

Building Stronger, Lighter Laminates With Vacuum Bagging Technology

By J.R. Watson

Vacuumping bagging is a technique that is gaining popularity for laminating a wide variety of materials. High-performance adhesives have made this technique practical for the average builder because they can form high-strength bonds with only contact pressure.

Vacuum bagging provides even bonding pressure, while eliminating the need for staples or mechanical clamps; clearly a production advantage.

Bonding with a vacuum can result in a superior resin-to-fiber ratio, which translates into great weight and cost advantages. Vacuum bagging is ideal for the production of lightweight, cored panels and high-volume laminates. This is possible because of the equal pressure exerted over the entire laminate as it cures.

Mechanical clamping, on the other hand, usually applies pressure to only concentrated areas. Mechanical clamping can also damage fragile core materials or veneers in one area while not providing contact in another.

Staples can be placed in a closely spaced pattern (perhaps one staple every few inches) but

they are limited to exerting less than 5 p.s.i. of clamping force, and only in the immediate area of the staple. Staples may also be impossible to use if you're laminating a foam or honeycomb core which have nearly zero fastener-holding power.

Vacuum bagging does have its drawbacks, however. There is a relatively substantial investment in equipment. You'll need a vacuum pump and some sort of a mold, whether simple a table for flat panels or an actual mold in the shape of the finished product. There are also additional bagging supplies which you'll need.

But once you've acquired the necessary tools and become familiar with the techniques for this method of bonding, you'll wonder how you ever got along without vacuum bagging.

Theory

Vacuum bagging involves placing a laminate between a mold and an airtight bag. The bag is sealed to the mold and a vacuum pump is attached. The pump evacuates the air, and presses the laminate to the mold with even, firm pressure across the entire laminate surface. Theoretically, the maximum pressure a

vacuum can exert is one atmosphere, or 14.7 p.s.i. Because it is difficult to achieve a perfect vacuum in most shop applications, 10 p.s.i. is a realistic vacuum pressure.

Excess epoxy between the laminates is squeezed out, resulting in a lighter laminate than might be possible using traditional clamping methods.

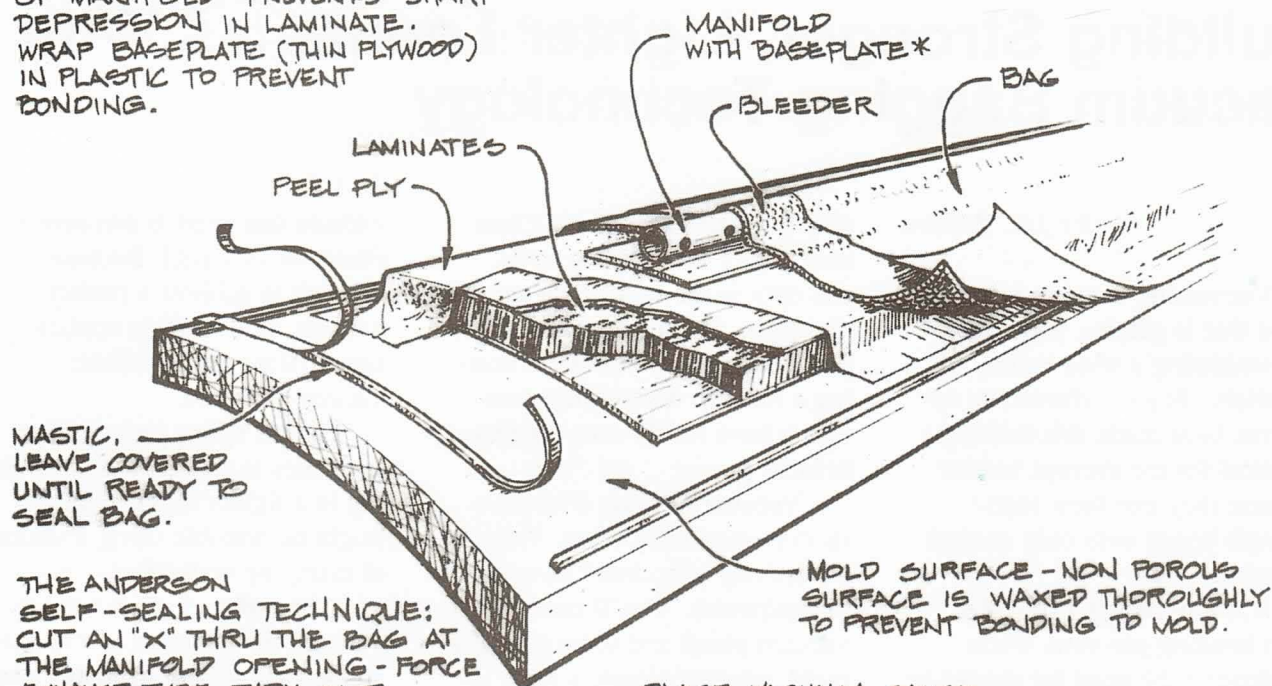
The molds that are used to vacuum the laminate to a specific shape vary widely in shape, size and method of construction. One of the simplest molds is a flat, rigid table, used for producing flat laminates or panels. Often, the table is faced with Formica[®] covering. The Formica surface is waxed so that the epoxy will not adhere to it. Any portion of the table may be used, and multiple lay-ups of different sizes or materials can be vacuum bagged at one time.

