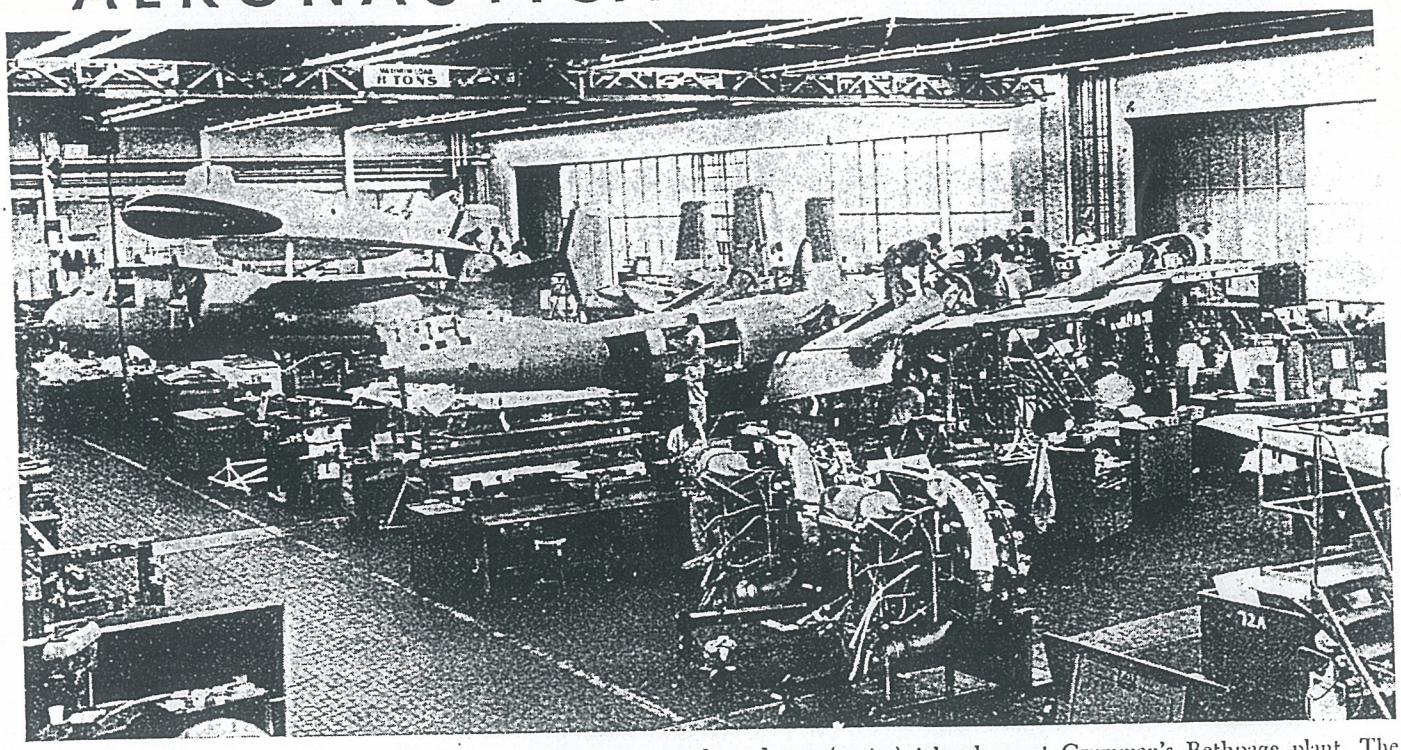


PREPRODUCTION YAO-1 Mohawk numbers one (right background) and two (center) take shape at Grumman's Bethpage plant. The number two aircraft is shown about two weeks prior to rollout. Aircraft visible in right background include a WF-2 early warning aircraft and an S2F-3 anti-submarine warfare plane. Grumman has begun tooling for the 35 AO-1s to be built starting January, 1960.

