



The Lewis and Vought Bluebird Airplane



***How and Why a Replica Was Built
December 2006***



Preface

- ***Dedication: The VE-7 replica was painstakingly researched and built by Vought Aircraft Industries Retiree Club. We are thankful to Vought Aircraft Industries, Inc. for years of support given to us and creation of the Vought Aircraft Heritage Foundation. Thanks to Vought Aircraft Industries for providing facilities and funds for materials to build the VE-7 replica. A special thanks to the machine, tooling, paint, and sheet metal shops personnel and the structures lab personnel for their outstanding support.***

In the mid 1990's, a group of Vought retirees and members of the Vought Aircraft Industries, Inc. Retiree Club, under the sponsorship and generous support of the Company, Vought Aircraft Industries, Inc., undertook the following two initiatives designed to preserve and promote the Vought heritage:

- (1) The Vought Heritage and Education Internet Program
- (2) The Vought Aircraft Restoration Program

The Education Internet Program has resulted in a 1000-page website that was opened in 1999 and is now accessible at www.vought/heritage.com. There you will find the entire picture of the company, its history, people, products, science and accomplishments from its opening day in 1917.

The Restoration Program involves the search and acquisition of Vought-produced aircraft artifacts, their transportation to our facility, and finally their restoration to museum-quality aircraft for local display to the public. Our first aircraft, a badly damaged A7B Corsair II, was obtained as a government loan in 1999 from the National Museum of Naval Aviation in Pensacola, FL. Since then, four Vought artifacts, including the A7B, have been restored, and four more are in the process of restoration. In addition to these, a full scale replica of Vought's first production airplane, the VE-7 Bluebird, is being built from "scratch." This is where our heritage began in 1917. The following pages show how and why we, the Vought retirees, with the support of Vought Aircraft Industries, built the aircraft.



Retirees' Objective for the VE-7 Replication Project

- **Construct a full-scale, non-flyable replica of the Chance Vought-produced U.S. Army and U.S. Navy VE-7 aircraft for static museum display to help promote and preserve the Vought heritage.**
- **The VE-7 flew for the first time in 1917. For the history of the VE-7, go to www.vought.com/heritage.**
- **The Lewis and Vought Corporation was organized in 1917 and became the Chance Vought Corporation in 1922.**



The Vought Retirees Who Did It

1. Richard Roberson
2. Jerry Fischer
3. Jim Lengen
4. Wayne Vaughan
5. Jim Walston
6. Bob Surratt
7. Roland Nepier
8. Robert Brown
9. Marvin Robinson
10. Jean Shelley
11. Jack Shelley
12. Carl Klapprott
13. John Jipp
14. Marvin Stifter
15. Robert Rainey
16. Jack Brouse
17. Jerry Burk
18. Brooks Taylor
19. Richard Sheaner
20. Dave Morse
21. Charlie Stalcup
22. Rich Colleoni
23. Danny Heard
24. Rick Hicks
25. Pat Patterson
26. Bob Szabados





The Vought Retirees Who Did It

*Looking down from above.
(Gone but not forgotten.)*



Walt Riggs



Harry Diehl
7-8-03



The VE-7

Building a Replica of the Aircraft that Turned Around a Company

The Challenge

How do you bring back a legendary aircraft that has been essentially extinct for more than 60 years? That was the task facing the Vought retirees who were challenged by Bob Turney to construct a VE-7, after Bob had been given tentative encouragement to explore the feasibility of the venture by the Restoration Governing Body. Turney, impressed by the record established by the venerable aircraft, had obtained and reviewed three-view/general arrangement drawings that replicated the actual configuration of the aircraft in reasonable detail. As an airplane pilot and a long time model airplane builder with some experience in full-scale light plane restoration, he was fascinated by the unique materials and construction of the aircraft.

Turney approached experienced aircraft designer, John Jipp, for his thoughts on the subject. John had worked on the Vought Heritage website and was familiar with the history of the aircraft, a highly acclaimed trainer/fighter that served a pivotal role in Vought's history. Undoubtedly, it was one of Vought's most successful airplanes, dubbed "the aircraft that got the Company off the ground."



