

THE VOUGHT O3U-3 CORSAIR I

Written by: Charles Forman and Dick Atkins

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U.S. NAVY OBSERVATION AIRCRAFT The Building of a Full-Size Replica by the Vought Aircraft Heritage Foundation



THE VOUGHT O3U-3 CORSAIR I

INTRODUCTION

In 2008 the Vought Aircraft Heritage Foundation (VAHF) selected the Vought O3U-3 aircraft as a build-from-scratch fabrication project. Vought would fabricate a replica of one of the Chance Vought Aircraft Company's outstanding products of its early years: the 1932 O3U-3 Corsair I float plane. This is a second replica which will join the other replica (VE-7 Bluebird) plus nine restored Vought aircraft in famous air museums in the U.S.

Fabrication started in 2009 and is estimated to be completed in 2021. Fabrication has been delayed by two work shutdowns due to loss of hanger facilities. There was an 18 month work shutdown in 2014-2016 and a 9 month shutdown May, 2018 to February, 2019. Work has now resumed in a building facility made available by the Grand Prairie Independent School District.

SUMMARY

Background

Selection of the O3U-3 Corsair as our next VAHF retiree project began in an unusual fashion. In early 2008 Dick Atkins, VAHF Archive Director, was asked to take our senior member, 97 year old Teddy Trept, to the International Plastic Modelers Society (IPMS) aircraft model display in Dallas, Texas. Dick and Teddy immediately spotted a beautiful model of the O3U-3, US Navy Serial Number (SN) 9156. This model was destined to be a donation to the National Museum of Naval Aviation in Pensacola, Florida. In addition, the actual fuselage side fabric of O3U-3 SN 9156 was also donated to the museum.



*Model of the Chance Vought O3U-3 Corsair I
as seen at the IPMS Meet
24 in. wingspan (approx.)*



*Dick Atkins -
Archive Director and VAHF Board member*

Atkins reasoned that this aircraft would be the perfect next project, since the Navy Museum has a replica of the first Vought Navy aircraft, the VE-7 Bluebird, and a Vought SB2U-1 dive bomber. The glory years of the "Eyes of the Fleet" provided by Vought Corsairs was not represented. Dick Atkins made a presentation to VAHF management and craftsmen in mid-2008 recommending that they build the O3U-3. The recommendation was approved and the project began.

Project Objectives

The primary objective of this project was to produce a replica of the O3U-3 Corsair with external appearance and cockpit internal appearance as defined by the production drawings.

Deviations may be taken where it was practical to use other means and where the deviation was not externally visible.

The replica is to be delivered on floats with a stand for movement.

DESCRIPTION

O3U-3 Navy Mission

The O3U-3 performed the patrol and observation mission for Navy ship task forces at sea. Before the days of RADAR, patrol aircraft were sent out from battleships and cruisers to look "over the horizon" for enemy ships. Information such as number and type of ships, their location and sailing direction were transmitted by radio back to the task force.

The aircraft were catapulted from a ship deck. After completing their mission the aircraft would land next to the ship and then be hoisted back onto the deck by crane. In the case of S/N 9156 (The O3U-3 model depicted in the Summary) it stationed aboard was the Battleship, Pennsylvania.

O3U-3 Physical Description

The Corsair was a two-place biplane. It was defensively armed with a forward firing 30 caliber machine gun for the pilot and an aft facing flexible 30 caliber machine gun for the co-pilot/observer. The aircraft was equipped with bomb racks on each lower wing.

O3U Designations and Quantities The O3U-3 made its first flight in 1932, and 76 aircraft were produced. All versions of the O3U aircraft fabricated between 1930 and 1934 totaled 309 airframes.

DESIGN ENGINEERING



Search for Drawings

In 2008, the Vought Aircraft Heritage Foundation had a large archive of Vought heritage drawings, mostly in the form of microfilm reels. The archives included most Vought aircraft from the 1920s through the 1960s A-7, and did include the O3U-3.

Volunteer archivist Bill Spidle agreed to do the research and find the drawings necessary to build the airplane. Bill gathered 1,600 + drawings from the VAHF microfilm library. He obtained approximately 20 major assembly drawings by personally visiting the National Archives and Records Administration in Washington, DC. Bill reviewed over 50 microfilm reels and made around 2,500 scans. He later searched for and found about 30 more drawings. Bill contributed over 2,000 hours of time researching, collecting, and making available these O3U-3 drawings.