Other common mold shapes are half-cylinder, torus or a section of a cone. In all cases, the molds must be airtight. Coat porous surfaces such as plywood with several applications of epoxy to provide the necessary air-tight surface.

Male molds, (a boat hull, for example) can be made up of stringers over mold frames. Two

VACUUM BAGGING

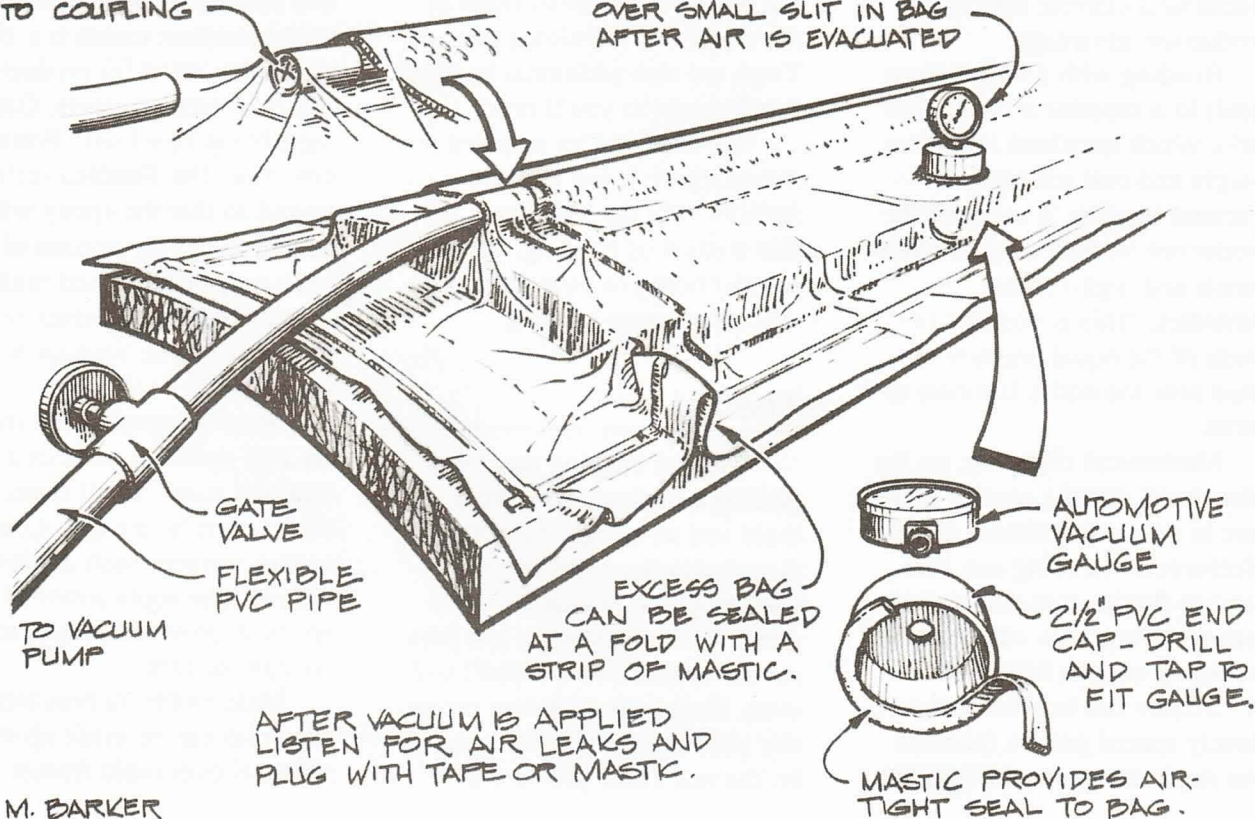
*BASEPLATE SPREADS LOAD OF MANIFOLD - PREVENTS SHARP DEPRESSION IN LAMINATE. WRAP BASEPLATE (THIN PLYWOOD) IN PLASTIC TO PREVENT BONDING.