Turney (left) asks Jipp for help in designing and building a VE-7 replica



The Challenge (Cont)

A search for parts revealed that there were not nearly enough to reconstruct a VE-7, so the decision was made to build a full-scale museum model replica. Bob Turney made a full-size partial wing section in his home workshop to stimulate the team's thinking as to how the wing might have originally been made.

With the continuing and important support of Vought Aircraft Industries, Inc., John Jipp began work in January 2002, reviewing VE-7 photos and contacting people and organizations who might have knowledge of the whereabouts of any existing VE-7 drawings. At the same time, Jipp spent three months "borrowing" drafting tables, chairs, table lights, drafting materials and machines in Vought and Lockheed Martin facilities. He then started recruiting a team of highly talented and experienced engineers and manufacturing specialists and set up an office in the Vought Aircraft Heritage hangar.

Jipp started designing the vertical stabilizer and rudder in April 2002. It was the first assembly to be manufactured and showed visitors that the team was serious about making a VE-7 replica from scratch.

In June 2002, Dave Morse visited the Boeing Museum of Flight in Seattle and found the only remains of a VE-7: an upper wing center section, horizontal tail, elevator, wing outer panel, wing panel skeleton and engine. Information obtained on that visit gave the team authentic dimension and materials information on the VE-7 parts, and photos taken showed the colors of the original airplane. The data from the trip assisted the team in making drawings for the wings and the horizontal and vertical tail.

The team acquired VE-7 model drawings with dimensions. In November 2002, after locating original VE-7 drawings (mostly various assembly drawings) at the Smithsonian National Air and Space Museum, the team bought all the available VE-7 drawings. These drawings lacked the detail required to make parts, so it was back to the drawing board.



VE-7 Design Engineering Team (Left to Right): Marvin Stifter, Robert Rainey, Dave Morse and John Jipp



The Team Gets Started on Design

Settling in at the drawing boards, the team rolled up their sleeves and got cracking, recreating the drawings as close to the originals as possible. These drawings were created in the “old fashioned way”, but within the capabilities of manufacturing:

- **Dave Morse started creating basic data from the model drawings for the wing design in March 2002, then designed the spars**
- **Bob Rainey started design of the horizontal stabilizer in March 2002, then produced the basic fuselage design. (The fuselage design was accomplished by scaling from a 1/8-size skeleton assembly drawing from the Smithsonian Institute.)**
- **Marvin Stifter started design of the wing ribs and wing assembly in April 2002**
- **Carl Klapprott started design of the fuselage upper fairing, upper bulkheads and instrument panels in November 2003**
- **Jerry Burk designed and made the tail skid and obtained some landing gear drawings**
- **John Jipp created the vertical tail drawings from model drawings.**

Fortunately, the team was able to obtain drawings of all the various fittings which provided terminals for the various cables that reinforced the basic structure. These cables, under tension, ensured that all the basic wood frame was kept in compression for all flight loads. The fittings were made from sheet metal and formed mostly with a hammer and vise.

Dave Morse surprised the team by relaying that Bob Surratt in the shop could make a propeller for the VE-7 if Dave could design it (since Dave was the only one who could do it).

The design of the VE-7 was an eye-opener for the team, with its unique characteristics, including 199 cable assemblies identified to date that add strength to the wooden parts in most components of the aircraft. The cable assemblies are made from stainless steel wire and the end fittings and turnbuckles are government standard “AN” and “MS” parts.



The Team Gets Started on Design (Cont)

Perhaps the most interesting aspect of the design effort was the difference in approach from modern engineering requirements. The design team was tuned to aircraft design techniques they had used during their working years, employing modern tooling to form and shape detail parts. They soon realized that the manufacturing team could not fabricate parts in these conventional ways, so they had to negotiate with the manufacturing specialists on a viable design for the unique VE-7 requirements.

The flight instruments were identified in some early photographs. They were found to be indigenous to the VE-7 era and generally unavailable. Richard Sheaner was able to accurately simulate the instrument faces using computer techniques and information from the old cockpit photos.