*Bill Spidle
Original Drawing Research & Collection*

Drawing Formatting and Clean-Up

Many of the drawings obtained from microfilm scans are fourth or fifth generation reproductions. Text and dimensions on these were barely readable. These drawings were "cleaned-up" by Adam Galan using Photoshop™ and PhotoScape X™ computer software, making text, dimensions, and drawing details readable. Large format paper copies were obtained for all of the drawings.

Scale Drawings for Part Fabrication

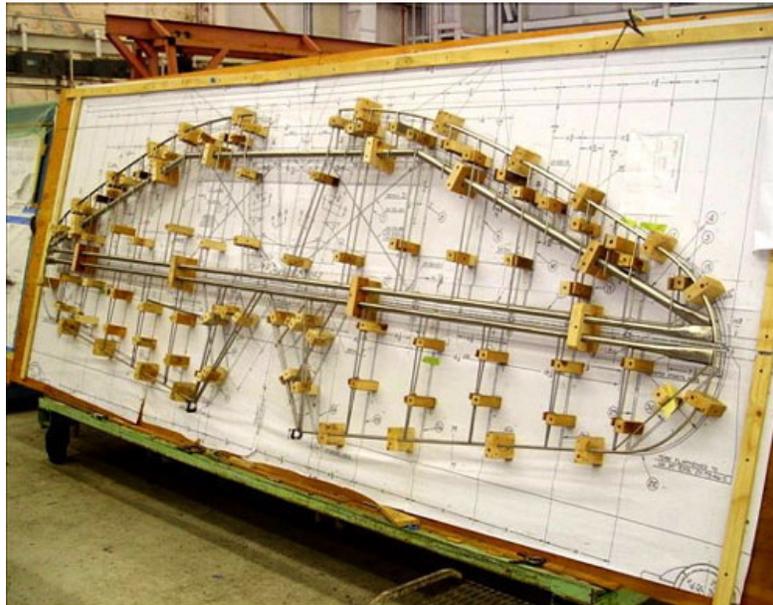


*Rex Wanger
Scale Drawing Preparation*

The VAHF shop workers needed full-scale or at least scale drawings so that they could fabricate O3U-3 parts. These drawings were produced by retired Vought structural design engineers. Carl Klapprott did this work from project start until the work shutdown in late 2013. Carl was assisted in this work by Dave Morse. Carl passed away in June, 2015. When the project was restarted in Building 23 in June, 2015 the scale drawings for the shop were prepared by Rex Wenger until fabrication was completed.

Full scale drawings were prepared for components such as the horizontal stabilizer, elevators, rudders, and

aileron. For these components, the drawings were attached to a sheet of plywood and this became the fabrication tool. The component was constructed on top of the drawing, as shown in the photo of the horizontal stabilizer and elevator below.



*O3U-3 Horizontal Stabilizer Fabrication
on top of Full Scale Drawing*

Scale flat pattern layout drawings were prepared for the aluminum fuselage skin panels that cover the forward fuselage and cockpit area.

Full scale drawings were prepared for upper and lower wing ribs and the OML outline of the ribs were digitized. This digital information was then used by an outside shop to NC cut all of the wing ribs. The wings are constant chord, so all ribs in a wing have the same contour except for three outboard and two inboard ribs. Most fabricated parts for O3U-3 construction required a scale drawing, so hundreds of drawings were made

EMPENNAGE FABRICATION

The empennage consists of the horizontal stabilizer, elevator, vertical tail and rudder.