MASTIC, LEAVE COVERED UNTIL READY TO SEAL BAG.

THE ANDERSON SELF-SEALING TECHNIQUE: CUT AN "X" THRU THE BAG AT THE MANIFOLD OPENING - FORCE EXHAUST TUBE THRU SLIT INTO COUPLING

PLACE VACUUM GAUGE OVER SMALL SLIT IN BAG AFTER AIR IS EVACUATED



M. BARKER

layers of 1/8"-thick veneer are bonded over the frame work, followed by a layer of fiberglass cloth. The smooth fiberglass provides an excellent air-tight bonding surface.

Female molds are usually constructed over a master male plug. The plug is waxed thoroughly to prevent bonding, and then a schedule of fiberglass, wood or core material, and more fiberglass are bonded onto the plug. The mold is then braced with a rigid framework. The new mold is removed from the male plug, and is cleaned and waxed. The new lay-up is then laminated inside the mold. The first laminate into the mold will become the exterior surface of the finished structure.

The advantage of a female mold is that it provides a nearly finished exterior surface and duplicates the shape of the original plug's surface. It also allows you to tailor the laminating schedule to avoid stress concentrations, while reinforcing highly loaded areas.

Equipment

- **PUMP** The heart of a vacuum system is the pump. The type and size of the pump will be determined by the typical job you'll be doing. Two stage, rotary vane pumps are ideal for vacuum bagging. Generally, a 1/3-HP pump will deliver 3.5 cubic feet per

minute (CFM) of displacement adequate for up to a 14' hull. For larger jobs, a machine with a displacement of 10 CFM may be required.

Some builders have even successfully used old cow milking machine pumps and even vacuum cleaner pumps. For details on the proper selection of pump size and type we suggest reading *Vacuum and Pressure Systems*, available from the Gast Manufacturing Corporation, P.O. Box 97, Benton Harbor, Michigan 49022, (616) 926-6191.

- **VACUUM BAG** If you plan to use vacuum pressure of less than 5 p.s.i., 6-mil polyethylene plastic can be used for the bag. Clear plastic is preferable to a color material for easy inspection of the laminate as it cures.

For higher pressure applications, specially manufactured vacuum bag material should be used, such as Capran[®] 512 LTX 2-mil plastic film. Generally, the better the air-tight seal and bag material, the smaller the pump you'll need. Poor seals, or material which allows air leakage, will require a larger capacity pump to maintain satisfactory vacuum pressure.

- **BLEEDER MATERIAL** A bleeder cloth allows air to escape to the manifold and helps

equalize the pressure over the entire mold surface. A variety of materials can be used for a bleeder including plastic bubble packing material, mosquito screen, burlap, fiberglass cloth or an air bubble swimming pool cover.

- **PEEL PLY** Peel Ply is a specially treated nylon material which is extremely strong, yet epoxy will not bond to it. Peel Ply helps provide a relatively fair final finish and protect the bag during the vacuum operation. (See Side Bar)

- **MANIFOLD** The manifold is usually a piece of 3/4" PVC pipe with a cap at one end. Holes, 1/4" in diameter, are drilled every 4" along the length of the tube. A variety of other materials can also be successfully used as a bleeder conduit, depending on the size of your job.

- **MASTIC SEALANT** The vacuum bag must be sealed to the mold after the laminate is in place. We use a mastic material (GS-213) produced by General Sealants Corporation. The mastic may also be used to seal the point where the manifold enters the bag and for repairing leaks in the bag.