As the design effort continued, an excellent team of highly skilled, retired manufacturing specialists joined the team. The roster included the following:

Jack Brouse – Fabric consultant

Bob Brown – Assisted in obtaining Vought's surplus materials

Jerry Burk – Built tail skid and provided landing gear engineering assistance

Dick Colleoni – Assembly of all ribs for tail and wings

Harry Diehl – Initial team leader for manufacturing and lead assembler of the spruce spars

Jerry Fisher – Fabricated wing and fuselage attach fittings wing strut assemblies, and did trial attachment of wings to fuselage

Jim Lengen – Team Leader for all VE-7 fabrication and assembly

Frank Laubenthal – Fabricated welded elevator hinges

Burt Noble – Fabricated some flight control parts and various small machine detail parts

Pat Patterson – Fabricated and assembled flight controls with all wire and cables and fuselage attach fittings

Walt Riggs – Assembled wing ribs and cap strips

Richard Roberson/Bob Brown – Fabricated entire horizontal and vertical tail assembly, did sheet-metal work on fuselage and attach fittings, and guy wire installation

Marvin Robinson – Fabricated virtually all the detail wood parts, wings, cap strips, leading and trailing edge contours, landing gear for the aircraft including the jigs and fixtures for fabrication of these parts



The Team Gets Started on Design (Cont)

Richard Sheaner – Fabricated cockpit instruments

Jack Shelley – Fabricated the engine cowling

Jean Shelley – Fabricated the engine cowling

Charlie Stalcup – Provided liaison with Vought manufacturing for materials, equipment and special fabrication

Bob Surratt – Assembled wing ribs, cap strips, leading and trailing edge contouring and fabricated the propeller

Bob Szabados – Provided wood finishing, tooling and assembly of engine exhaust system

Bob Turney – Contributed to the extent possible, but administrative assignments on the overall restoration effort prevented full-time participation on the VE-7

Wayne Vaughn – Fabricated wing spars and completed assembly of four ailerons and rudder pedal fittings

Editors: Adam Galan – Writer and editor for this book

Brooks Taylor – Writer and editor for this book

Janet Cumby – Production formatter for this book

Photos by – Marvin Robinson

Dick Guthrie

Dick Atkins

Richard Sheaner

The last engineering drawing was completed June 2005.



Manufacturing Progress

Engineering empennage releases started in June 2002 and manufacturing work started immediately in the west side of Building 76 by Charlie Stalcup, Richard Roberson, Frank Laubenthal, Bob Brown, and Dick Colleoni. At the same time, consideration was given to equipment needs. Wood fabrication needed table saws, a planer, belt sanders, hand drills and plenty of flat space table tops for layout and assembly (Vought surplus, plus some new equipment).

Jim Lengen, Team Leader, started work on the manufacturing effort in August 2002, planning a manufacturing sequence with attention to tooling needs and methods of fabrication. It was obvious that fabrication of details and assembly had to be controlled for uniformity. Four full-size templates were ordered from Vought Aircraft Industries for detail and assembly fabrication and control. One was established as the master and the other three were used to make rib assembly fixtures.



The team made a 1/2-scale mock-up of the upper fuselage to determine body contours between the aft and forward areas.

(Shown, left to right: Carl Klapprott, John Jipp, Bob Rainey and Dave Morse)



Manufacturing Progress (Cont)

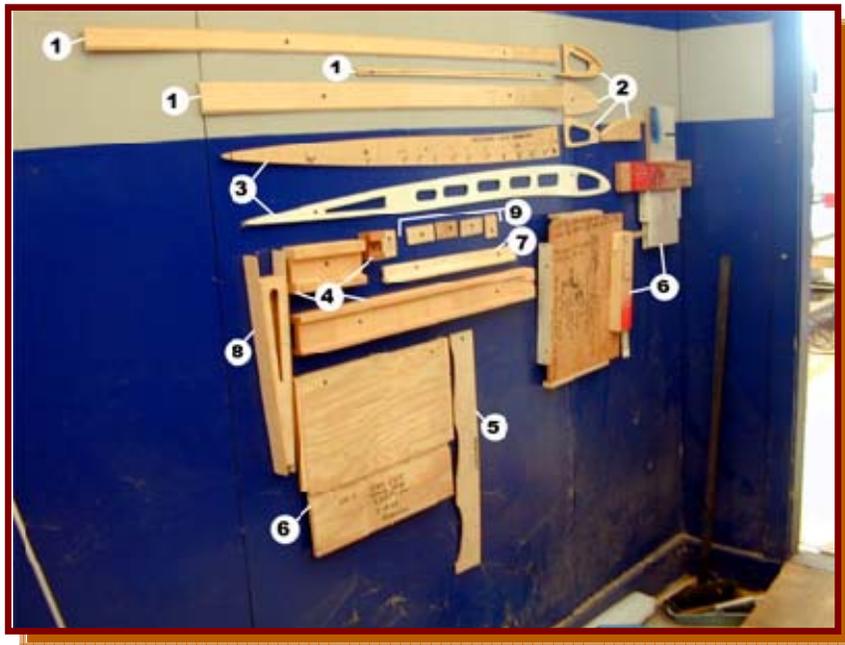
The original VE-7 was made using spruce for main spars and longerons, with ash used for high stress areas (fuselage structure around the cockpit and landing gear). Current availability of spruce is limited and expensive, so decisions were made to limit spruce to the main wing spars and use ash throughout the fuselage and marine grade birch plywood for flat work such as rib webs and capstrips.