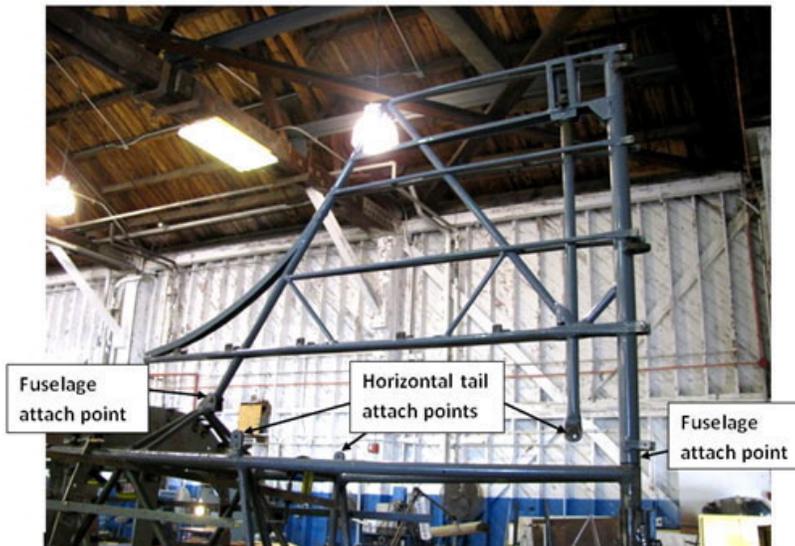
Materials

Frames for the O3U-3 empennage components were fabricated from welded stainless steel tubing. The O3U-3 replica empennage frames were also fabricated from welded stainless steel tubing of the same diameter as the original O3U-3 empennage components, with some exceptions. The horizontal stabilizer rear spar and elevator front spar in the O3U-3 were 1.5 in. high by 1.0 inch wide oval tubes. Replica spars are 1.0 in. diameter tubes. Horizontal stabilizer front spar tube diameter (0.50 in.) and rib tubes diameter (0.25 in.) in the replica are same as in the O3U-3. Wall thickness of these tubes is 0.035 in. All empennage frames were painted with a gray epoxy paint.

The replica empennage frames will covered with the same Poly-fiber Dacron polyester fabric as used on the wings and fuselage.

Vertical Tail and Rudder

The vertical tail and rudder frames for the O3U-3 replica is shown in the figures below. The vertical tail aft member is the rudder hinge support tube, 1.5 in. OD stainless steel.



*O3U-3 Vertical Tail Frame
Inditating the Fueslage and Horizontal Tail Attaching Points*



*O3U-3 Rudder Frame
Indicating Hinge Points*

Horizontal Stabilizer and Elevator

The horizontal stabilizer and elevator frames for the O3U-3 replica are shown in the figures below. The horizontal tail main spar is a 1.0 in. OD stainless steel tube with elevator hinges welded to it. The actual O3U-3 main spar was a 1.5" x 1.0" oval tube, 4130 steel. The horizontal tail maximum thickness is 2.0 in.



Horizontal Stabilizer Fram



*O3U-3 Elevator Frame
Indicating Hinge Points*

WINGS FABRICATION

General Description - Materials

The wings are all wood construction, except for some metal fittings and bracing cables. Spars and other solid wood components are fabricated from Sitka fir (in the original O3U-3 these components were Sitka spruce). Commercial grade birch plywood was used for the leading edge and ribs. Wood wing components were bonded together using "Titebond III" waterproof wood glue. All wood surfaces were coated with epoxy varnish. The wing structures will all be covered by polyester fabric.

Wing Structure Fabrication

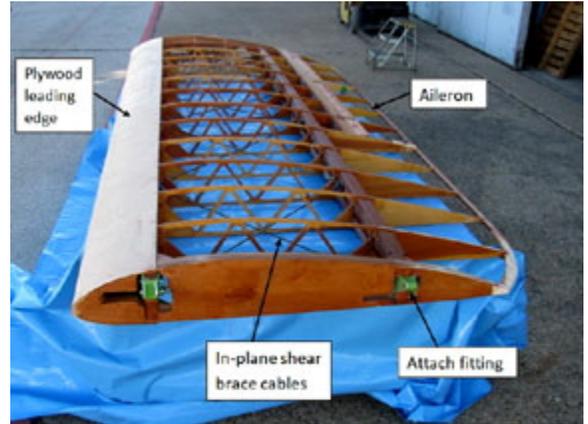
In the O3U-3 there are five wing sections: Left and right upper wings, left and right lower wings, and upper wing center section. Construction of each section is similar, with a leading edge cell, front spar, and rear spar. Ribs are placed at 11 to 14 inch spacing. Tip ribs have 7 inch spacing. Rib OML contour was NC cut and internal truss-work was cut by hand using a jig-saw.



*Howard Widmann
O3U-3 Wing Construction*

Each wing component was fabricated on top of a large, flat plywood table. Original O3U-3 wing drawings were used to layout locations of ribs and spars on the plywood table. Ribs were held in position at their designated locations and then spars were placed against the ribs. Rib/spar joints were then bonded using the Titebond III adhesive, with small vertical wood corner reinforcement pieces on each side of the ribs. The joints were clamped until the adhesive cured.