- **VACUUM GAUGE** A vacuum gauge, available at most automotive stores, is modified by threading a 2-1/2" PVC pipe cap to the base. In

use, the end of the cap is sealed over a hole in the vacuum bag. The gauge will monitor the vacuum.

Most gauges usually read in inches of mercury. To convert this reading to pounds per square inch (p.s.i.), simply divide the reading by two.

Procedures

The mold should be clean and waxed with a mold release agent (automotive wax works well), or covered with a piece of plastic to prevent the laminate from bonding to the surface.

The laminate materials, pre-cut and fit, are coated with epoxy. For maximum open assembly time, use WEST SYSTEM 105 Resin and 206 Slow Hardener or Gougeon Laminating Epoxy. (See article on page 11.) Place the laminate into the mold and cover with a piece of Peel Ply. The manifold is then usually positioned in the center of the mold and the bleeder material placed over it. Finally, the bag is placed over the laminate and sealed in place with the mastic.

With the bag tightly sealed, the manifold is then attached to the vacuum pump. A piece of flexible PVC tubing usually connects the manifold to the pump and is fitted with a gate valve.

After the pump is started, the gate valve is gradually opened. The pump begins evacuating the air from the bag, squeezing the

laminate tightly against the mold. The pump must run for the duration of the epoxy cure cycle, a minimum of 5 to 6 hours. The vacuum gauge is positioned over a small slit in the bag and sealed with mastic.

After the laminate has cured, the gauge, bag, bleeder material and manifold are removed, and the Peel Ply is pulled from the cured surface. Finishing steps, such as trimming, and fitting and bonding interior components, can

be completed while the laminate is still in the mold.

At Gougeon Brothers, we routinely use this technique on molds as large as 300 square feet, or as thick as 12 inches. The possibilities and uses for high performance laminates using vacuum bagging techniques are limited only by your imagination.

For a price list of pumps and vacuum bagging supplies available from Gougeon Brothers, call (517-684-7286).

Peel Ply: A Work Saver

Professional-looking fiberglass repairs and new construction laminates can be made with the help of a new product GBI product called #775 Peel Ply. Peel Ply is a re-usable woven nylon fabric treated with a finish to which epoxy will not bond. It weighs about 2 ounces per square yard and is available in 30" x 18" pieces or by the yard in 60" widths. It is very strong, and useful in a number of bonding applications.

A layer of Peel Ply laid over a wetted fiberglass laminate is easily smoothed with a plastic squeegee. This removes irregularities and trapped air from the surface. Excess resin will seep through the weave of the Peel Ply, leaving the laminate with a higher fiber-to-weight ratio. The result is a strong, lightweight laminate.

Peel Ply protects fragile wet fiberglass cloth as it cures and allows you to level layers of fiberglass without damaging the fabric. The Peel Ply is left in place until the laminate has cured.

When the epoxy has cured, the Peel Ply is pulled away. The surface of the laminate will be smooth and attractive, needing little or no sanding. The fine texture of the Peel Ply is transferred to the laminate surface and is ideal for further bonding.

Peel Ply is a versatile application tool. We would like to hear about any new uses you discover for this product, so we can try them out ourselves and pass them along to our readers.

. Cedar Falls man's avocation takes off by building planes

By [JIM OFFNER, jim.offner@wcfcourier.com](mailto:jim.offner@wcfcourier.com) | Posted: Tuesday, September 28, 2010 8:45 am | [\(0\) Comments](#)

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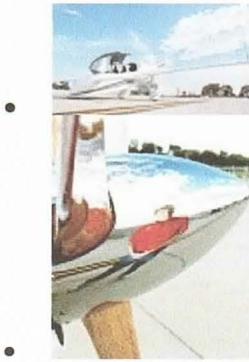
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[Buy this photo](#) Dennis Oelmann, of Cedar Falls, poses with his Cozy 3 vintage airplane, at left, as he holds his newly acquired award, at Livingston Aviation, in Waterloo, Iowa, on Wednesday, Sept. 15, 2010. Oelmann's plane was self-built (without any formal training) by following drawings in 1989. Oelmann got the award at the Oshkosh air show, which he has been flying in every year, for his vintage aircraft. (DAWN J. SAGERT / Courier Staff Photographer)





CEDAR FALLS, Iowa - There are dreamers who will themselves to success in the business world, and there is Dennis Oelmann, who has taken the concept to heights that the Wright brothers would appreciate.

