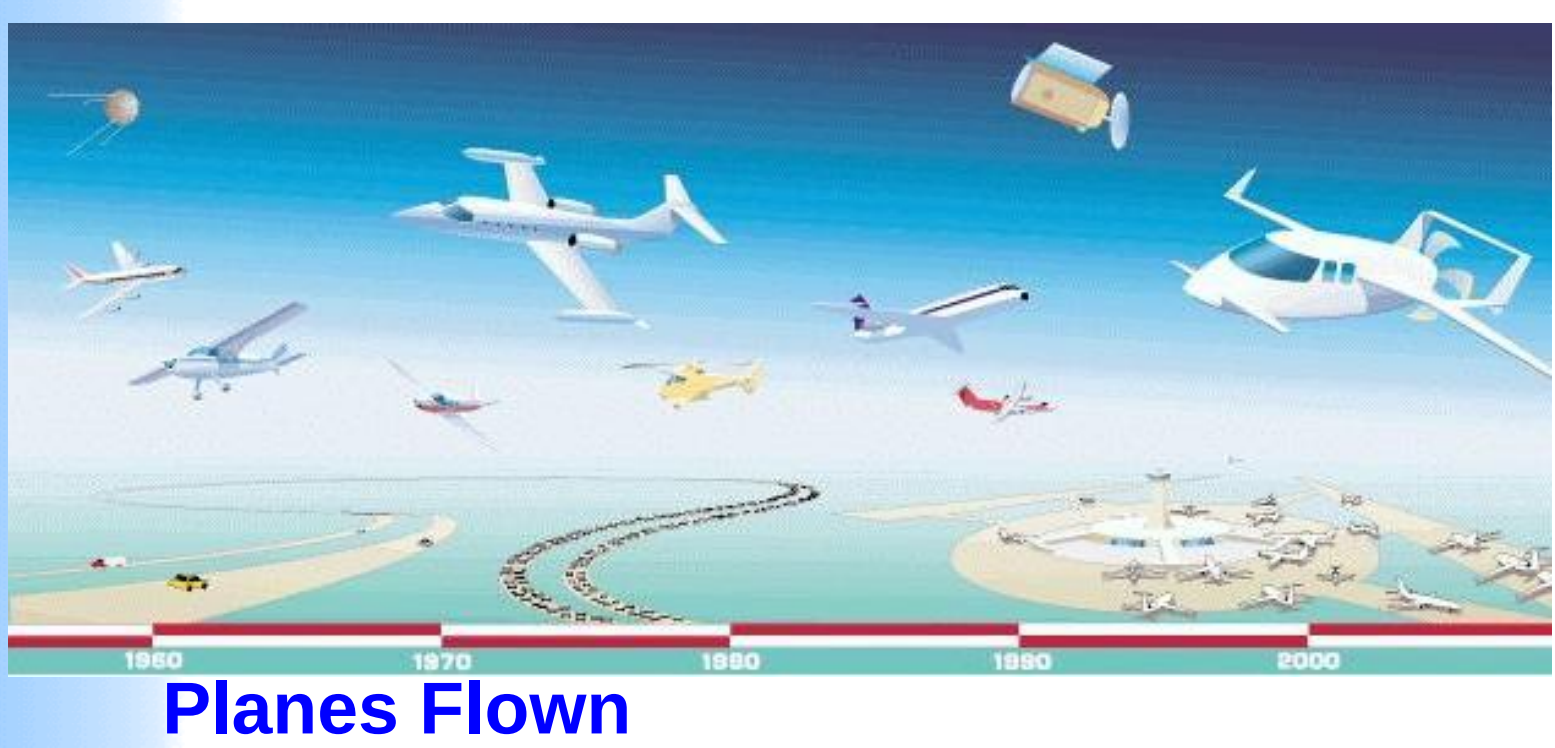

Planes Flown

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Rating Distribution

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Benefits Ranking

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Features Ranking

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Ownership Cost

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Pilot Costs