The thin plywood leading edge covering was bonded to the upper and lower edges of ribs and front spar. Small nails were used to hold the plywood in position



*O3U-3 Right Upper Wing Structure
Indicating some Wing Features*

until the adhesive cured. The rectangular section spars were made into I-sections by machining pockets into each spar face.



*O3U-3 Right Upper Wing
Left to Right: Howard Widmann, Rusty Branum, Jerry Fisher,
Jim Hill, Martin Gallaviz, Bill Privett*



*O3U-3 Upper Wing Center Section
Left to Right: Rusty Branum (with Camera), Jerry Fisher,
Howard Widmann, Rex Wenger*



*O3U-3 Right Lower Wing
Indicating Aileron and Aileron Hinge Points
Right to Left: Jerry Fisher, Jim Hill, John Huffman (in background)*

. FUSELAGE FABRICATION

General Description - Materials

The O3U-3 fuselage primary structure is a welded space frame constructed from 4130 tube steel. The forward portion of the fuselage is skinned in sheet aluminum. The aft portion, from the aft cockpit to the tail, is covered in fabric. The fabric is stretched over and is attached to longitudinal wood stringers. The stringers attach to frames fabricated from aluminum plate. Saddle fuel tanks on each side of the cockpit were fabricated from sheet aluminum and locally form the OML surface of the fuselage.

Steel Truss Frame Weldment

Original O3U-3 drawings were used to fabricate the steel truss frame. Tube diameter for the upper and lower longitudinal members is 1.10" in the forward and cockpit area and 1.00" reducing to 0.875" going aft. Vertical and diagonal members are 0.875" and 0.563" diameter.

Stan Bullard built the truss frame, including all of the welding. A long tooling table was set up to provide a level platform on which to layout and weld the frame members. This table consisted of plywood sheet on top of a wood base. An aluminum plate was placed over the plywood. The aluminum plate was shimmed as needed to provide a level tool surface.

The frame top members and connecting trusses were built first. Using the O3U-3 frame drawing, the coordinate points of all of the tube intersections were marked on the aluminum plate. Tube holder brackets were attached to the aluminum plate. Tube members were positioned on the aluminum plate and all of the joint intersections were welded. The frame bottom truss was built in a similar manner.



*Stan Bullard
Welding O3U-3 Fuselage Truss Frame*

With the bottom truss in position on the aluminum plate, the upper truss was positioned into the correct vertical location. It was held in place with temporary supports attached to the aluminum tooling plate. Vertical and diagonal tubes were then welded between the upper and lower trusses. Attach brackets for the wings, pontoon, engine, saddle tanks, and controls were then welded to the frame.

Aluminum bulkheads (0.080 inch thick) were fabricated and installed in the aft fuselage to support the wood stringers. These bulkheads attach to the fuselage truss frame, and can be seen in the photograph below. These bulkheads in the original O3U-3 were fabricated from 3/16 inch thick plywood. The stringers in the photo are temporary aluminum stringers, used to develop the OML contour and to locate the stringer notches to be cut into the bulkheads. Wood stringers will be fabricated, placed in the bulkhead stringer notches, and attached to each bulkhead.



*Discussing Fuselage Construction
Left to Right: Carl Klaprott and John Huffman*

Bulkheads and Stringers

Aluminum bulkheads (0.080 inch thick) were fabricated and installed in the aft fuselage to support the wood stringers. These bulkheads attach to the fuselage truss frame, and can be seen in the photograph below. These bulkheads in the original O3U-3 were fabricated from 3/16 inch thick plywood. The stringers in the photo are temporary aluminum stringers, used to develop the OML contour and to locate the stringer notches to be cut into the bulkheads. Wood stringers will be fabricated, placed in the bulkhead stringer notches, and attached to each bulkhead.



*O3U-3 Fuselage
Left to Right: Dick Atkins and Stan Bullard*

Nose and Cockpit Aluminum Skins

Aluminum skin panels were fabricated for the fuselage forward section between the engine and the cockpit, and for the upper fuselage area around the cockpits, as shown below. Skin panels are 0.032 in. thick. Louvers were stamped in the forward section skin panels using a louver die.



