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Freedom of the Skies

Everyone knows about the horrors of modern air travel. What almost no one knows is how inventors, entrepreneurs, and government visionaries have teamed up to create new kinds of small planes that can take off from and land almost anywhere. "Escape From Airline Hell" the scenario might be called, and it's coming soon to an airport near you.

by James Fallows

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Overload

People who travel on airlines all have stories about how bad the experience is when things go wrong. Lost or damaged luggage. Unexplained waits on the taxiway, with the passengers strapped in but the plane not allowed to take off. Missed connections and overnight delays because of snow in Denver or fog in San Francisco or thunderstorms in the Midwest.

But the more striking fact is how unpleasant and inefficient the experience can be when nothing in particular has gone wrong. The series of waits: to get over the bridge or through the tunnel or the tollbooth en route to the airport; to drop off the rental car or catch the shuttle bus from the parking lot; to make it to the check-in counter; to pass through the security gate; to get the shuttle to the far-off terminal; to buy coffee or sandwiches to supplement the pretzels offered as food on the trip; to get onto the plane and join the fight for space in the overhead bins. Because any of these waits can turn out to be much longer than "normal," worst-case padding for all of them must be built into plans for leaving home or work to get to the airport. When flight delays were reaching record levels last summer, an executive from an airplane-manufacturing company told me that he'd made a bet with a friend. The bet concerned how long it would be before an argument over a canceled flight or a lost bag led one frustrated person to kill another in an airport. It would have happened already, the man said, except that airport security gates keep passengers from bringing in guns.

Then, on the other end, more waits: for the bags, for the car or taxi from the airport to the home, office, meeting, or vacation site one is trying to reach. That final leg of the trip can be a minor factor for those traveling nonstop from one airline hub city to another—New York to Chicago, say, or Atlanta to Dallas. But it represents a large share of the total travel time for people either beginning or ending their journey somewhere other than in one of these hubs. For trips of 500 miles or less, which include the majority of air journeys, going by commercial airline is effectively no

Langewiesche

"Slam and Jam" (October 1997)
For all the reports of equipment failures and "close calls" and controller burnout, the nation's air-traffic-control system is in fact far less precarious, in terms of safety, than people imagine it to be. The real threat to the system's integrity has as yet received little attention. By William Langewiesche

"The Turn" (December 1993)
"At the very heart of winged flight lies the banked turn, a procedure that by now seems so routine and familiar that airline passengers appreciate neither its elegance and mystery nor its dangerously delusive character." By William Langewiesche

"I Fly With the Eagles" (November 1981)
"Roger, 90 left, SPAD 2." "God, no!" By James Fallows

"Supersonic Bust" (January 1977)
Faster than the speed of sound comes the plane of the future. The Concorde is the benighted offspring of Anglo-French diplomacy and once-and-future dreams of glory in the skies. Now its builders are trying to keep it from crashing in a sea of red ink. By Peter Gillman

From *Atlantic Unbound*:

Interviews: "The Soul of a New Flying Machine" (May 25, 2001)
James Fallows, the author of *Free Flight*, argues that the next generation of small planes could usher in a new age of travel.

Elsewhere on the Web
Links to related material on other Web sites.

AGATE ("Advanced General Aviation Transportation Experiments")
The Web site of a "cost sharing industry university government alliance" dedicated to revitalizing the aviation industry by developing new technology and flight standards.

faster than traveling by car. "Think about it," the administrator of NASA, Daniel Goldin, said in a speech in 1998. "You are flying through the air at three hundred to five hundred miles per hour 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 fifty or sixty miles per hour."

The steep pricing penalty for last-minute bookings and changes helps the airlines use their fleets efficiently, as does hub-and-spoke routing. But both policies mean less freedom and flexibility for the traveler. Together they have also put air travel distinctly out of phase with the evolution of the modern economy as a whole.

Since at least the early nineties the trend in most businesses has been toward on-demand, always-available products and services that suit the customer's convenience rather than the company's. You can make or receive phone calls from almost anywhere. You can get money at any time from any ATM in almost any part of the world, and you can do your banking at 3:00 a.m. on your home computer rather than queuing up for a teller during bankers' hours. You can order books, clothes, movies, by phone, computer, or fax, and have them delivered overnight.

Through most of the twentieth century commercial air travel was an important part of the movement toward giving people more freedom, flexibility, and control over how they used their time. By the early 1940s airplanes had made it possible to cross the country in one long day of travel, rather than in several days by train. In the 1960s touring families and students could get to Europe on overnight charter flights, rather than having to spend five days on a ship. Businesses could receive timely shipments from distant suppliers and coordinate work among offices in different states or countries.

But starting in the 1990s commercial airlines added more rigidity than flexibility to the system, in order to keep airplanes full while competing on price. More and more of the traffic was routed through a small number of hub airports, although the United States has well over 13,000 "landing facilities," many thousands of which would be suitable for all but the largest planes. Today more than 80 percent of all airline traffic takes off from or lands at one of the fifty busiest airports, and most of it at the twenty-four major hubs. As Dallas-Fort Worth, Dulles, Denver, and O'Hare become saturated with travelers and airplanes, one canceled flight means passengers sitting in the hallways and filling the standby lists for subsequent flights. Weather delays in one part of the country have ripple effects thousands of miles away.

Those who can pay enough for first-class seats and last-minute tickets can better fit travel to their own schedules. And those who can amortize the cost of a corporate jet see airplanes as the miracles of freedom they originally were. One springtime evening when I was living in Seattle, I took a ride in a ten-passenger jet owned by a software billionaire who was going to Monterey, California, for a dinner meeting—and coming back the same night. He and I and one other guest bound for the dinner left Seattle around five, spent two hours in the air each way, were flown by a team of two professional pilots, and were back a little past midnight. The fastest connection on a commercial airline, with a change in San Francisco, would have meant leaving Seattle at 1:00 p.m. and getting back at noon the next day. But that private jet had cost well over $10 million, and the direct operating costs for the trip were well over $12,000 not counting the pilots' pay.

There have been few dramatic changes in large-aircraft design since the 1960s, when the Concorde and the Boeing 747 made their debuts. But planes from Boeing and Airbus have become ever more efficient, more reliable, less polluting, quieter. Despite occasional horrific crashes, modern airliners are about the safest means of travel ever devised. Airline pilots may sound like corny travel guides when they come onto the intercom, and through the vast majority of a flight they do little more than monitor the engine gauges, autopilots, and "moving map" displays of where the plane is heading. But to have any knowledge at all of the world of flying is to respect the experience, judgment, and training that airline pilots must accumulate. No other group of professionals is retrained and retested so frequently. An oddly compelling book called *The Black Box* (1998), edited by Malcolm MacPherson, consists of little more than cockpit transcripts from flights that encountered serious trouble. In most cases the planes crashed and everyone died; in a few the pilots brought them in with minimal damage. In virtually all the cases the competence of the crews as they tried to cope with disaster must be called heroic.

