

AN INSIDE LOOK AT ECLIPSE

BEHIND THE SCENES AT AN UPSTART STARTUP

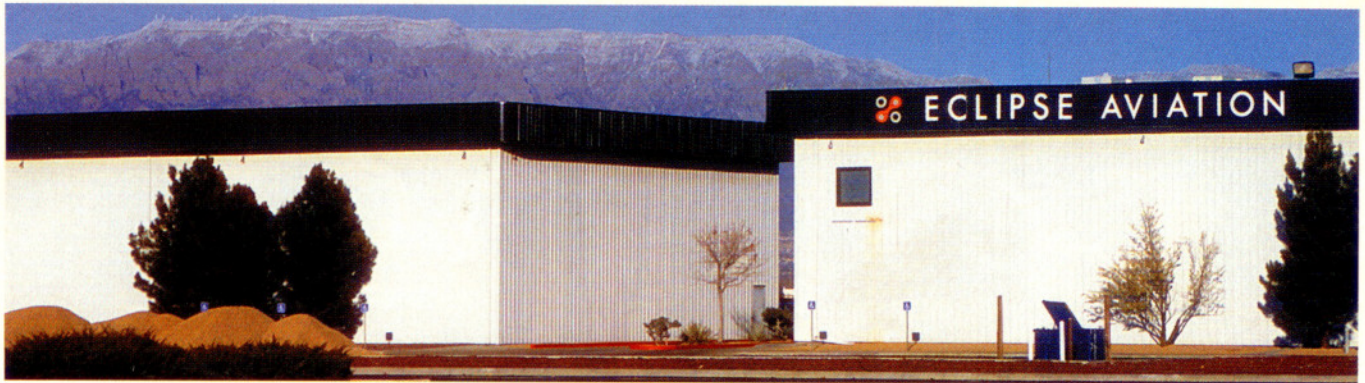
Plowed snow lines the streets of Walled Lake, Michigan, a small town northwest of Detroit, and the lake itself is frozen over. A visitor might believe that nothing exciting will happen here until the spring thaw—but that assumption would be mistaken. ■ Sequestered in Williams International's engineering and administrative headquarters on the east side of town, some 140 engineers and other specialists are designing the Eclipse 500 twin-engine personal jet. Computer monitors show 3-D color render-

ings of wing ribs and the airplane's horizontal stabilizer. Large charts depicting manufacturing flow plans and production schedules literally cover several walls. "What are you going to do *today* to reduce the weight?" reads a sign taped to a cubicle wall. ■ Eclipse Aviation Corporation plans to produce the airplane at a facility in Albuquerque, New Mexico, more than 1,300 miles away. Company officials believe that the five-place jet (a sixth seat is optional)—with an expected 4,700-pound maximum takeoff weight, 355-knot cruise speed, and \$837,500 price tag (in

BY MICHAEL P. COLLINS



ECLIPSE AVIATION



June 2000 dollars)—will revolutionize air travel.

BEGINNING THE ECLIPSE

The Eclipse 500 was first announced in March 2000, but development of the airplane already had been under way for two years. Four months later, Eclipse Aviation Corporation debuted full-size aircraft and interior mock-ups at EAA AirVenture in Oshkosh. The display allowed the company to show its progress and to collect valuable feedback, said Eclipse President and CEO Vern Raburn. "We put our butt on the line in that we guaranteed performance and equipment," he added.

Although the company will not discuss sales figures, orders are secured with nonrefundable deposits. As a result, "these people are committed to us, and they're very involved," Raburn said. "They're also our absolute worst critic—and that's invaluable." Customer feedback has resulted in some changes to the Eclipse 500 design, especially in the interior. "I think most changes have come from how people want to use the airplane. [Now] we have a much better understanding." One change was from six seats to five, with an optional sixth.

Eclipse is guaranteeing a 355-knot maximum cruise speed and a 2,000-lb useful load (both to plus or minus 2.5 percent); a 62-kt stall speed (plus or minus 4 percent); and a 1,300-nm range with four occupants (plus or minus 5 percent). Customer deposits become refundable if those targets are missed. The price includes full electronic flight information



The first Eclipse 500s will be built in this facility at Sunport International Airport in Albuquerque, New Mexico (top). Avionics and electronics will be provided by Avidyne and BAE Systems Aircraft Controls (above).

system (EFIS) displays on the primary flight display (PFD) and multifunction display (MFD); a flight management system; three-axis autopilot; color weather radar; air conditioning; and a full complement of redundant avionics.