The VE-7 replica was made with standard shop tools and the VE-7 manufacturing tools fabricated for making the wooden parts. In addition, each retiree furnished his own hand tools.



VE-7 Manufacturing Tools

The tools shown in the photo below were made to ensure conformance to engineering requirements and used to make the wooden parts listed in the legend.



Tools for Wooden Parts

Legend:

- 1. Cap strips for wings and horizontal stabilizer**
- 2. Wings and horizontal stabilizer leading edges**
- 3. Wing rib templates**
- 4. Wings forward and aft spar models**
- 5. Leading gear struts contour gages**
- 6. Table saw fixtures for making cap strips**
- 7. Wing trailing edges**
- 8. Ailerons and trailing edge ribs**
- 9. Horizontal stabilizer rib spaces**



Tooling Fixture for Building Airplane Cowling



VE-7 Manufacturing Tools (Cont)

All cables, including turnbuckle adjustable landing gear wheels and tires and assorted minor hardware, were purchased. Table 1 shows purchased parts data.

Table 1. VE-7 Purchased/Donated Parts

Supplier Name	Parts Purchased
Aircraft Spruce & Specialty Co., Corona, CA	Flight Control System Components
Air Salvage of Dallas	Cockpit Seat Belt Buckles
Key Aviation, Inc., Grand Prairie, TX	Cable Assemblies
J. C. Whitney, LaSalle, IL	Wheels and Tires
Bill's Trim Shop, Arlington, TX	All Cockpit Cushions and Seat Belts
Custom Decals, Grand Prairie, TX	Decals for Vertical Tail Markings

Due to the limited fabrication capabilities available, most attachment bracketry was made of aluminum, in accordance with building a replica.

The availability of a Hispano-Suiza 150 hp water-cooled engine was questionable, therefore, a wooden engine mockup was fabricated as a temporary substitute.



The Detail Fabrication Assembly Sequence

The vertical stabilizer and rudder were the first assemblies completed (around September 2002), both made from hand-formed tubing and requiring no woodwork. The horizontal stabilizer and elevator consisted of a formed tubular frame with wood rib assemblies (typical web/capstrip design). The most difficult technical challenge was aligning six independent hinge points – each hinge a small weld assembly riveted in place to the main spars of the stabilizer and elevator. These assemblies were completed in February 2003.



Vertical Stabilizer and Rudder



Dick Colleoni Working on Horizontal Stabilizer



The Detail Fabrication Assembly Sequence (Cont)

Wing work started in January 2003, after acquisition in the last quarter of 2002 of basic table saws, work tables and master wing rib templates. Wing rib master templates were used to make three rib assembly fixtures. Initial spars for the wing center section were made using the three-quarter-inch plywood (spruce was not yet available). Rib material was 3/16 and 6 mm birch marine grade plywood purchased in 4 ft by 8 ft and 5 ft by 5 ft sheets.

There are two basic rib configurations: compression ribs (two webs held apart by two wide capstrips) and single ribs (one web with two slotted catsrips). There are 171 total ribs for various configurations in the wings – a formidable task started in December 2002. It was obvious that fabrication of details and assembly had to be controlled for uniformity. Four full-size templates were ordered from Vought Aircraft Industries to control detail and assembly fabrication. One was established as the master and the other three were used to make rib assembly fixtures. There are 28 ribs in the ailerons and 13 ribs in the horizontal stabilizer and elevator. The VE-7 has a total of 212 ribs.