On the surface, Oelmann, 53, a food-safety inspector for the Iowa Department of Agriculture, would seem to blend into the workday world

That's how the Cedar Falls resident pays the bills.

He feeds his dream in the ethereal world of aviation.

And, he literally built that aspiration from the ground and worked his way up.

A little over 20 years ago, Oelmann, who has had no formal training, built himself an airplane in his garage in Evansdale, he said.

"My neighbor bet me \$100 I wouldn't finish it," he said.

Starting with nothing more than a set of instructions, Oelmann went to work.

"You get drawings and written instructions on how to do it and which suppliers you can buy materials to make it from," he said.

He spent about \$30,000 in 1989 dollars on materials and devoted 28 months to his project.

When he was finished, he had a three-seat Cozy III rear-engined craft capable to traveling 190 miles per hour.

His neighbor paid up on the bet.

"Now, he asks me to help him with hot rods he works on," Oelmann said.

Winning awards

Shortly after Oelmann finished the plane, he entered the Lindy Awards competition at the annual Experimental Aircraft Association (EAA) AirVenture air show in Oshkosh, Wis., and came away with an Outstanding Workmanship prize.

It was not his last. Since then, he has won two more Lindys - including a Bronze Lindy in the Plans Champion category for Vintage Aircraft at the 2010 EAA show in July.

A second plane he built in 1999 - and subsequently sold - won a workmanship award at the 2000 show. Yet another, which was built with parts he designed and built, captured a Lindy in 1994.

Oelmann said he never received any formal training; he didn't attend college.

But, he says he has been passionate about aviation at least since his teens. In fact, he got his pilot's license at age 19 and even spent eight years as a part-time flight instructor at Livingston Aviation in Waterloo.

Then, he got an itch to build his own plane.

"Instructing is hard work, and I worried about my students," he said. "I just thought I'd just build my own airplane and enjoy flying."

That, he does. He has flown his creation from its permanent berth at Hangar 4 at the Waterloo Regional Airport to both the East and West coasts. If there are fish to be caught in Lake Michigan, he and a friend will fly to the shore in Wisconsin.

"It's an hour, as opposed to 5 1/2 by car," he said.

Seeing the dream through

Dreaming is easy; seeing a dream through is the tough part, Oelmann said.

He said he was fortunate to have aptitude that could live up to his dream.

"Not everybody has all the skills it takes to build an airplane," he said.

Oelmann said he couldn't do the job entirely alone.

"You have to find the people that can help you," he said. "I'm not very good at wiring, so I had to have somebody help me wire it."

He got now-retired UNI professor and fellow aviation enthusiast Rex Pershing to handle that job.

"He was also building a plane," he said. "We kind of built them at the same time."

In turn, Oelmann helped others build their own planes.

He designed and produced parts for Doug Koster, an aviation enthusiast from Aurora, Ill., who was inspired to build his own Cozy Mark IV by seeing Oelmann at the Oshkosh air show.

"I saw his airplane at several shows; it's a beautiful airplane, so I decided to build one like his," Koster said.

Koster added that Oelmann's expertise was invaluable in his own plane-building odyssey.

"He has a gift to build airplanes very well," Koster said.

Koster's plane won a Lindy award, in 1994.

"He's got a talent that's unbelievable," Koster said.

Oelmann has since branched off into other areas.

He has built parts for the U.S. Navy in 2007 for unmanned drones, built tractor hoods used by Deere & Co. and has built parts for other home-based airplane builders throughout the world. He says he has parts all over the world, including Australia, Italy, Russia, France, Germany, Israel, Singapore, Hawaii, Canada, South America and across the U.S.

"We consider him one of the prime resources of specialized talent we draw from," said Bob Diedrichs, president of Cedar Falls-based Diedrichs & Associates Inc., an engineering, design and building consulting firm that has contracted work to Oelmann.

"When we build a product prototype for a client to show to their upper, upper management, Dennis can help make that prototype look like a production model."

Oelmann says he doesn't have a pat explanation for his building skill.

"I just read the plans," he said. "If I buy something and read the plans and put it together, it's something that comes natural to me."