Mohawk Shows Good STOL Capability

By Barry Tully

Bethpage, N. Y.—First Army turboprop aircraft, the Grumman YAO-1 Mohawk tactical observation plane, demonstrated good short field and low altitude performance at the company's Peconic River facility.

The two-place twin-engine aircraft, intended for rough field operation, will carry aerial cameras, side-looking radar or infrared mapping equipment for its tactical observation mission.

The aircraft was flown from a taxiway by Grumman test pilot Ralph Donnell to demonstrate short-field takeoff, high-speed and single-engine flyovers, slow-flight and a short-field landing.

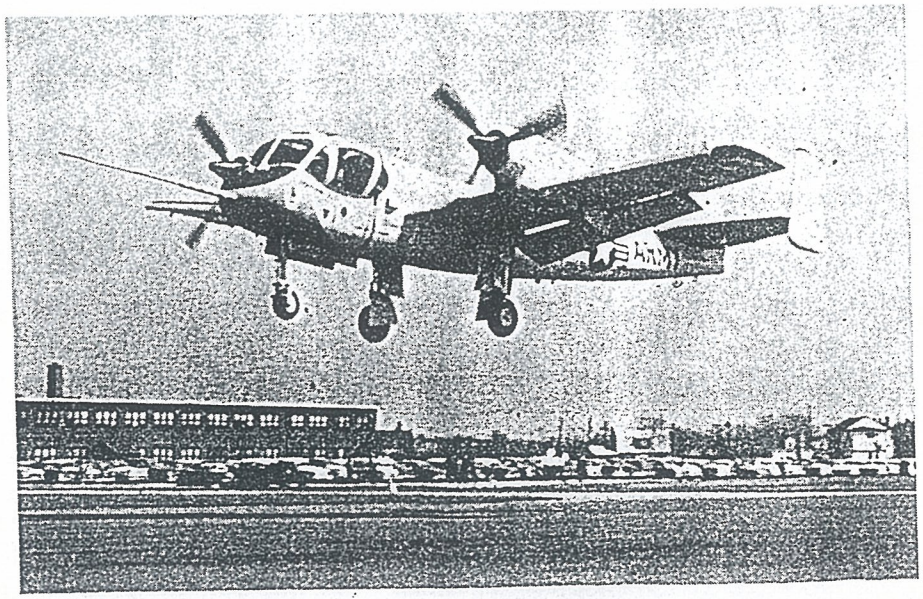
Turning Radius

The twin-turboprop aircraft demonstrated its extremely small turning radius and, with wing slats and flaps extended, showed its ability to "hold" over a ground position by flying a tight figure eight pattern.