Richard Roberson Fabricating Elevator



Jim Lengen Checking Chord Line



The Detail Fabrication Assembly Sequence (Cont)

The spars were basic I beam construction, a ½-inch centerline web with longitudinal capstrips on either side. Appropriate web stiffeners were provided at each compression rib. Each of the four wings contained a forward (main) and aft spar. All the many wooden parts are handmade to fit perfectly and finished equal to or better than expensive furniture.



Jim Lengen Holds Completed Upper Wing Center Section Structure

(In the background, left to right: Dave Morse, Bob Surratt, Jim Lengen, Dick Colleoni, Marvin Robinson and Jerry Fisher)



Richard Roberson and Dave Morse Inspect Completed Upper Left Outer Wing Section Structure



The Detail Fabrication Assembly Sequence (Cont)

The wing ribs were web and capstrip design. Each capstrip was dado cut 3/16 inch by 1/16 inch deep to receive the 3/16-inch webs. Control of the external contour was maintained by assembly fixtures using the steel templates cut to basic data. The leading edges of each catsrip were relief cut to one-half of their depth to provide contour flexibility. It was decided to use “Tightbond II” for all glue joints.





The Detail Fabrication Assembly Sequence (Cont)



**Last Outboard Wing Being Completed
(Richard Roberson)**



Completed Wing Assemblies



First of Four Aileron Assemblies Is Complete



**VE-7 Building Team
Jerry, Richard, Wayne, Bob
Pat, Bob, Marvin, Jack, Jim
Charlie, Marvin
18 Nov 2004**



The Detail Fabrication Assembly Sequence (Cont)

As noted, all structural members of the fuselage would be made of ash. Bulk ash was purchased in basic 1 and 1/8 inch by 6-inch planks which were cut and planned to size. Some members had weight-reducing router cuts made to produce a basic structural cross section.

Engineering released a set of complex clips to provide joining members and also provide structural anchor points for cross-based cabling for strength and truing of the fuselage. Due to our limited sheet metal capability, flat patterns were subcontracted for fabrication. The most significant fuselage problem was forming the basic side panel longerons to shape. This was controlled by joining members in a flat pattern layout which was held in place by a rigid jig frame capable of restraining the shape during steam bath treatment.

After joining the side panels structural cabling was installed. The cables were adjusted to true up the basic box structure of the fuselage.



***Initial Work on Fuselage (Structure in Foreground)
(In Photo: Dick Colleoni, Pat Patterson,
Carl Klapprott, Dave Morse, Walt Riggs,
Richard Roberson, Jim Lengen and Wayne Vaughan***



Fuselage Assembly Progresses



The Detail Fabrication Assembly Sequence (Cont)



VE-7 Engineering Team
Back Row: Dave Morse, Carl Klapprott, Marvin Stifter
Front Row: Robert Rainey, John Jipp, Jerry Burk



June 2005, John Jipp and Bob Turney agree that the airplane was looking good, and it had been a long time since that beginning conversation in December 2001.

The VE-7 Replication Project was completed in December 2006.



The following photos were taken during the fabrication and assembly of the VE-7 Bluebird airplane.



The Fuselage Assembly Progresses. The forward portion of the fuselage lower longeron was steamed and held in a fixture to obtain the proper curvature.