Why does a system that is so technically advanced and admirable lead to such unpleasant results? Because for more than a generation the money, effort, and innovation in civilian aviation have gone toward planes that can carry hundreds of passengers between Atlanta and Chicago, New York and Los Angeles, or any other "hub pair" at 400-500 miles an hour with ever higher reliability and ever lower cost per mile. While Boeing and Airbus have fought for this market, such companies as Gulfstream, Learjet, Challenger, Raytheon, and Cessna have poured effort and money into developing ever faster and sleeker jets that can take corporate officials or millionaires wherever they want to go whenever they want to go there. The result is like a land-travel system consisting of long-distance rail lines for most passengers and private limousines for a tiny elite.

It is a system that is nearing the limits of its capacity. Only so many airplanes can land at La Guardia or take off from LAX. At least two dozen of the major hub airports are classified as "seriously congested," working near their theoretical maximum capacity for takeoffs and landings in busy periods. Federal officials predicted last fall that overall airline traffic in the United States would more than double by 2010, with most of the increase occurring in the already busiest airports.

What could relieve the overload and change the tedious realities of travel? I believe that the answer is being invented by entrepreneurs at a variety of start-up companies who are allied with sympathizers within the federal government in trying to create new air-travel alternatives to airlines. The government's role here, which is more than a decade old but has received virtually no publicity, is consistent with the century-long history of federal support for aviation. In the past this support came mainly through military contracts, but now the government is dealing with new, tiny companies and trying to help them survive without making them into mini-defense contractors permanently dependent on federal funds.

Eventually these projects should make it possible for many people to travel much of the time the way a few very rich people do now: in greater comfort, without fighting their way to and from crowded hubs, leaving from the small airport closest to their home or office and flying direct to the small airport closest to their destination. This would be made possible by a product now missing from the vast array of flying devices: small planes that offer much of the speed and as much as possible of the safety of big airliners, at a small fraction of the cost of today's corporate jets.

The people racing to create new systems of air transportation are nearly all men who learned to fly as teenagers. I can't recall one I've interviewed who didn't have a poster of an airplane on his office wall or a little model plane on his desk. They think about airplanes all the time, and many say they started their companies because they wanted to have a different kind of plane to fly. Some of them argue, or at least dream, that if they make new planes that are nice enough (more comfortable, easier to fly, less expensive, above all much safer than today's small aircraft seem to be), then larger numbers of the public will eventually decide to become pilots themselves. Those pilots could then take advantage of the now underused network of small airports and relieve strain on the big hubs.

Whether or not the pilot population increases in the long run, for the foreseeable future small planes will make a difference mainly if they constitute the operating fleet for a new national system of air taxis. A supply of inexpensive, safe, comfortable small planes, flown by hired pilots and available at rates comparable to today's coach air fares, could bring freedom and convenience to a broader share of the traveling public than the class to whom "flying commercial" is a badge of shame.

Two of the companies deeply involved in the race to create this fleet are the Cirrus Design Corporation, of Duluth, Minnesota, and Eclipse Aviation, of Albuquerque, New Mexico. Cirrus is the first company to begin large-scale production of a genuinely new small airplane, which it calls the SR20. Eclipse is the company that is moving fastest toward the production of jet planes priced at well under a million dollars apiece, versus at least three to four times that much for all competitors. Its first plane is scheduled for delivery in 2003. Several other companies are working toward the same goal: Lancair, of Bend, Oregon, which makes a small, fast, propeller-driven plane like the SR20; Safire Aircraft, of West Palm Beach, Florida, which is planning a small jet to compete with the Eclipse; established airplane makers, including Cessna, of Wichita, Kansas, and newcomers such as Honda and Toyota, of Japan, which are all considering developing the new class of planes; and equipment manufacturers, such as Avidyne, of Lincoln, Massachusetts, and Garmin, of Olathe, Kansas, which are producing advanced electronic systems for use in the new planes. But for the moment Cirrus and Eclipse are setting the pace.

These companies face all the standard perils of start-ups in complicated manufacturing industries. For Cirrus the main challenge is a continuing struggle to raise working capital. For Eclipse it is to deliver the product it has promised to investors and customers. But if these companies falter, some of the others are likely to take their place. Building airplanes has for decades been a notorious way to lose money. The new contenders believe that this time market conditions and technological possibilities are on their side.

The General-Aviation Mafia

In the fall of 1998 Bruce Holmes noticed that it was taking him longer and longer to get where he wanted to go. Holmes, an official at NASA, had been trained as an engineer, and his first instinct was to quantify and measure. So he decided to use himself as a kind of test probe to see exactly what had happened to the air-transportation system.

Holmes lived in Newport News, Virginia, near his work at NASA's Langley Research Center. When he took a business or personal trip that involved air travel, he would note the exact time he stepped out the door. He would glance at his watch at different stages of his journey: when he got to the airport, after he'd gone through the check-in line, after he'd found a seat on the plane, and after the plane had finally begun to roll. He would record the time the plane landed and would make a final entry when he reached the hotel, office, or meeting site that was his destination.

"You know W. Edwards Deming?" Holmes asked when he described this ritual to me, at our first meeting last year. Deming was an American consultant whose prime analytic tool in the study of how to increase productivity was taking minute measurements at each stage of a factory's production process. "My friends like to say, 'Deming would be proud!'"

The log was just the beginning. When the trip was over, Holmes would calculate the "great circle" distance (what most people would call "as the crow flies") between his starting point and his destination and compare it with the total time spent en route; the result was his effective travel speed, on what he calls a "doorstep to destination" basis. Holmes, himself a pilot, would then use flight-planning software to see how long the same trip would have taken in a variety of modest propeller-driven planes—not corporate jets, not million-dollar turboprops, but a typical Cessna, Mooney, or Beech Bonanza. These planes are much slower than mighty Boeing or Airbus jets, and he would allow time for refueling stops. His aim was to see exactly how modern the modern transportation system is.