*O3U-3 Fuselage
with Aluminum Skin Panels in Place*

Fuel Saddle Tanks



*O3U-3 Installation of
Left Saddle Fuel Tank*

Twin fuel tanks are located on each side of the cockpit. The geometry and dimensions of these tanks were constructed according to the O3U-3 original drawings. Outer skins are sheet steel and the end bulkheads and eight vertical ribs were fabricated from aluminum (outer skins of the original O3U-3 tanks were made from aluminum and all seams were welded). The tanks are 68 inches long, 28 inches high, and 8.25 inches maximum width. Each tank holds 68 gallons.

A wood mold shaped to the fuel tank outer skin contour was fabricated. The steel skins were heated and then wrapped around the wood mold. Small steel angles were riveted to the internal ribs. The steel angles were then welded to the outer skins. The wood mold and fuel tanks were fabricated by Stan Bullard.

COCKPIT INSTALLATIONS

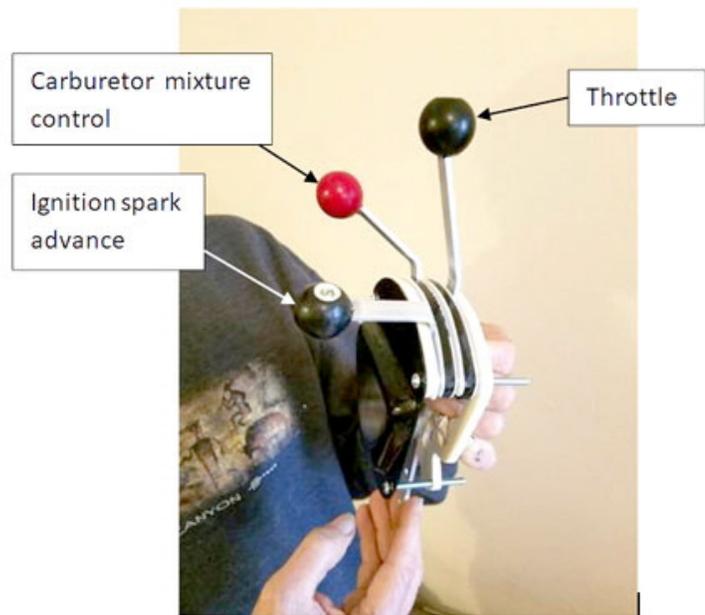
Cockpit Controls

The O3-U3 has a dual, tandem cockpit configuration. Both cockpits have stick and rudder controls, engine throttles, and flight instruments. Dillon Smith was led the cockpit and controls fabrication team.

The throttle quadrant, located on the left side of the front cockpit, has three levers: engine throttle, carburetor mixture control, and spark advance control. The rear cockpit has only a throttle.