Lower Rt Wing
8-24-04



Upper Center Wing
10-21-04



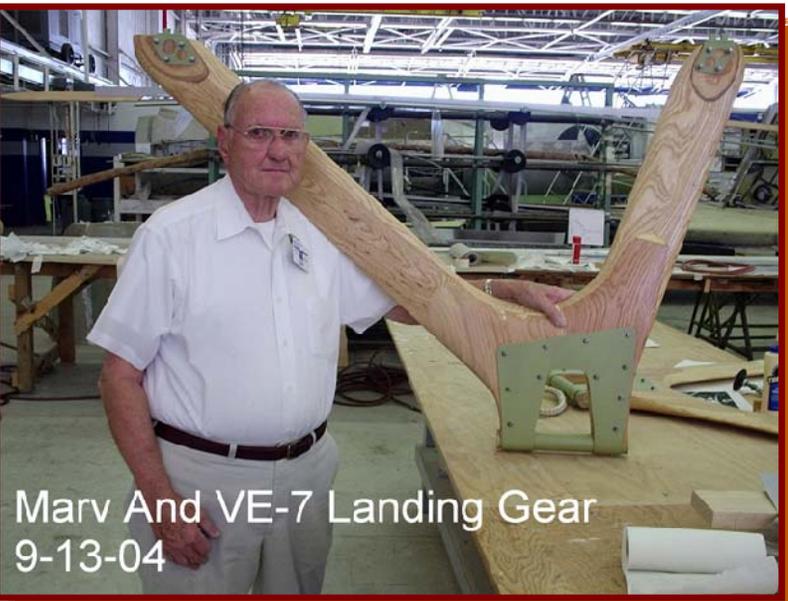
Lower Left Wing
Fuselage Join
2-10-05



VE-7 Wings Installed
2-17-05



VE-7 Horiz Tail
7-8-03



Marv And VE-7 Landing Gear
9-13-04



VE-7 Control Tube
10-21-04



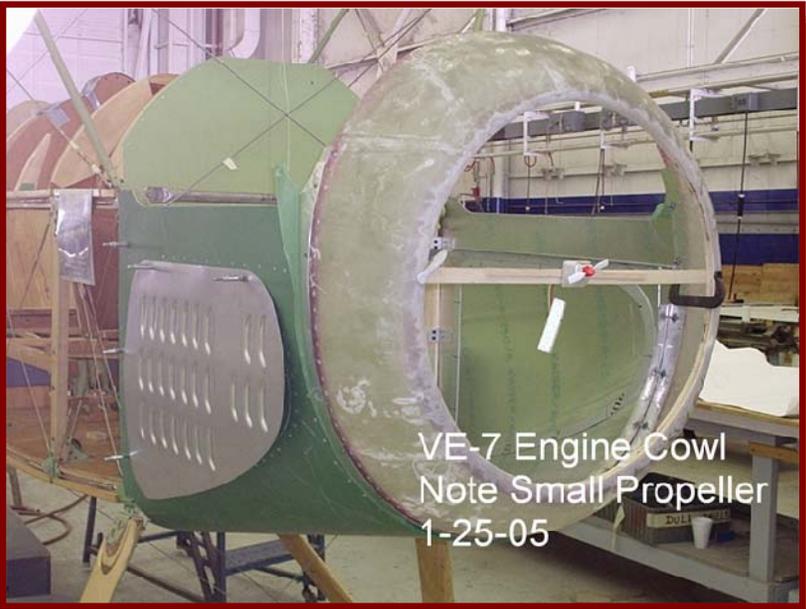
Rudder Pedals
10-21-04