What Holmes began to see was that if he was going anyplace within 500 nautical miles (that is, on a trip from Newport News to Boston or anyplace nearer), his effective speed by air averaged 75 knots, or somewhat faster than he could have traveled by car. (The aviation world uses nautical miles rather than statute miles to measure distance, and knots rather than mph to measure speed. A nautical mile is about 15 percent longer than a statute mile, and a knot is a nautical mile per hour.) Going by car, of course, would have been much less expensive than going by airplane, and it would have allowed him more flexibility in departure and return times. Given that airliners can travel through the sky at 400 knots, this is impressive testimony to how much of the average airline trip is spent other than in the air. Holmes's worst short journey was from Boston to Newport News when a string of thunderstorms caused delays throughout the hub-and-spoke system. That trip took twenty-seven hours, for an average speed of 15 knots. For trips of 1,000 miles Holmes averaged 125 knots. For trips of 2,000 miles he averaged 200 knots. Holmes thought, *I have my proof.*

For coast-to-coast hauls, of course, flying is superior to driving. And for people who live close to major airports, short-haul trips, too, can be fast on an airline. But for the past five years the effective speed of air travel, especially for short trips, has been declining, because passengers spend so much of their travel time doing something other than whooshing through the sky in a jet. This wasted time—in lines and traffic jams and crowded hubs—is what small planes going direct to small airports could reduce.

His obsessive travel logging was the culmination of a process that had begun in 1989. Bruce Holmes had recently turned forty, and he was wondering how to spend the rest of his working life. He had always been interested in airplanes: he took his first flight when he was five years old, soloed when he was in high school, and earned money in college giving flight lessons and transporting bodies for funeral homes. Holmes is a fit-looking man with a full head of straight, light-brown hair and a genial air. His style of speaking combines an engineer's precision with the sort of "busting paradigms" talk found at corporate seminars on the new economy.

Holmes had gone to work at NASA in 1974 and had become involved in various projects for the better design of airplanes. Although NASA's role in space exploration dominates news about the agency, its full name is the National Aeronautics and Space Administration, and it is a major center for research into the technology of normal flight.

Through the late 1980s Holmes had been meeting with colleagues at the Langley Research Center. They gathered weekly at a neighborhood pizza place and called themselves the "GA mafia." GA stands for "general aviation," which covers the class of airplanes defined as belonging neither to the military nor to the airlines. Of the more than 200,000 civilian airplanes registered in the United States, about 95 percent are GA craft, and the great majority of those are small propeller planes. At its meetings the GA mafia discussed how the changes so dramatically transforming the worlds of computers and communications might be applied to the relatively stagnant world of air transit. Its ideas became widely known and discussed in the tight community of aviation hobbyists and the businesses involved in building small planes, but these ideas have almost never been discussed in the general-interest media. During the very years when news about NASA mainly concerned the agency's struggle to recover from the 1986 explosion of the *Challenger*, some of its most creative efforts—and the ones likely to have the greatest impact on the daily lives of the American public—were those undertaken by the GA mafia.

In 1974 Jack Olcott, then a contributing editor of *Flying* magazine and the chairman of the NASA advisory committee on general aviation, had written a report recommending the development of an "advanced personal transportation system." By this he meant a new generation of small planes that ordinary travelers—"civilians," as opposed to pilots or aviation hobbyists—could view as a reasonable alternative to the airlines. Only a concerted technological drive could make this possible, he argued.

Olcott's paper inspired the GA mafia. The impending saturation of the hub-and-spoke airline system gave the group its motive to consider other air-travel systems, and the effects of ever cheaper computing power suggested new possibilities. The existing small-airplane fleet was too much like European sports cars of the 1950s: hand-built, defect-prone, tricky and expensive to maintain. Computer-driven "lean manufacturing" techniques were making modern cars far more reliable, and the GA mafia thought the same could happen with airplanes. The electronic guidance equipment in airplanes was famously expensive and unreliable: the use of light, inexpensive, dependable integrated circuits could solve that problem.

Perhaps most important, the GA mafia reasoned, the computer revolution could make small airplanes much safer than they had been. Although the civilian impression is that small airplanes fall out of the sky more or less at random, the truth is that the two great dangers are weather—thunderstorms or freezing clouds that coat the plane with ice and destroy its ability to fly—and pilot disorientation (now unfortunately familiar as the John Kennedy scenario), in which a pilot loses sight of the horizon and, if he has not had sufficient instrument training, can no longer tell up from down.

The group believed that weather hazards and pilot disorientation obscured a deeper problem: that pilots couldn't get enough information fast enough about the environment through which they flew. A shortage of information is exactly the sort of problem that computers were designed to correct. The first four satellites in what would eventually become the twenty-four-satellite Global Positioning System had gone up in 1978. With signals from the GPS, pilots (or anyone else) could navigate by means of moving-map systems like those in 1960s spy movies. While the GA mafia was meeting regularly, the GPS was still mainly for U.S. military use, and in any case computing power was still too expensive for GPS navigation to be practical for most GA craft. But Holmes and the others knew that sooner or later the GPS would reach the GA market.

In 1989 Holmes had been temporarily transferred from Langley to NASA headquarters, in Washington, and felt he was in a position to act. That year he convened a conference of representatives from every company, research organization, and regulatory agency that might play a role in revitalizing GA and got them to agree on a white paper supporting new, safer, easier-to-fly planes. Holmes's boss in the aeronautics directorate of NASA, Roy Harris, was familiar with the discussions of the GA mafia. "He told me, 'Bruce, this project is so important, you really should work on it full time,'" Holmes said when we met, at the small Newport News airport. In 1992 Harris told Holmes that he could set up a "skunk works" research center within NASA to concentrate on future small-plane development with a few chosen allies. "Most of my peers thought I was nuts to consider it," Holmes told me, "because of the career risk." But he wanted to try something new.

So did Daniel Goldin. As a young engineer out of City College of New York, Goldin had gone to work at NASA in the early 1960s, during the glorious race-to-the-moon days. A few years later he joined the defense contractor TRW, and by the early 1990s he was in charge of its space-technology division. In 1992, with the presidential primaries well under way, George Bush invited Goldin back to NASA as its administrator.

Appointees who arrive very late in an administration rarely have sweeping agendas. But Goldin, who is a compact man with wavy gray hair, had also been thinking about big changes in small-plane travel. Within a few months of taking office Goldin was ready to address the 1992 Oshkosh air show and convention—the big annual event in the GA world, at which more than 150,000 aviation enthusiasts gather for a week of displays and seminars—and promise a bright future for general aviation. NASA would do everything it could, he said, to help make advanced technology practical and affordable for small planes.