NEW AIRPLANE FOR NEW MARKETS

Because the Eclipse is so different from current aircraft, Raburn calls it a *disruptive technology*. He doesn't consider Cessna, Piper, and Raytheon as his competition. "We see our ultimate competition as United, American, or Southwest." The jet is designed to serve both the existing general aviation market and a new air taxi-like market for on-demand, point-to-point travel that Eclipse terms the *air limousine* concept.

Does that sound reminiscent of NASA's Advanced General Aviation

Transportation Experiment (AGATE) program? Perhaps it should—key to the Eclipse 500's success will be its Williams International EJ22 engines, derived from the 700-pound-thrust FJX-2 that Williams developed under AGATE's General Aviation Propulsion program. The EJ22 weighs 85 lb and produces 770 pounds of thrust.

Not only will Williams certify and produce the Eclipse 500's engines, but Eclipse Aviation has contracted with the engine manufacturer

to design, develop, and certify both the aircraft and its production facility. FAA certification and the first customer deliveries are scheduled for 2003.

AN UNUSUAL START

An early employee of Microsoft, Raburn has held senior executive positions at Lotus Development, Symantec, Slate, and the Paul Allen Group. He's also a pilot with 5,000 hours of flight time and type ratings in 15 aircraft. In 1997 he recognized the convergence of digital technology, efficient lightweight engines, high-volume manufacturing, and computerized management systems. That year, Williams International flew its all-composite twin-engine V-Jet II light jet at EAA AirVenture in Oshkosh. Burt Rutan designed the forward-swept-wing airplane to demonstrate the potential of a small, low-cost jet. Raburn met Dr. Sam Williams, Williams International's chairman and CEO, through mutual business acquaintances, discovered that they had similar views, and Eclipse is the result.

What Raburn really wanted to do was

design and certify the airplane, build 20 or so—and just show up at Oshkosh with them ready to sell, recalled Williams. Williams' company had designed a turbojet engine for the military that was 10 percent of the size of the next-largest turbojet and propelled target drones. Williams' small military turbofan led to the cruise missile program. "We are strictly in the engine business here," he explained. "Our role has been to generate new markets by first developing new engines that are quite unique, and then develop a market for them." The company designed its FJ44 engine without a market, he noted, and more than 1,000 are now flying on business jets.

Next up was the FJX program. A NASA contract helped to develop reduced-size components. "In the pursuit of a market for such an engine, I got acquainted with Vern [Raburn]," Williams said.

"The market and opportunity are wide open for what Vern's developing here."

There's a lot of duplication and overlap between an airframe, engines, avionics, landing gear, and other aircraft components, observed Williams, who sits on the Eclipse board. "The approach that Eclipse has taken is to have a well-integrated airplane, much like a modern automobile." This will result in lower cost, weight savings, and performance benefits, he said.

This spring will see endurance testing of Eclipse's EJ22 engine, as well as flight testing of an engine mounted on a larger business aircraft. Williams International is already building a test cell for the "iron bird," essentially a systems testbed that will accommodate two engines and all systems—electrical, mechanical, pneumatic, and hydraulic—that extend into the airplane. "By the time we fly the airplane, all of those systems will have been worked over on the ground," Williams said. That's particularly important because there won't be a prototype—the first Eclipse 500 built will conform to the production design.

Although the EJ22 engine is being built exclusively for Eclipse, Williams said that his company will be developing similar engines for other customers. "[Eventually] we'll build smaller engines. That's been our history, to keep driving down the size of these engines." And although Williams himself prefers



At RCO Engineering, Mike Norkiewicz removes a seat's trim piece from an injection-molding machine (top). Eclipse's seats will be constructed like automotive products (above).

twins, he anticipates single-engine aircraft powered by turbofan engines smaller than the EJ22.

FROM V-TAIL TO T-TAIL

Williams' V-Jet II was very much the model for the Eclipse 500, according to Raburn. "It showed the way on a lot of issues." Although some changes became necessary as the aircraft was scaled up in size, some of the V-Jet's traits—such as engine placement—have been retained. Its composite construction was not, however.