*Richard Sheaner with Throttle Quadrant
He Fabricated from O3U-3 Drawings*

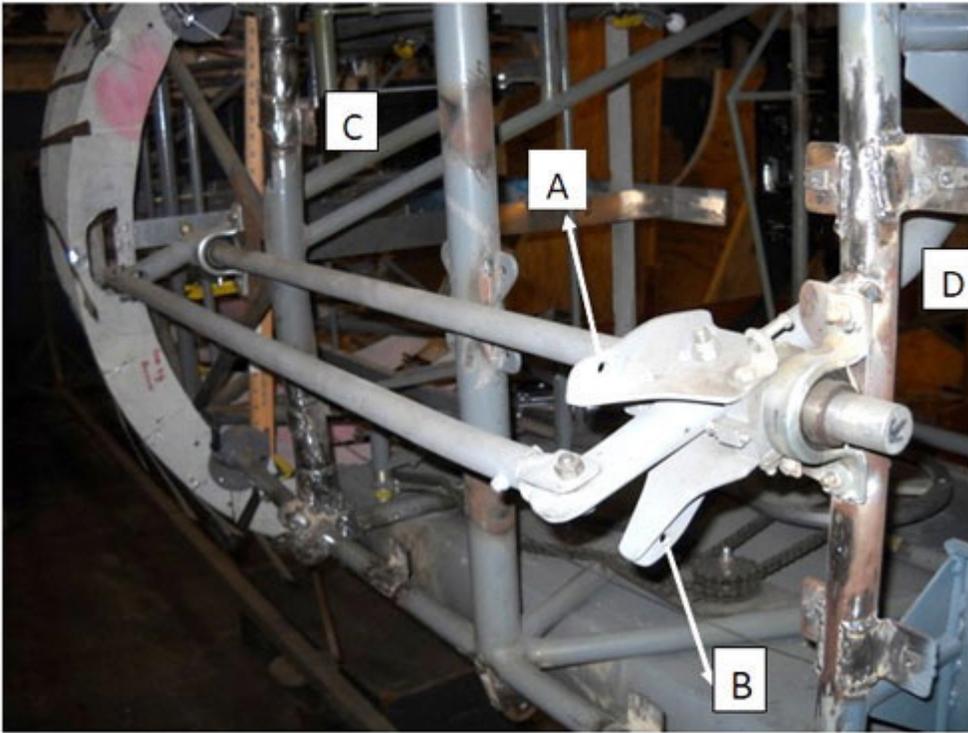


*O3U-3 Throttie Quadrant
Indicating the Three Control Levers*

Pilot's Sticks and Rudder Pedals

Both forward and aft cockpits have interconnected pilot's sticks and rudder pedals. The pilot's stick (forward and aft) and connecting parts were fabricated by Dillon Smith. Aluminum tubing and 0.125 in. thick aluminum flat stock were used. The shaft connecting forward and aft sticks is steel. Controls were fabricated according to O3U-3 drawings as closely as possible. The pilot's stick in the aft cockpit can be removed and stowed in-flight so that it does not hinder operations of the rear facing machine gun.

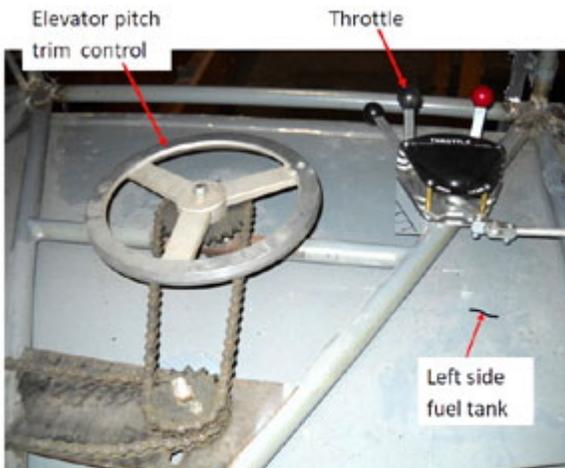
Stick control rods below seats connect to cables which activate the ailerons and elevator. Rudder pedals were also fabricated from aluminum, and attach to cables which activate the rudder.



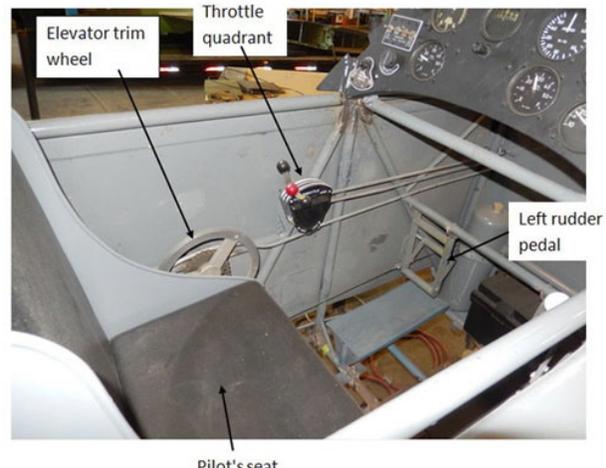
A - Cable to left aileron	C - Forward pilot's stick
B - Cable to right aileron	D - Aft pilot's stick

***O3U-3 Pilot's Stick Controls
Indicating Control Sticks and Aileron Cable Connection Points***

An elevator pitch trim control wheel is located on the left side of the forward cockpit. The wheel drives a sprocket and chain mechanism which is attached to cables aft of the cockpit. Near the elevator, the cables turn a jackscrew which is attached to the elevator. Aircraft pitch trim angle is changed by rotating the elevator on its hinged supports.



O3U-3 Elevator Pitch Control Wheel



***O3U-3 Forward Cockpit
Indicating some Flight Controls***

Instrument Panels

Cockpit instrument panels were fabricated by Bob Essler, Richard Sheaner, and Huey Barrilleaux. They were fabricated using O3U-3 drawings. Most instruments were purchased used from various sources. Replica instruments were fabricated for those that could not be found.