In this nurturing environment Bruce Holmes began organizing what was called the agate project. The acronym stood for "advanced general aviation transportation experiments," and the idea was to stimulate competition among companies to bring new technologies to market. Holmes had made a little drawing of the cockpit in an ideal airplane of the future. It would have advanced guidance systems, which would give the pilot a graphical path to follow even if the real view outside was hidden by clouds or fog. It would have moving maps to let the pilot know exactly where he was—and where weather, mountains, and other planes were. It would be comfortable, like the interior of a modern car. It would have display panels, rather than old-fashioned steam-gauge dials, to report on the condition of the engine and the electrical system and anything else the pilot needed to monitor. "For me that picture became a touchstone," Holmes told me. "The agate alliance came out of that sketch—and a lot of weekend-consuming telephone conversations with my fellow thinkers in government, industry, and trade associations."

In the 1990s Congress authorized $63 million for research sponsored by agate. The money went to companies willing to develop demonstration models of the technology that would make small planes better. These innovations would include computer-generated displays that would let a pilot follow a "highway in the sky," even if he could not see anything out his window; ways to train pilots much more quickly and safely than had seemed possible before; ways to make planes less likely to crash and less likely to kill the occupants if they did; ways to make planes safer in an unexpected encounter with ice-filled clouds; and new manufacturing techniques and an across-the-board effort to make the costs of planes come down the way the costs of most other high-technology products had since the 1970s.

While Bruce Holmes was working as Mr. Inside for the small-plane crusade, Dan Goldin was Mr. Outside. In appearances before Congress and in speeches on the aviation-policy circuit he placed more and more emphasis on the importance of small-plane programs to NASA—and on the potentially revolutionary impact of agate and related efforts on the traveling public. As the economy developed and per capita income rose, he said, per capita travel rose even faster—and per capita demand for high-speed travel rose faster still. Air travel was thus both a cause and a consequence of a more advanced economy. If the air system bogged down, increasing numbers of people would be annoyed, and it was conceivable that economic productivity would slow as well.

It was this need for air-travel innovation that the NASA team thought small airplanes could fill. In practice this would mean the creation of what was still missing: small planes with the speed, safety, comfort, and comparatively low price to serve as a national air-taxi fleet. NASA's specific goals were these:

Small planes should be safe enough that normal, non- risk-taking people could think of trusting their lives to them. NASA wanted to cut the accident rate by 90 percent within twenty-five years. The planes should become fast enough that their effective speed was at least three times as great as that of cars on the highway. The existing small-plane fleet averaged 150 knots; that should be raised to 300 knots within a decade, and eventually to 450 knots, so that small planes could compete with the jetliners' speed. The planes should be more efficient and environmentally safer, using less fuel, creating less pollution, and generating less noise. They should be more consistent in their operations and far simpler to fly, much like cars that vary little from one rental site to another. And they should be radically more reliable and cheaper to maintain—following the example of automobiles, with their quality revolution of the 1980s and

1990s.

NASA also set targets for the coverage and convenience a small-plane network should achieve. To make a difference a new system should serve every part of the United States more than fifty miles or an hour's drive from a hub airport. "Fortunately," Holmes says, "more than ninety-eight percent of the U.S. population lives within a thirty-minute drive of [one of] over five thousand public-use landing facilities." Although these small airports are far more evenly spaced across the country than the hubs, not enough of them are equipped for all-weather operation. The most important all-weather component is a precision-landing system, which lets pilots safely descend for a landing even if clouds are within a few hundred feet of the ground. Some 1,200 of the nation's public airports already have precision-landing systems. Holmes argues that if landing systems and air-traffic-control services were installed at many more airports, they could collectively handle some 500 million takeoffs and landings a year (versus 37 million now) without building a single new runway except at the most congested hub airports.

So the NASA of the late nineties had its plans laid: different airplanes, better engines, a bigger network of improved airports; and connected to these goals a variety of subsidiary ones, including faster, surer, more natural ways of training pilots, and improvements in manufacturing that aircraft companies could learn from car makers, much as they had during World War II. NASA officials knew that one change would matter more than any of the others: reducing the impression that small planes were deathtraps. Much of their research was directed toward radically simpler navigation systems. They were also interested in how the airplanes could better protect occupants when crashes occurred. This brought them in contact with the engineers at Cirrus Design.

The Plane With a Parachute

When Ralph Nader published *Unsafe at Any Speed,* in 1965, the typical automobile interior was full of sharp edges and projections that proved lethal in collisions. In that era before seat belts, airbags, or collapsible steering wheels, a head-on crash often left a driver impaled on the steering column. Since the 1960s cars have acquired dozens of features that collectively make them more crashworthy. Although there are more—and more aggressive—drivers and many more miles driven than in the sixties, the total death toll from traffic accidents has dropped substantially. NASA was determined to bring some of the same safety features to small-airplane design.

Cirrus Design was founded in the mid-1980s by two brothers just out of college, Alan and Dale Klapmeier, who believed that they could do for the safety of small airplanes what seat belts, airbags, and other features had done for the safety of cars. By the early 1990s they were planning to introduce this new concept of safety with a small plane called the SR20. The plane had four-point seat belts for all occupants, which were similar in effect to shoulder harnesses in cars. It had a different kind of airframe, to absorb energy and make sudden impacts easier to survive—part of a NASA project to see whether the shock of a plane's slamming into a bank of trees or a wall could be directed away from the passengers, as in a modern car.

And there was one other innovation. This was the most startling feature and the one that caused the most bickering and sneering from the rest of the industry:a parachute for the entire plane. The decision to thus equip the SR20 was based on an episode that had nearly killed the company's president, Alan Klapmeier. On May 2, 1984, when Klapmeier was twenty-five, he was taking a flying lesson at the Sauk-Prairie airport, just north of Madison, Wisconsin. It was late afternoon, and the sun was low in the sky. Klapmeier was in the pilot's seat, with an instructor sitting next to him. This was advanced training—Klapmeier had been flying for years.

He had just taken off and was turning away from the airport, with the sun at his back. A plane was nearing the airport from the opposite direction, flying with the sun in the pilot's face. The other pilot, a friend of Klapmeier's, was in a variant of the Piper Cub called the PA-7, with no radio installed. Pilots may fly NRDO, or "no radio," as long as they stay out of certain kinds of controlled airspace.