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Purchase Information

People who travel frequently (Q 1o) and are a Pilot but not an Owner

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Retrofit Response

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Purchase Probability

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Former Pilot Information

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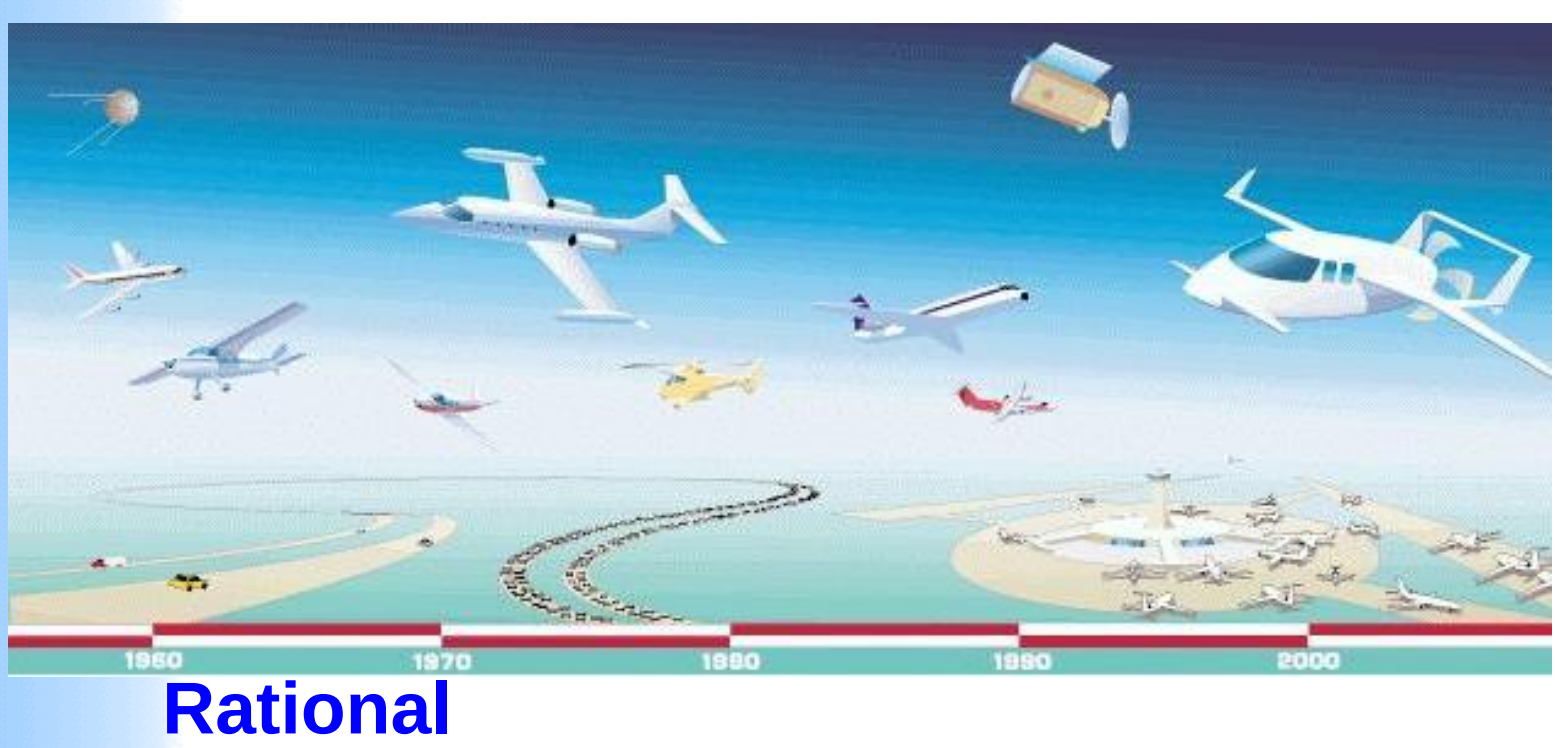