*Left to Right: Bob Essler,
Dillon Smith and Huey Barrilleaux*



Stick
Rudder pedals
*O3U-3 Forward Cockpit
Instrument Panel*



*O3U-3 Aft Cockpit
Instrument Panel*

Pilot Seats

The pilot seats were fabricated by Dillon Smith, and are made from 0.063 in. thick aluminum. They were fabricated using original O3U-3 drawings. The seats were constructed from four pieces (bottom, back, and two sides) riveted together.

Seats have bottom and back cushions made of foam and covered with black naugahyde material. The cushions were fabricated by Bill's Trim Shop in Arlington, Texas. The front seat

back support is slightly curved and was made from 0.25 in. thick plywood. Partial thickness vertical saw cuts were made in the plywood so that it would bend to the curved shape.

The front seat is adjustable fore-aft by pulling a pin. The back seat is not adjustable. The seat bottom folds up and latches to provide room for the aft pilot to use the rear facing machine gun.

Cockpit Windshields

Dimensioned drawings of the forward and aft cockpit windshields were made from O3U-3 drawings. These dimensioned drawings are being used by Grand Prairie Glass and Mirror Company to fabricate the windshields, which are formed from 0.150 in. thick Plexiglas. The windshield transparencies will be mounted in aluminum frames. The aft windshield is hinged at the bottom and folds forward.

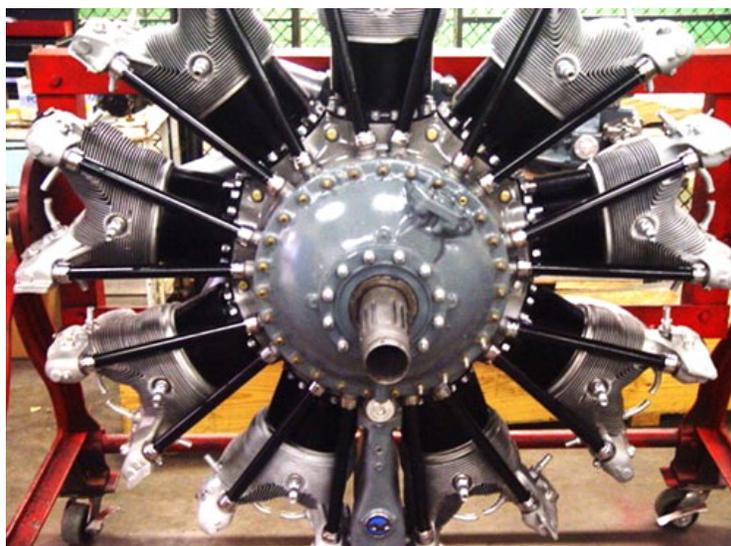
ENGINE INSTALLATION

Engine Acquisition and Assembly

Purchase of a complete, flight worthy R-1340 engine for this static display replica aircraft would have been prohibitively expensive. To get a non flight worthy engine, Dick Atkins negotiated with Covington Aircraft of Okmulgee, Oklahoma to get the needed engine and parts donated to Vought Heritage.

Covington Aircraft specializes in the overhaul of R-1340 radial engines and PT-6 turbo engines. The donated engine parts were worn beyond the point of rework for a flight condition engine. However, the engine assembled from these parts appears externally to be flight worthy.

The R-1340 parts were assembled into a complete engine by Jack Brouse and Bill Condon, with help from local R-1340 users. Jack Brouse (deceased) was a retired Vought engineer and certified aircraft engine mechanic. The engine was assembled in 2010.



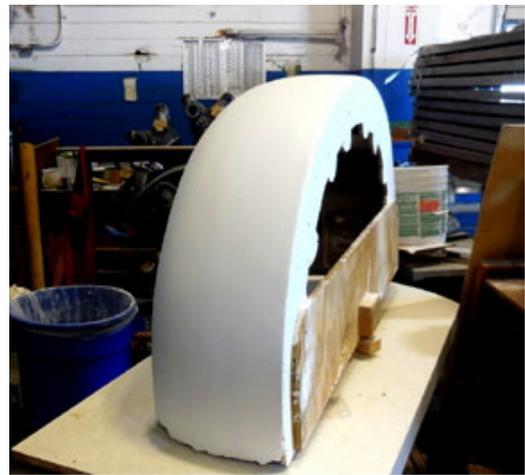
O3U-3 Pratt & Whitney R - 1340 Engine

Propeller Acquisition

The propeller is a Hamilton Standard and was purchased used from an aircraft supply shop near Beaumont, Texas. This is a fixed pitch, stainless steel propeller of the same type used on the production O3U-3.