Every person who learns to fly is amazed by the reality of the "big sky"—you may fly for hours across several states and not see another plane except around airports. Most midair collisions therefore happen within five miles of an airport, and most happen in good weather, since on bad-weather days the planes are flying on instrument flight plans and are being separated by a controller's instructions.

On this clear spring day, near an airport, Klapmeier's plane collided with the other one. His wing sliced through the strut that supported the other plane's wing. That plane lost its ability to fly and spun into the ground, killing the pilot.

Klapmeier had to ram the control yoke hard to the left to keep his plane, which had lost part of its right wing, on course back toward the runway. As he neared a landing, Klapmeier realized that he had pushed the yoke as far left as it would go. Each of the next few seconds contained its own complete drama. Act I: the yoke would go no farther. Act II: the plane, gliding above the runway, began rolling over to the right. Act IV: the plane rolled so far that its disabled wing struck the ground, sending the craft into a cartwheeling crash. But Act IV never happened, because in Act III, with a second to spare, Klapmeier felt the wheels touch the runway.

From such an episode many people would draw the conclusion that flying was too great a risk ever to expose themselves to it again. Alan Klapmeier concluded that existing small planes were too risky and had to be made safer.

A stocky, square-faced man with glasses and bushy, blondish hair, Klapmeier has a grin that often edges into a smirk. Although he is forty-one, he gives the impression of a star student who would get in trouble for making wisecracks when the teacher's back was turned. I have met him half a dozen times over the past two years, at his company's headquarters, in Duluth, and at airplane shows. His brother, Dale, three years younger, is taller, lankier, and more taciturn—a man who likes fast airplanes, automobiles, and motorcycles. When I saw him one day at the factory wearing a black-leather jacket and heavy boots, I felt I had glimpsed him in his natural state.

The SR20 had a big moving map in the cockpit to help the pilot keep track of where he was going, and its wings employed a novel design that made the plane less likely to go into dangerous spins. But because of his narrow escape at Sauk-Prairie, Alan Klapmeier was determined to bring to his company's airplane some last-ditch safety measure for circumstances in which mechanical failure, reckless judgment, or simple bad luck put the pilot in an impossible situation. "It kind of goes against the pilot culture to admit that people are going to make mistakes," he told me. One of the most striking traits of aviation culture is the extensive study of accidents in which pilots make mistakes and die. The idea is for still-living pilots to learn the pitfalls they must avoid. Klapmeier was saying that the usual emphasis on training and caution is fine, but it isn't the most effective way to increase the number of people who survive small-plane emergencies.

The military's solution to this problem was ejection seats, but these were heavy and expensive, and would not work with planes that had solid roofs rather than canopies to blow off. (They are also violent: ejection often breaks bones.) Nor did it make sense to equip every passenger in a cramped plane with a personal parachute, like those that early air-mail pilots wore. Among other problems, the doors on small planes are not made for fast or easy escape, especially from the back.

Since the sixties certain "ultralight" planes had been equipped with rescue parachutes for the planes as a whole. Ultralights are the inexpensive homebuilt craft that satisfy many people's desire to fly but are not regulated by the Federal Aviation Administration. They crash with alarming frequency. In more than a hundred cases the pilots of ultralights have been saved by these parachutes. The Klapmeiers decided that a whole-plane parachute would come as standard equipment on the SR20—not an extra-price option, not something that could be either selected or disabled later on, but an integral part of the plane, like the energy-absorbing bumpers in modern cars. The SR20 is now the first and only "certified" plane—that is, one approved by the FAA for general sale—so equipped.

"If we had known exactly how hard this was going to be, we wouldn't have done it," Paul Johnston, Cirrus's chief engineer, told me, about five years after Cirrus decided to build a plane with a parachute inside. Johnston is a high-strung, fidgety person with a mop of unruly dark hair, whom others in the company call their most gifted designer and engineer. "We probably would have said, Okay, let's pursue this as a goal, but in the meantime let's get the first plane out the door."

The problem with a whole-plane parachute is that no one had made it work quite this way before. The Cirrus airplane would be four or five times heavier than the typical ultralight, and it would be going much faster when the parachute needed to arrest a fall. The parachute would therefore have to be much bigger and stronger, and a system designed for ultralights would have to be scaled up to handle the weight of a four-person plane.

The testing team spent weeks in the summer of 1997 in the high desert of southern California. Because the design of the SR20 was still being worked on, they had no actual airplane to use for tests. So they would attach parachutes to pallets covered with drums full of sand, load the pallets into a C-123 cargo plane, shove them out the back, let them free-fall until they reached nearly 200 mph, and then push a switch to deploy the chutes. They filmed the results. "We drilled *a lot* of holes in the desert in those days," Paul Johnston told me. "We put a lot of sand back in."

The crucial idea came from the BRS company, which makes parachutes for ultralights. In engineering it can be difficult to make things that are *slow*. As a way of slowing the deployment of the chute, so that its shock force was spread over several seconds rather than hitting all at once, BRS proposed to Johnston and his colleagues the use of a "slider ring"—a device that encircled the shroud lines leading from the parachute canopy to the plane. When the chute first deployed, and the plane's speed through the air was at its greatest, wind force on the ring would keep it near the top of the lines, where it would allow the chute to open partway. Over the next few seconds, as the drag from the chute began to slow the plane, the slider ring would move farther down the lines, allowing the chute to open more fully, which would slow the plane more, which would let the ring move farther down, until the chute was fully deployed.

The drops out of the C-123 proved that the ring would work. By the summer of 1998 the team was ready for its first test with an actual SR20. This was potentially a very expensive test: the parachute was designed to save the lives of the people in the plane, but not to spare the plane itself from damage. "The airplane is designed to absorb energy on impact, and it does so by sacrificing itself," Johnston says. The total supply of Cirrus airplanes was two. In order to test the chute repeatedly, the team needed to deploy the parachute, have it slow the plane on its descent—and then permit the pilot to start the engine and cut the chute loose as the plane neared the ground, so that it could land normally to be tested again.

Because desert air gets hot and bumpy as the day goes on, the team would get up at 4:00 a.m. and rehearse each morning's drop. At dawn the main test pilot, Scott Anderson, would fly the test plane, which was white with high-visibility orange marking points on the tips of its wings, tail, and elevators to make its motions easy to follow on film. Chase planes, helicopters, and the occasional jet would accompany Anderson, to film the test from every angle. Time after time Anderson deployed the parachute during dives and spins, to simulate recovery after a midair collision or after a pilot had become disoriented in the clouds, and from level flight, to approximate engine failure. Before the FAA will certify a plane, the manufacturers must show that a pilot can bring the plane out of a spin. The SR20 met this standard through a combination of spin resistance and the parachute, which would arrest the fall within 1,000 feet of where the handle was pulled—less altitude than planes typically lose when recovering from a spin.