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The couple who reached for the skies

By jenny grant jenny.grant@essnmedia.co.uk

AN INTREPID Reigate couple have flown two-thirds of the way round the globe in an aeroplane they built in their garage.

Husband and wife crew Patrick Elliott and Linda Walker have already plane-hopped through 20 countries.

Only 10 people have completed a full circumnavigation in a homemade light aircraft before. The couple could join that select list, even though a recent hiccup forced them to ship their plane by sea across the Pacific.

Mr Elliott, a retired British Airways pilot, built the tiny Rutan Long-EZ craft with the help of a manual in the couple's Reigate garage.

It took 16 years to finish and it was only once the couple started flying it that the around-the-world plan took seed.

"We are not ones for just piddling about in the sky," said Mr Elliott, 57. "We always wanted to get somewhere with it. Initially it was going to the Isle of Wight for a cup of tea, then it got further to visiting relatives around the UK, and [France](#) for lunch. Then early last year we made our first long trip down to [Malta](#). That made us realise we could probably do this."

The couple set out for [Australia](#) on September 11 last year, hitting France, [Italy](#), [Greece](#), Saudi Arabia, [Bahrain](#), United Arab Emirates, [Pakistan](#), [India](#), [Bangladesh](#), [Thailand](#), [Malaysia](#) and [Indonesia](#) on the way.

Their feat – and their minute, futuristic-looking plane – attracted attention at every stop.

Aside from a couple of hairy landings in high winds, the adventure went smoothly until they hit a stumbling block on the return journey.

The Japanese authorities would not permit them to land without a particular certificate that is not granted to homemade planes.

"We tried everything to get in," said Mr Elliott. "But when the earthquake and tsunami hit we decided it would not be moral to continue to pursue it.

"The alternative route was [China](#) but it hasn't quite opened up enough yet."

Their beloved plane is now being shipped from their last stop, Taiwan, to Vancouver, from where they will continue their trip this summer.

They may not now qualify as "earth rounders" – although others have after shipping their planes for a section – but the duo are philosophical.

"I think it is an amazing achievement that we have gone as far as we have," said Ms Walker, 57. "We have always said we will get as far as we can and if we don't make it all the way around, so be it. It's a journey of a lifetime."

"It irks me that we aren't going to be able to do it," added Mr Elliott, "but at the end of the day Linda is right. I do look at the map though, and just think, 'if only'.

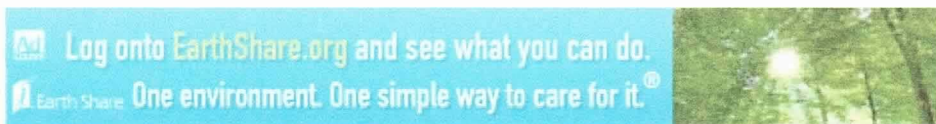
"The trip has been about having fun and visiting lots of places. The highlight has been the people we have met, who have been just amazing."

Follow the adventurers' blog at www.travelpod.com/s/L.P+EZ+Adventures

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They know 'Hoot loves EAA'

NORTHWESTERN STAFF

Tom Poberezny got some help from NBC's Katie Couric when he introduced Robert "Hoot" Gibson to the audience at EAA's Theater in the Woods Thursday evening.

"I just love to say the name 'Hoot,'" joked Couric, in a clip from the "Today Show" shown on an oversized movie screen. Then she asked him about his "I Love EAA" bumper sticker. Many in the

crowd stood and waved similar signs when Gibson stepped on the Oshkosh stage.

Poberezny thanked Gibson for the free advertising, but chided him for not going far enough. The EAA president presented Gibson with a hat that read, "Hoot loves EAA" and a blue jumpsuit with the embroidered message, "1-800-Join EAA."

After introducing three other members of the 10-member NASA crew, Gibson

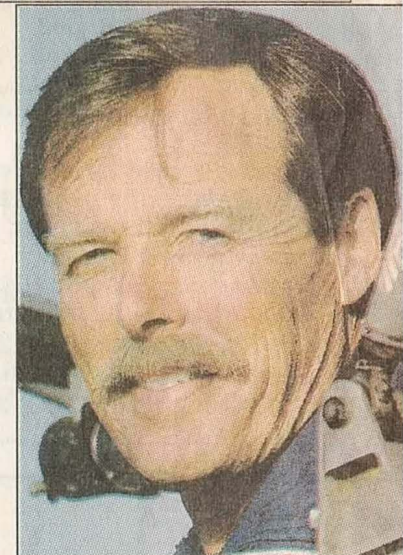
narrated breathtaking slides of the shuttle's recent docking with the Russian space station Mir.