Engine Cowl Fabrication

The compound curved engine cowl was fabricated by Bill Condon. He first fabricated a mold for the cowl which covered 180° of the full-circle cowl. He fabricated a wood shell and then covered this shell with plaster to approximate the desired contour. Bill filed and sanded the plaster to the final cowl contour. The plaster was then sealed and coated with a release agent.



O3U-3 Engine Cowl Mold



*Bill Condon
Sanding Engine Cowl*

He then covered the mold with several layers of fiberglass fabric impregnated with epoxy resin. This cured part created one-half of the engine cowl. A second identical part was made from the mold. These two 180° parts were spliced together with fiberglass/epoxy to form one full engine cowl. This cowl was then trimmed, sanded, and primed, and ready for the final paint finish.



O3U-3 Cowl Installed on Engine

The photo above shows the air deflector nose piece installed on the engine. This component helps to direct the cooling air flow around the cylinders. This component was fabricated by Bill Condon using a roof-mounted air vent. This photo also shows the attachment of the cowl to each cylinder head. Aluminum T-brackets are attached to the cowl by two rivets and to a screw on the intake valve rocker cover.

Exhaust Stacks Fabrication

The R-1340 engine, as used in the O3U-3 aircraft, had short exhaust stacks that extended beyond the back edge of the engine cowl. Exhaust stacks for this O3U-3 replica were fabricated by Bill Condon. Steel sheet was formed into the conical shape, with the exhaust exit slot, and then welded to form an exhaust stack. Nine exhaust stacks were fabricated, one for each cylinder. The exhaust stacks were painted black before installation on the engine.



O3U-3 Exhaust Stack

PONTOON AND FLOATS FABRICATION

Pontoon - Description and Material

The O3U-3 pontoon (center float) for the O3U-3 replica was fabricated from 7075-T3 aluminum sheet, and was fabricated from the original plans. The pontoon is 272 inches (22'- 8") long, 42.9 inches wide and 36.8 inches deep. It has a full depth center keel and 20 bulkheads. Bulkhead spacing ranges from 9" to 16."



*O3U-3 Center Pontoon Construction
Left to Right: Wat Watkins and Billy Newberry*



*O3U-3 Finished Center Pontoon
Ready for Paint*



*O3U-3 Wing Float
(Inverted)*

Wing Floats - Description and Material

Floats are mounted under RH and LH lower wings. The floats are 72 inches long, 20 inches wide and 20.5 inches high. The floats contain two full internal bulkheads at attach fitting locations and two lower partial bulkheads. The floats were fabricated according to the original O3U-3 plans. External skins and bulkheads were fabricated from 0.040 inch thick 7075-T6 aluminum. The floats were fabricated by Wade Anderson and Don Blanton.

Attach Struts and Fairings

All attach struts for the wings, pontoon and floats are 4130 steel with an airfoil (streamline) cross section. Cross-section dimensions are 2.7 x 1.1 inches, with a 0.049 in. wall thickness. The original O3U-3 had struts with different cross-section dimensions for the different applications. Wing struts were aluminum and pontoon and float struts were steel.

There are four pontoon-to-fuselage struts, two forward and two aft. The struts have welded lugs and 0.50 in. dia. bolts at each end. Upper and lower ends of the struts have fiberglass aerodynamic fairings to cover the end fittings. These fairings were fabricated by John Huffman. Diagonal wires are used for fore-aft and lateral bracing.

There are three outer wing vertical struts per side at approximately two-thirds span and six center wing-to-fuselage struts, three per side. These struts have threaded end fittings for length adjustment.

Each outer float has six float-to-wings attach struts. These struts have welded lugs at each end for bolt attachment. Diagonal wires are used for fore-aft bracing.



*John Huffman
Holding a Pontoon Strut with Fiberglass End Fairings*

REMAINING FABRICATION TASKS April 2019

- Completion of aft fuselage
- Completion of control cables in wings and fuselage
- Installation of electrical wiring
- Preliminary assembly - fit-up check before covering is applied
- Fabric covering of wings, empennage, and aft fuselage
- Painting and markings
- Final Assembly

AIRCRAFT TRANSFER TO MUSEUM

- Partial disassembly
- Shipment
- Reassembly at museum

The O3U-3 replica will probably be displayed at the National Museum of Naval Aviation in Pensacola, Florida. The disposition is still to be negotiated.