After the tests the company was satisfied that it had a product that not only would meet the FAA's explicit safety standards but also could provide a measure of safety not previously available for small planes. The Cirrus pilot would not be able to control the direction of the plane's flight once he—or a passenger, if the pilot was disabled—pulled the handle for the parachute. The plane would drift down wherever the wind took it. But its speed at impact would be comparable to that of a straight drop from only ten feet—violent enough to jar the passengers and damage or destroy the plane, but controlled enough to allow the passengers to survive, probably without serious injury, and to avoid destroying structures on the ground. Some pilots pooh-poohed the need for this safety measure, saying that its main effect would be on nonpilots, who now had an answer to what they would do if the pilot passed out or something else went disastrously wrong.

Cirrus had started with a clean sheet, and the novelty of its new plane got attention throughout the industry as signaling progress out of a stagnant era. By early this year the company had delivered more than 120 planes and was producing them at a rate of one a day. Of its many innovations, the most discussed was the parachute—the first step toward making the public less fearful of travel in small planes.

The Pocket Jet

The Cirrus SR20 was a better, safer, more attractive plane for people interested in learning to fly, and it could serve effectively as an air taxi on short-haul routes. But providing a true alternative to airlines would require turbine-powered planes—the ones we call jets.

The attraction of planes with turbine engines is not simply that they are faster. They are more comfortable, because they can fly high above the storms, ice-filled clouds, and other kinds of weather that produce bumpy rides at low altitudes. They are quieter, for passengers on the plane and for people on the ground. And they are dramatically more reliable, because their fewer moving parts almost never fail. Indeed, a leading reason for failure is that some foreign object—usually a bird—has been sucked through the engine, breaking off turbine blades. This is why "bird-strike tests," in which the carcasses of turkeys or chickens are fired into test engines running at full speed, are an important part of certifying new engines. Their greater reliability means that turbine engines are safer, very rarely forcing a pilot into an emergency landing because an engine has quit.

Cirrus would have loved to race right into the development of an inexpensive "pocket jet," but it didn't have the capital. In the spring of last year the small-plane industry was startled by the appearance of an entrepreneurial firm that seemed to have the necessary cash to do for small jet aircraft what Cirrus had done for propeller planes. This new company, Eclipse Aviation, has an unusual corporate structure, with thirty executives in an office building near the Albuquerque airport and about 150 engineers and designers in a factory in Walled Lake, Michigan, outside Detroit. Together they are working to produce the Eclipse 500, which they claim will be the first jet plane cheap enough to make a difference in a national transportation system.

With a new approach to computerized aircraft design, lean-manufacturing systems, and a dramatically new jet engine, Eclipse promises to market a plane for less than a third the cost of existing small jets. Because this plane will be a jet, it will be fast enough and safe enough to attract civilians. Because it will be cheap, it could provide the hardware for a nationwide network of air taxis and air limos, which could pick up passengers at local airports and take them direct to their destinations. Because it will be small and able to use short runways, it could land at nearly any of the 5,000 to 6,000 airports in North America, rather than just at the 700-odd that now have scheduled commercial service of any sort. And because it will have been designed to hold five people comfortably or six in a pinch, it could be positioned as the SUV of the air, with a hired pilot up front and a small family or business group in the rear.

All these things will be possible ... if the plans work. Eclipse is still in the exhilarating promise stage of the product cycle, when it can excite customers and investors with projections of what its plane will do—rather than, like Cirrus, having to repair the inevitable bugs and apologize for the inevitable delays that come with actually being in production. Eclipse's rivals claim that it is selling "vaporware"—drawing investors and customers away from existing manufacturers with promises that it can't fulfill.

These claims won't be tested until the first Eclipse plane goes on the market, in two years. But enough is going Eclipse's way to have earned it the benefit of the doubt for now. If the efforts of the Klapmeier brothers at Cirrus recapitulate a classic American pluck-and-luck story, Eclipse's tale is one of strengths in one industry being adapted and applied to another. Of the two men directly responsible for its creation, one is in his early fifties and spent most of his career as a software entrepreneur. The other is near eighty and was a leading defense contractor throughout the Cold War. These men, Vern Raburn and Sam Williams, believe that they and the team they have assembled can change the way millions of people travel.

Vern Raburn spent twenty years in the software business, as an executive at Microsoft, Lotus, and Symantec. He has been interested in aviation nearly all his life. One of the first things he did when he began to have money was to buy a Lockheed Constellation airliner from John Travolta and spend a million dollars restoring it. In the mid-1990s, as Raburn was ready to look for another career, Burt Rutan, a famous airplane designer, suggested that he get in touch with Sam Williams, who had an idea Raburn might like to hear.

The name was not new to Raburn. His office was stacked with copies of *Aviation Week* and *Jane's* military journals, and to be interested in military aircraft was to be in awe of what Williams had done. Williams was born in 1921, in Seattle, and raised in Columbus, Ohio; he trained in mechanical engineering at Purdue before World War II. He has devoted his working life to studying, developing, and perfecting turbine engines. In the 1940s he worked at Chrysler, developing gas-turbine engines for airplanes and for an experimental turbine-powered car. In 1954 he established his company, Williams Research, outside Detroit, with three employees. The company grew as it built turbine engines for a variety of uses—in boats, helicopters, airplanes, even a military jeep. His dream of developing a practical turbine-powered car for Detroit's big auto manufacturers was never realized. In the 1960s Williams International engines were used in a turbine-powered "flying belt" roughly similar to the one in the James Bond film *Thunderball*. Williams later bought the rights to the concept and built a kind of personal flying platform; he sold several such platforms to the military.

Williams's company became an important vendor of turbine engines to the military. Its breakthrough came when it designed the engine that made a whole class of weaponry possible. In the 1960s and 1970s the military was struggling to develop cruise missiles, which could carry nuclear or conventional warheads hundreds of miles and deliver them accurately. To be practical the cruise missile required a very small, light, and fuel-efficient engine. Major manufacturers like General Electric and Pratt and Whitney said such an engine wasn't feasible. Williams invented and built one and sold thousands to the military. Most of his factory is generally closed to visitors, but one public room shows letters from Presidents Jimmy Carter and Ronald Reagan thanking Sam Williams for saving the cruise-missile program.