Originally Eclipse planned to build its airplane using a thermoplastic composite process, considered more suitable to high-volume production because it avoided the curing required by a thermal-set composite process. But certifying such a process would cost more than \$50 million and take up to two and a half years, so the decision was made in late 1999 to build the Eclipse from aluminum.

Negative market perception of a V-tail design started a critical look at the tail, and Eclipse's engineers realized that a much more complex structure would be required to mount the engines aft in a V-tail design. And the V-Jet's forward-swept wings—easier to do in composites—were changed in the switch to alu-

minum. "From there, the rest of it was just sort of evolutionary," Raburn explained.

ECLIPSE TAKES SHAPE

The secrecy initially surrounding the project made recruiting employees difficult, recalled Oliver Masefield, Eclipse's vice president of product development. Formerly vice president and head of research and development at Pilatus Aircraft, where he was responsible for the development of the Pilatus PC-7, PC-9, and PC-12, Masefield joined Eclipse in July 1999 and began work full time in January 2000.

"As any design does, [this one] has matured tremendously," Masefield said. His theory is to verify the design mathematically and through simulation, including computational fluid dynamics and wind-tunnel testing, and then run with it. "[Eclipse] was very much [more] a project than

a product a year ago. The devil is in the details, but it can be produced now." Minimizing weight and maximizing production efficiencies influenced the switch to aluminum, despite the much higher initial cost, he said.

Eclipse plans to employ *friction stir welding*, a machine process in which a special tool with a protruding pin is pressed against one of two pieces of material to be joined. The rotating tool moves along the aluminum, creating frictional heat that softens the metal and causes it to bond to the adjoining piece. The process, which is used in the construction of Boeing Delta rockets and by the shipbuilding industry, eliminates rivets and produces a stronger, lighter bond.

FAA certification will require five airframes, three for flight testing and two for static and fatigue tests. In addition, Eclipse will build three "beater" aircraft that will be flown extensively—ideally 1,000 hours each—before the first customer deliveries.

Eclipse's preliminary design review (PDR), conducted during four days last September, was a significant milestone. "PDR was a great experience and an enormous success, but we left PDR with some issues," Masefield explained. But that handful of issues has been resolved, "and the aircraft is better as a result."

The company invited its FAA certification engineers to attend. "The FAA told us that, to their knowledge, this was the

first time they'd been invited to sit in on a PDR," noted Raburn, adding that they provided some valuable feedback. Two weeks after the PDR, Williams International applied for FAA type certification of both the Eclipse 500 and the EJ22.

BUILDING AN INFRASTRUCTURE Eclipse has to do more than design an airplane; it must also build the company that will produce it. Sixty cities vied to host Eclipse's production facility, and Albuquerque, New Mexico, was selected. The company already occupies an inter-

im facility at Sunport International Airport with 78,000 square feet of manufacturing and assembly space. Twenty employees currently work there, including much of Raburn's core management team. An enthusiastic work-hard, play-hard atmosphere permeates the building.

A permanent facility is being designed now for Double Eagle II Airport northwest of the city. It's likely to encompass several hundred thousand square feet. Construction of the facility is expected to begin in 2003.

Initially Eclipse didn't even have a

name. Pronto Aircraft was the secret project's "code name," and it came within 10 days of becoming permanent. A name-consulting firm had suggested Axient and Vectris. But it was an acquaintance of CFO Peter Reed who, at a wrestling match, said, "You should call it Eclipse."

Chris Herzog, vice president of supply management, is tasked with designing Eclipse's supply management strategy. He plans to implement a *demand flow technology*, in which a defined inventory is kept on hand and consumed parts are replaced. "It's a pull principle—I like to use that term instead of 'just in time,'" explained Herzog, who has 20 years' experience at aircraft manufacturers in the United States and Europe, and who worked with Masfield at Pilatus on the PC-12.

With each system, Eclipse has invited in potential suppliers to help develop specifications. "This gives us a confidence level in both the technological side and the costing side," Herzog said. Selected vendors will then work closely with Eclipse in a parallel development effort. Most parts are being bid now and contracts will largely be in place by the end of March.

Herzog said that the interior, being designed by RCO Engineering of Roseville, Michigan, will employ a high degree of automotive technology. RCO built Eclipse's mock-ups and is bidding to produce the interior. RCO primarily does development and prototyping for the automotive industry, but it also provides some limited-run production—and it turns out that high-volume aviation production compares favorably with limited-run automotive production.