Rational

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Former Pilot Aircraft

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Last Flown

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Likelihood of Resuming

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Potential Pilot Information

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Number of Times

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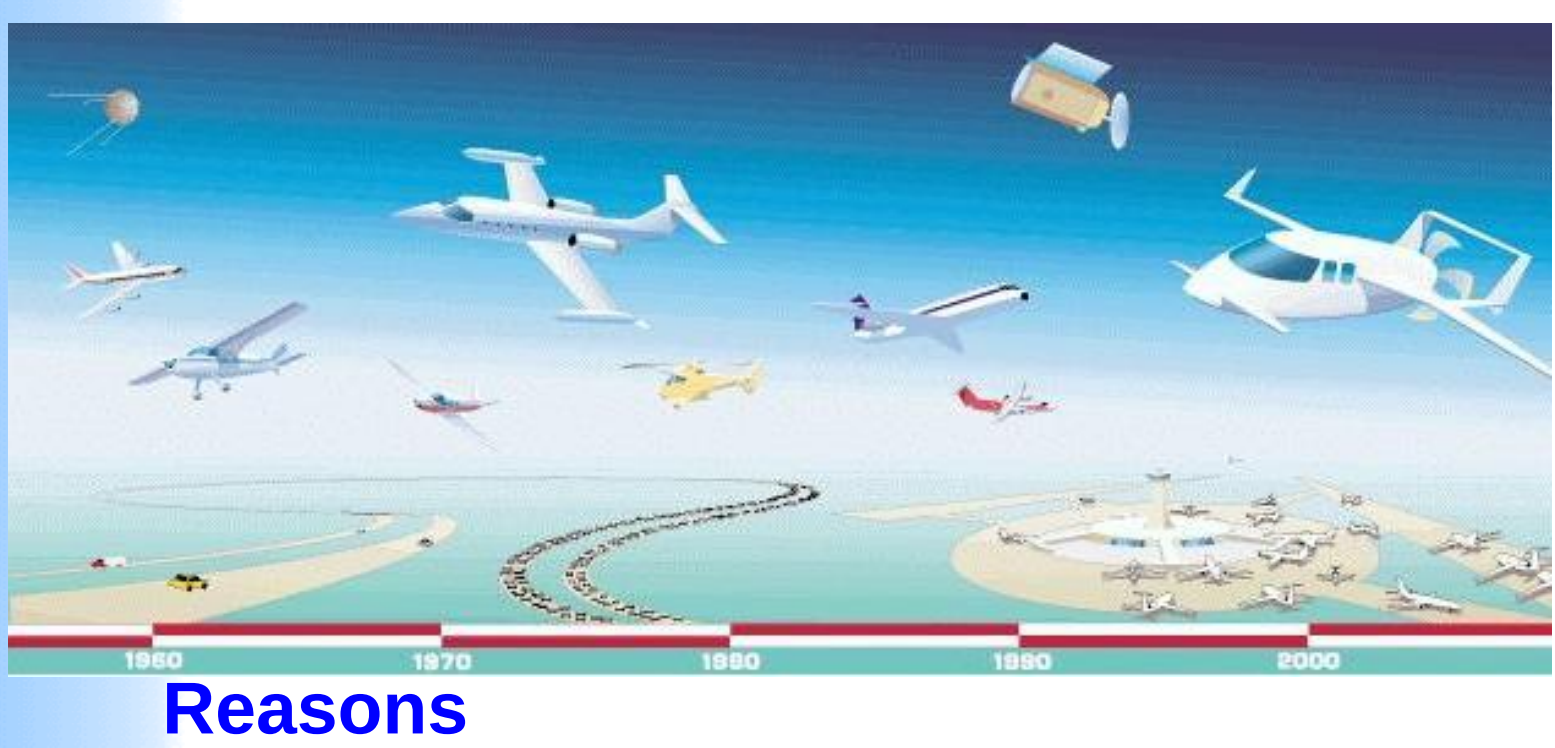