In the 1980s and early 1990s Williams began thinking about how to apply his engine technology to civilian transport. The great challenge in general aviation, as he saw it, was similar to the one the military faced with the cruise missile: how to make modern, efficient propulsion systems available on a small scale. "I saw an opportunity for making turbofan engines that would be lighter and smaller, and lower in cost, than any then available for commercial uses," he told me early this year. Williams generally avoids interviews, and I hurriedly arranged a trip to Walled Lake when he finally agreed to talk with me. At the last minute he had to leave town, so although I saw his factory, I spoke with him only on the phone. In photos he is a serious-looking man resembling the elder George Bush, with gray hair combed back from a high forehead. On the telephone he spoke in a virtual whisper, so that I had to concentrate and press the receiver hard against my ear. "A man used to being listened to," one of his associates said the next day, when I asked if Williams had been sick.

Through the early and mid-1980s Williams International, as it is now called, spent several hundred million dollars to develop a new, small engine called the FJ44. The company is privately held, and the investment was essentially family money. The FJ44 was as important to the business-jet market as Williams's earlier engine had been to the military's cruise missiles, and Cessna, Raytheon, and other manufacturers designed new planes to take advantage of it.

These business jets cost many millions of dollars apiece. Williams wanted to take a more dramatic step. In the late eighties, again with the company's funds, he began work on an engine he called the FJX. What would be extraordinary about this was its size. The very popular FJ44s weighed at least 400 pounds and produced from 1,900 to 2,400 pounds of thrust per engine. That is, their thrust-to-weight ratio was four to one or five to one. Williams's goal was an engine that produced about 700 pounds of thrust but weighed around eighty pounds, for a previously unheard-of thrust-to-weight ratio of nine to one. If he could achieve this compact propulsion system, he thought, changes in nearly everything else about aviation would follow.

Beginning in the early 1990s Bruce Holmes, Daniel Goldin, and the GA team at NASA were also thinking about the potential of smaller, lighter turbine engines. Holmes had launched three big research programs to carry out the vision of the GA mafia. In addition to agate, which had played an important role at Cirrus, there was the "small aircraft transportation system," or sats, to prepare small airports for larger numbers of small planes; and the "general aviation propulsion" program, or GAP.

The idea behind GAP is that the major advances in air transportation have come mainly from advances in propulsion. The truly big change in general aviation would come when small planes could switch from noisy, heavy, unreliable piston engines to efficient, quiet, dependable turbine power—and the key would be bringing down the cost. Thus the primary goal of GAP, NASA said in announcing the program, was "reducing the price of small turbine engines by a factor of 10," from hundreds of thousands to tens of thousands of dollars.

In the mid-1990s NASA and Williams were moving toward the same goal: Williams wanted to build a light, cheap engine, and NASA wanted such an engine to be built. In 1996 NASA promised to contribute $38 million to support the technology needed to bring the engine into operational reality, provided that Williams also invested at least that much.

At the Oshkosh air show in the summer of 1997 Williams was able to display a preview version of his new engine. It attracted enormous attention, because it had achieved the nine-to-one thrust-to-weight ratio previously thought unattainable. The combined weight of the engines for a twin-engine jet could be less than 200 pounds. Suddenly it seemed practical to design a four-to-six-person jet that could land at small fields and would be relatively inexpensive to build.

Exactly how Williams accomplished this breakthrough is something about which his company will say virtually nothing. When I asked Williams himself, he said, "There's no one element that makes these light engines feasible. It's just continuous, steady improvement in fans, compressors, combustion chambers, turbines, control systems—all of the elements that make up an engine."

For example, a crucial element in any turbine engine is the compressor. This is a series of fans, spaced close together, that compress the air more and more tightly, in several stages, before the fuel is introduced for combustion. In a traditional turbine engine a compressor might include several thousand parts, hundreds of which are the individual turbine blades. Williams found a way to machine an entire compressor for the new engine out of a single piece of titanium whose final weight was less than one and a quarter pounds. Other companies now do the same thing. The difference is that Williams learned to do it faster, more carefully, and with a lower defect rate than anyone else.

Before I walked through the Williams factory, I had to agree to consider the visit the equivalent of "deep background": I was allowed to get a sense of how the place looked and what sort of machines it contained but not to describe in any detail the work that was going on there. What I can say is that everything I saw was consistent with the company's official explanation of how it was able to squeeze so much power out of engines so small and light.

As Williams International and NASA were discovering their shared interests, in the mid-1990s, Sam Williams was developing alliances on another front. He believed that his company should only be in the engine business. His customers, therefore, were the companies that built airplanes. Sometimes these companies weren't as quick to recognize the potential of new engines as he would like. Therefore he sometimes built working prototypes of complete airplanes, to give major aircraft companies ideas about how to use his engines and to drum up public demand for a new kind of plane.

Williams was especially eager to do this with the new engine that NASA was helping him create. For the design of the plane that would show off the engine's potential Williams turned, as he had before, to Burt Rutan. Rutan is best known for designing the Voyager experimental airplane, which his brother Dick Rutan and Jeana Yeager flew around the world on a single load of fuel in 1986. By the spring of 1997 Rutan's company, Scaled Composites, which is in the Mojave Desert, had created a flying model, called the V-Jet II.

The plane was based on Williams's concepts and had a self-consciously futuristic look. The wings were swept forward, toward the nose of the plane, rather than back. The tail was in the shape of a large V, something rarely seen in small planes. It was somewhat cramped inside—in theory it held five passengers, but one of the five had to sit more or less in another passenger's lap. The V-Jet II was powered by existing Williams engines, because the very lightweight engine was ready for preliminary display but not for full operational use. This meant that the plane could not go as high or as fast as Williams thought a revolutionary new small jet should be able to. But it did fly, and in Williams's view, it showed the way to the future.

It was with the V-Jet II in mind that Burt Rutan had asked Vern Raburn, "Say, do you know Sam Williams?" In 1997 Raburn took his old Constellation to Oshkosh for display—and found that its assigned space on the tarmac was immediately next to that of the V-Jet II, which was making its debut. Maybe this was an omen. Over the next year Raburn joined Williams in forming Eclipse, began raising money, and quietly took orders for a plane that would be based on the V-Jet II and could provide the backbone of a personal air-transportation system.

Free Flight

As business stories, Cirrus and Eclipse are both admirable—no, inspiring. The more I have learned about the obstacles these companies face, the more impressed I have become by their daring in thinking that they could actually design and produce new airplanes.