VE-7 Engine Cowl
12-21-04



VE-7 Landing Gear
8-24-04



VE-7 Engine Cowl
Note Small Propeller
1-25-05



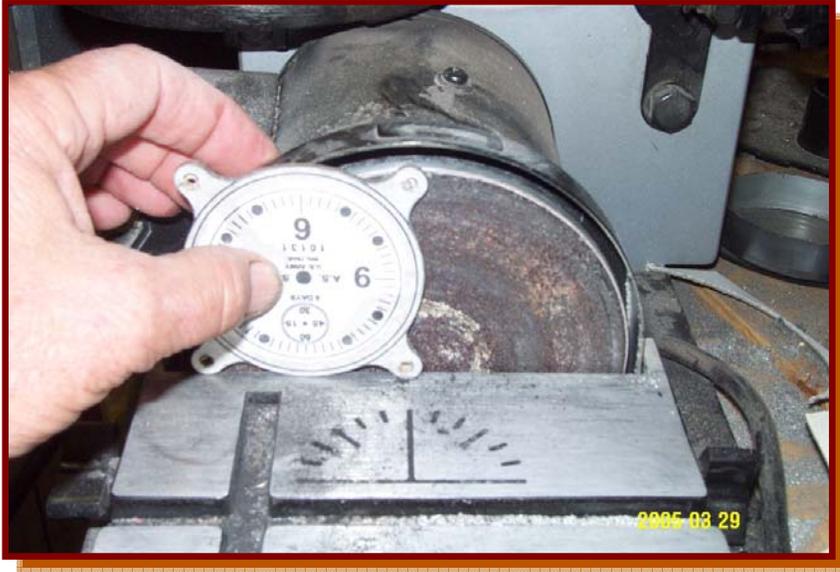
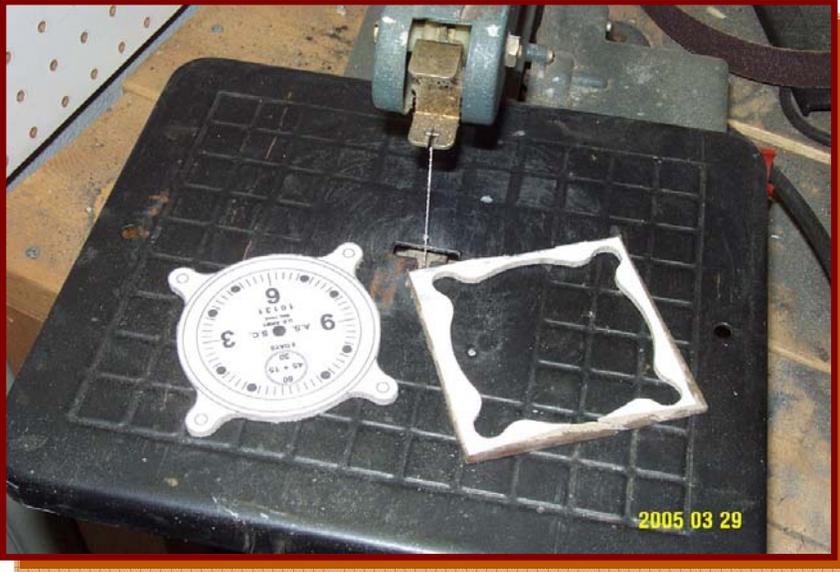
VE-7 Tail Skid
8-24-04





The following photos show the elements and techniques Richard Sheaner used to create the VE-7 instruments.