Reasons

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Learning Importance

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Personal Aspects

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Practical Aspects

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Learning Likelihood

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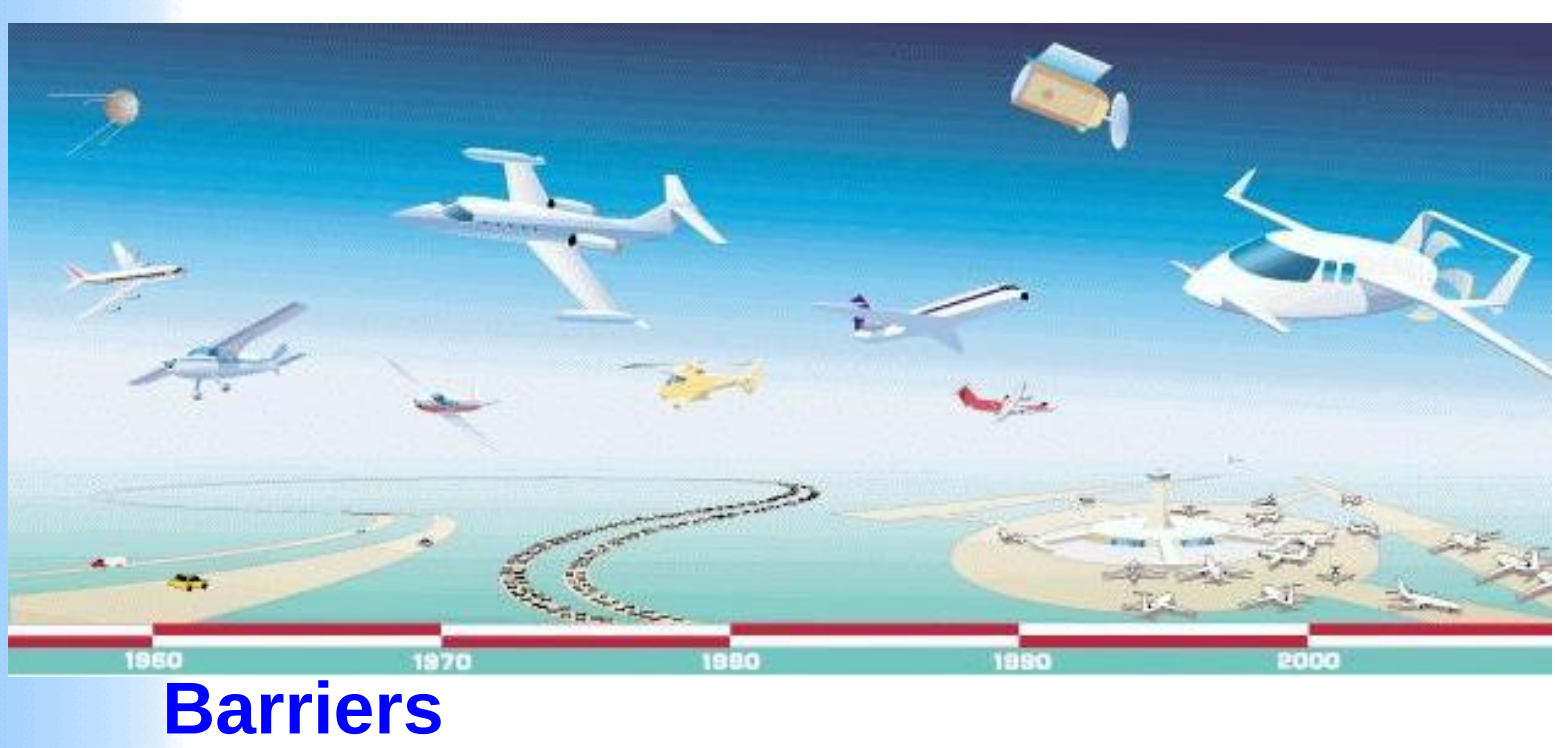

Barriers

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