What the federal government has accomplished, through the efforts of Dan Goldin, Bruce Holmes, and their colleagues at NASA, is perhaps the most surprising part of the story. It is certainly the part to have received the least notice or acclaim. Starting more than a decade ago senior officials at NASA foresaw today's airline morass. With cumulative expenditures of some $180 million—or less than sixty cents per American citizen—they encouraged competition among private companies to design the engines, wings, guidance systems, and safety protections that could make small-plane aviation a realistic alternative for civilian travel.

Bruce Holmes takes the view that in the long run innovations like those under way could change the broad social attitude toward flying. For now piloting airplanes is clearly an oddball pursuit, but its practical advantages might eventually seem great enough and its elements of risk contained enough to make it broadly appealing. The skills necessary for piloting do not seem in any deep way beyond the public. In terms of hand-eye coordination and the need for split-second decisions, driving in traffic is far more demanding than normal, noncombat or non-aerobatic flying. Indeed, when cars first appeared, it was thought that only experts would be able to control them. The real difference in an airplane is that the consequences of a mistake or a misjudgment can be so great. Also, the equipment is still so much less reliable, and so much extraneous knowledge is required—about weather, about engine systems, about radio commands, about navigation.

Holmes says that it's not even worth speculating about whether more of today's licensed drivers might be drawn to flying. The people to watch are children. "If you went back to the time of the Wright brothers," he says, "and asked if the average person would travel on an airplane, the answer would be 'You've got to be kidding.' Over time that changes." Airline travel became safer, cheaper, ubiquitous, routine. Personal air travel—that is, people flying their own aircraft—can change in the same way, he says, if small airplanes become as safe, cheap, ubiquitous, and routine. Toward that end NASA has launched other programs, as part of sats, to make flying a plane as close as possible to driving a car. For instance, pilots could easily see when to climb, turn, descend, or avoid hazards by following computer-generated highway-in-the-sky displays even in clouds or pitch dark.

Suppose that, a generation from now, planes have met all the goals that NASA has set out. "Then the traveler will have the choice of standing in line for an ever more crowded hub-and-spoke system or flying a plane," Bruce Holmes says. "She could drive ten minutes to the local airport, get to her destination two or three times faster than on the airlines, and find a rental car waiting on the other end. If the prognosticators are right, and the 'golden rule' is 'time is gold,' cultural adaptation will lead us this way."

Between that hope and today's reality lie numerous practical challenges. Above all, small-plane flight must become much safer. Turbine engines are the main step in this direction. The fatal-accident rate for airlines fell by 90 percent from the 1940s, when planes had mainly piston engines, to the 1980s, when they were nearly all jets. The engines weren't the only factor, but they were the most important one. Their effect should be similar in small planes. Better navigation systems, better anti-icing systems, more-durable cabins, parachutes, and other innovations should make a difference too. Sooner or later what Bruce Holmes calls the "Airborne Internet" will become a reality. This is the current incarnation of the GA mafia's original intent to surround the pilot with up-to-the-minute information about every relevant flight condition. It would involve wireless broadband transmissions to give every pilot immediate access to information about hazardous weather, oncoming traffic, and other circumstances that can make the difference between a safe and an unsafe flight.

Small planes must become less expensive. In their different ways, Cirrus and Eclipse are demonstrating progress in that direction. The techniques that have driven down cost and driven up quality for cars, computers, appliances, and most other products will eventually reach the aircraft business too.

New small planes are much simpler to operate than old ones, but they can become simpler still. In the 1950s futurologists routinely predicted that cars would soon be able to guide themselves along freeways: the driver would punch in a destination, and the car would do the rest. It hasn't worked for land travel, and won't for a long time—but the airborne equivalent of such a system is almost in place right now. The autopilot and the GPS aboard even the SR20 are already capable of guiding the plane through virtually every phase of flight.

A full "free flight" system—the FAA's term for letting the computer in each plane find its own, most direct route across the sky—would require only somewhat more computing power than planes like the SR20 now have. Each plane must be able to detect all others in the vicinity, adjust its path for weather problems or high terrain, and synchronize its arrival time for smooth sequencing. This last is the sort of task at which computers excel: routing planes is akin to routing data packets across the Internet. Garrett Gruener is a veteran pilot and a computer entrepreneur who co-founded the Internet search engine Ask Jeeves. He says that in principle such a system could leave the pilot with only two controls. "go" would begin the process of steering the plane all the way along its course, to a safe landing at its destination. "trouble" would be a fail-safe device, like the Cirrus parachute, to rely on if things went wrong.

Then there is the challenge of airports. It is difficult to imagine modern America's building more of them, and yet the vast majority of those already built are mostly idle most of the time. The busiest two dozen airports can barely accommodate another flight. Several thousand others could handle, on average, ten times the traffic they now receive.

This would mean more noise at smaller airports—which is why progress toward much quieter engines is another must on NASA's list. The noise burden increases greatly with the size of the plane. Twenty planes, each carrying five people, can—with the right engines—have a smaller total noise "footprint" than a single airliner carrying a hundred people. Turbine engines are thought to be noisy, because we associate them with the scream of a military jet or the roar of a mammoth 747. But for a given unit of power turbines are quieter than piston-engine propeller planes. The tiny jet engine Williams built for Eclipse is much more powerful than a standard propeller engine, and quieter, too. At the Williams factory I stood a hundred yards from a small turbine engine that was being tested outdoors. At that distance the noise it produced was a moderate whine, like a vacuum cleaner's.

An expanded small-plane fleet would also use more fossil fuel. No small plane can carry as many people as far and as fast on a gallon of fuel as a 747. Similarly, no automobile can match a train in fuel efficiency. But cars still have their place, and car engines can be made much more efficient—as they have already been when the price of oil has risen significantly. Similar progress is possible with aviation engines. Already many small planes compare favorably with cars. The SR20 gets about twenty miles to the gallon, carrying four people at two to three times the speed of a car.

The big airlines will, naturally, continue to play the leading role in high-speed transportation. They will offer the best way to go from New York to Los Angeles, from Atlanta to Seattle, from Washington to London, and on any other long-haul routes. But they clearly need help doing the job. When that help arrives, and people can visit their relatives without trekking hours ahead of time to the airport; salesmen can go from one small city to the next without endless routing through crowded hubs; hospitals can get specimens and supplies from one remote location to another in the same day; and a family in Los Angeles doesn't have to cancel its trip to Kansas City because there was snow in Denver—when these things happen, civilians should thank the aviation hobbyists whose obsessions are making the dreams of a better system come true.

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