"We had a docking window of two minutes, and we were two seconds late," he said.

Gibson, who has been coming to the EAA since 1985, pleased the crowd when he mentioned that everyone on the Atlantis crew was an EAA member.

If Wittman Regional Airport were a fly-in motel, accommodations for an overnight stay might be hard to come by.

An estimated 10,000 to 11,000 aircraft were parked Thursday during opening day of the 43rd Experimental Aircraft Association Fly-In Convention, according to Mark Ringham, a volunteer air traf-



Robert 'Hoot' Gibson

HOOT, PAGE A2 ▶



Gates open at 8 a.m. every day except for Friday through Sunday when gates will open at 7 a.m.

Today

Air show starts at 3 p.m.

Bud Light Jet (Bill Beardsley), Delmar Benjamin, Julie Clark, Bob Davis, Eagles Aerobatic Team, Rick Fessenden, Jim Franklin, Marine Corps Harrier, Liberty Parachute Team, Gene and Cheryl Rae Littlefield, Dave Morss, Jim Mynning, Howard Pardue, Russian Sukhoi, Len Shattuck, Sean Tucker, and Bob and Pat Wagner.

Evening programs at Theater in the Woods include National Aeronautic Association Awards; Hints for Homebuilders Awards; EAA President's Award; EAA Freedom of Flight Award to Gen. Chuck Yeager; Recognition of General Aviation Manufacturers Association; Eagles Aerobatic Team looking back over 25 years of air show excellence and family entertainment by the Grand Ole Opry's Mike Snider.

Saturday

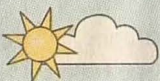
Air show starts at 3 p.m.

Warbirds of America (extended show), Bud Light Jet (Bill Beardsley), Ken Brock, Eagles Aerobatic Team, Jim Franklin, Wayne Handley, Marine Corps Harrier, Liberty Parachute Team, Sean Tucker, Patty Wagstaff and Homebuilt Review.

Evening programs at Theater in the Woods include Mass celebrated by the Rev. Donald Braun, sung by Yvonne Matt; Don "The Whistler" Conrad, the longest-running act at Theater in the Woods; EAA's Young Eagles Program; Recognition of NASA Administrator Dan Goldion; EAA/MSOE Award presented to Paul Poberezny; EAA's "Tribute to Valor," with host David Hartman.

Forecast:

Mostly sunny. Highs in the 90s.



A FRACTION OF the VariEzes that are on static display in the transient parking area draw the attention of a spectator on the opening day of the EAA Fly-In Convention.

DAVID BURTON/OF THE NORTHWESTERN

◀ Hoot

FROM PAGE A1

fic controller at the Wittman tower.

"We're not quite full," said Ringham, of Fargo, N.D. "When we're full, we've got 12,000 planes."

Ringham said transient aircraft parking was filled to capacity, but spaces were available in the show plane area.

More than 1,500 of the parked aircraft are show planes, according to Golda Cox, chairman of the EAA press headquarters.

Ringham, however, said that because the transient parking area was full, pilots who wanted to land at Wittman were asked Thursday to use airports in Appleton and Fond du Lac.

Room in the transient aircraft area should open up Monday morning, he said.

Despite an inch of rain Thursday, Ringham reported no problems in landing aircraft.

"We haven't had any problems with field conditions through 8:30 (p.m.), but I don't

as the North and South Exhibit Hangars.

The \$1.4 million project is one of the biggest changes on the convention grounds in recent years. It is the first expansion of exhibit area on the grounds since 1985.

The new buildings will help meet the need for more exhibit space. The hangars will provide 608 indoor exhibit booths, compared to 289 last year.



One of the highlights of opening day was the arrival shortly before noon of more than 60 VariEze (pronounced "very easy") homebuilt airplanes.

This year is the 20th anniversary of the sleek white aircraft, designed by Burt Rutan. Rutan is best-known for designing the "Voyager", which circled the globe non-stop on one tank of fuel in December 1986.

The planes, from throughout the country, gathered in Racine for the 30-minute