"Diversity is absolutely the strongest driving factor" in RCO's interest, said Norman Perkins, RCO's general manager for design and engineering services. "The skill set that is necessary is incredibly similar." Several years ago RCO helped to develop an automotive interior for a new aircraft program that didn't get off the ground, but the exposure proved beneficial, said Norman Starr, director of sales and marketing.

They expect the Eclipse interior to contain few injection-molded plastic components because of their weight. Many parts will be vacuum formed. Look for heating and air-conditioning ducts to be integrated into interior components, much like on a high-end sport utility vehicle.

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Harrington, vice president of business affairs, are working to see that Eclipse customers with no jet experience will be able to obtain insurance. Harrington is working with the insurance market to set up both product liability and customer hull and liability insurance. "Both of them key into the training program," he explained. "The flying's the easy part—it's the planning and decision making that are much more difficult to master."

Harrington, president of the EAA Warbirds of America, sees a parallel involving the Czechoslovakian L-39 jet, which has become a popular warbird in the United States. "It's such an easy airplane to fly, you can train just about anybody to fly it," he said. When the insurance industry saw the training that was being done, it became willing to insure the model.

"We're approaching training from a very professional, airline-style approach," because it will help with the insurance underwriting. Eclipse wants to implement a "line check" concept in which an experienced pilot accompanies a new pilot for some period of time. A contractual agreement may even establish individual weather minimums for pilots; if conditions are below those minimums, then they must be accompanied by an Eclipse check airman.

"The carrot on the stick here is that you'll be able to get the insurance that you probably couldn't get otherwise," Harrington said.

PAYING THE TAB

The company recently completed its second round of financing, raising \$65 million. That will carry the company into mid-2001. "The next 18 months is really the peak of spending," Raburn said, noting that by this spring, 300 people will be working on the program, and the company will begin buying fixtures and tools. Eclipse has raised \$125 million of the \$300 million that he believes will be required to certify the aircraft and bring it into production.

He said that Eclipse 500 sales are well beyond where he expected them to be at this point. The company is talking with "a lot" of fleet buyers, added Raburn, who expects some large orders in the not-too-distant future.

YOU COULDN'T, BUT WE WILL

At trade shows last fall, Eclipse distributed "No WCSYC" stickers. Pronounced *wick-sick*, the term means "we couldn't, so you can't" and reflects the skeptical attitude toward Eclipse that many initially held—and some still do. But

Raburn believes that with each company accomplishment, the number of skeptics shrinks.

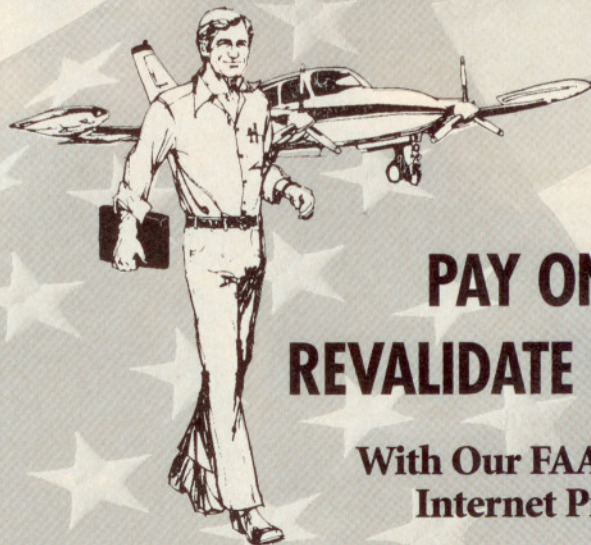
After all, the three biggest challenges encountered so far have been overcome. Raburn's proud of the team he has assembled; the airplane's design has firmed significantly; and, although there will be more capital to raise, the financing is where it needs to be. "There's always been risk," he said. "There's real potential for failure, [but] we feel the risk/reward ratio is balanced—and it's hard to achieve any sig-

nificant reward without taking risk. We're far enough into this program now, and we've accomplished enough, that I feel pretty good."

And Raburn projects the confidence that, when the inevitable next challenge comes along, his team will resolve it with the same efficiency displayed to date. □

i Links to additional information about Eclipse and small jet aircraft may be found on AOPA Online (www.aopa.org/pilot/links.shtml). E-mail the author at mike.collins@aopa.org

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