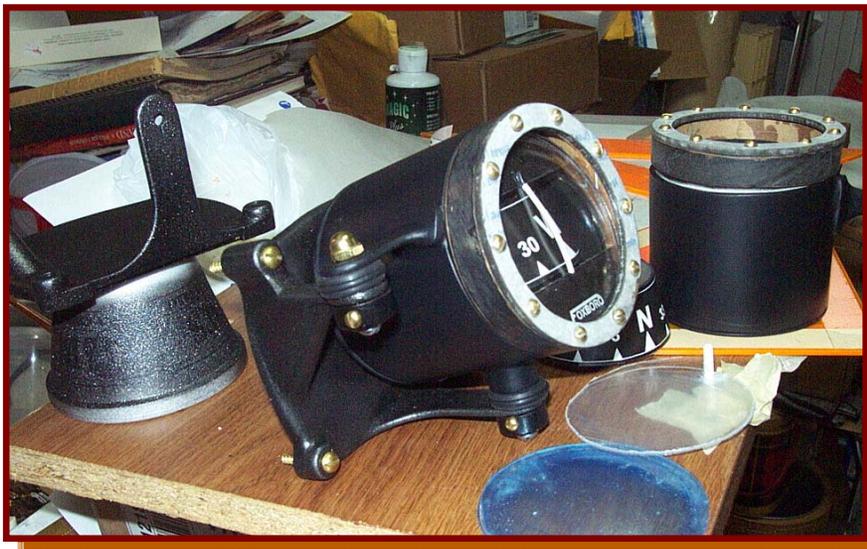




Basic Components Made from Wood, Cardboard and Plastic



Compass Test Assembly



Compass Nearing Completion



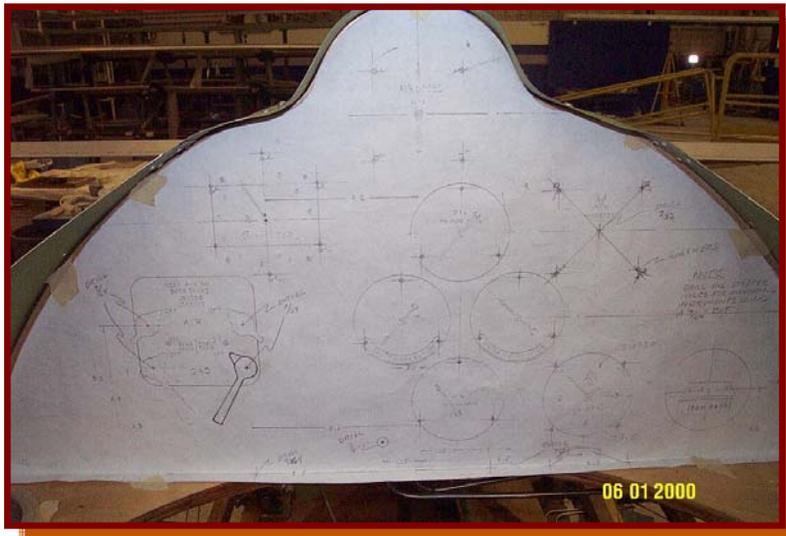
Compass Complete



The fuel gage was made from a bicycle headlight, flower vase pedestal, a cat litter container lid and the face was computer generated.



Fuel Gage Complete



Preparing to Install Aft Cockpit Instruments



Richard Sheaner Installing Instruments



Covering the Airplane Structure

After 3 ½ years, we began covering the airplane structure with fabric. The tail section was first and is covered with Dacron (polyester) fabric. Several step processes are required as follows:

- **Fabric cut to size**
- **Fabric glue in place with fabric cement**
- **Heat is applied using a clothing iron to shrink the fabric**
- **Brush on one coat of Poly Brush**
- **Rib stitching attaches fabric to substructure when required**
- **Trim tape is glued around edges and reinforcing patches for fittings over rib stitching**
- **Apply Poly Spray containing aluminum powder**
- **Lightly sand rough spots for smooth paint base**
- **Apply silver primer**
- **Paint with Polytone.**





Wing Outer Panel Covering Complete



Covering the Airplane Structure (Cont)





VE-7 Bob Surratt building his Propeller 9-6-05

The propeller is 104 inches long and has 9 layers of wood of oak, ash and pine.



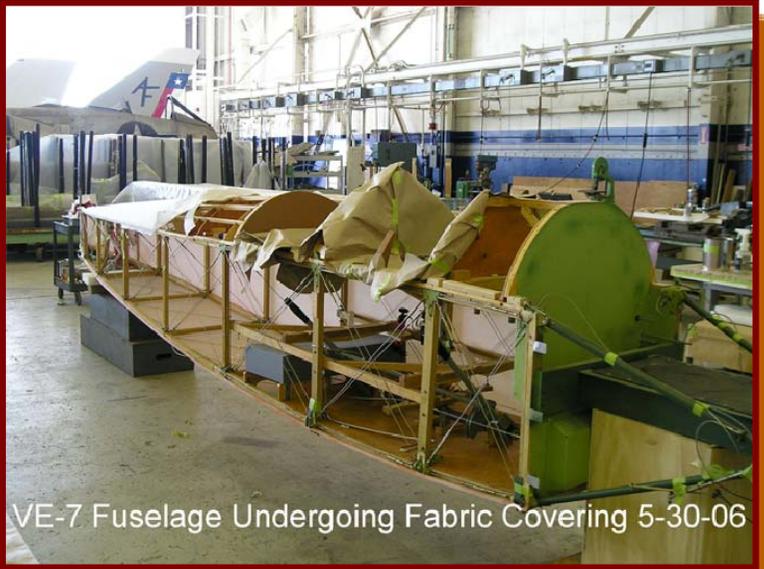
VE-7 Jim's Upper Center Wing Covering 9-27-05



VE-7 Wayne and Jerry covering Wayne's aileron 10-27-05



VE-7 Wayne Covering Upper Center Wing Section 9-27-05



VE-7 Fuselage Undergoing Fabric Covering 5-30-06



VE-7 Mask Fuselage for Painting Bob, Richard, Pat, Jack, Jim, Richard 6-01-06



VE-7 Preparing for Painting Pat, Richard, and Jerry 6-01-06



VE-7 John Masking Fus for Painting 6-6-06



VE-7 Bluebird Replica

- After painting and reassembly, the VE-7 Bluebird replica is complete.



Fuselage side and lower wing tip open for viewing





Acknowledgements

- ***This book could not have been written without each individual noted and their unique skills. They unselfishly contributed to designing and building the VE-7 Bluebird airplane. These individuals, all retirees, volunteered their time, special skills and talents because of their strong dedication to Vought Aircraft Company.***

Author: John E. Jipp