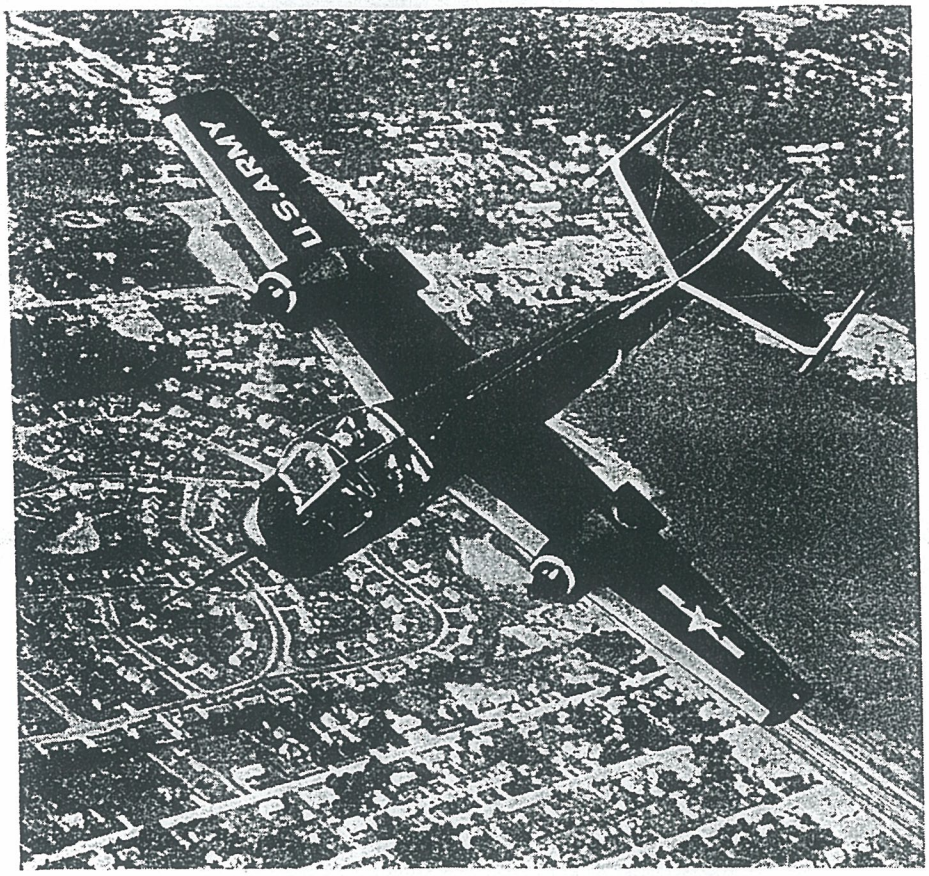
The short landing capability of the Mohawk, which touches down at 55 kt., is enhanced by reversible pitch propellers fitted to the Lycoming T53-L-3 turbine engines. By applying full reverse pitch power upon touchdown, and vigorously braking, Donnell brought the 11,000-lb. aircraft to a stop in approximately 300 ft.

Although the prototype aircraft does not contain any surveillance equipment, Grumman says the flight test instrumentation weighs more than its operational equipment. Empty weight of the aircraft is 8,000 lb.

The two aircraft now flying are the first of nine YAO-1s that Grumman is building for the Army under a $22 million contract. The last YAO-1 model is slated for completion in De-



MOHAWK takes off with 25 deg. flap setting. When flaps are extended, the section outboard of the engine nacelles acts in conjunction with the ailerons for increased lateral stability at low speeds. The aircraft is intended for rough field operation.



ARMY markings and olive drab color of number two YAO-1 are for purposes of aircraft demonstration. The aircraft will be repainted in high visibility red and white test colors. Semi-planform view accentuates large plastic canopy and aircraft's 5.3 aspect ratio wing.

cember, after which Grumman will begin production of 35 AO-1 aircraft under a second $22 million Army contract. The program is being administered for the Army by the Navy's Bureau of Aeronautics.

Conceived as a joint Army-Marine aircraft, the Mohawk is now being developed solely for the Army. The departure of the Marines from the project, a move dictated by Defense Department economy measures, has influenced the design of the aircraft. One change was the dropping of a water-ski landing gear which would enable the aircraft to land on the water and taxi to a beach at a minimum speed of 20 kt. (AW Mar. 3, 1958, p. 83). The Army decided that it did not need this capability, so it was dropped in favor of a less complicated snow-mud ski. This ski has a drag penalty of 6 kt. when retracted.

Design Distinction

Another design distinction between Marine Corps and Army aircraft is that the Marines are permitted the use of tactical ground support aircraft whereas the Army is not. This means that since the Marine Corps is now out of the project, anything that looks like a bomb rack or rocket rail on the aircraft is likely to draw fire from other branches of the Defense Department for usurping another service's mission. The aircraft, incidentally, does exceed the 5,000 lb. weight limitation imposed upon Army aircraft as does the 26,000 lb. de Havilland Caribou.

During the design stage of the aircraft the empennage was changed from a T-tail to the present three fin configuration. Wind tunnel tests indicated a lack of single-engine control with the single fin and rudder. The asymmetric thrust forces could have been controlled with a hydraulically-boosted single-engine rudder assist which increases rudder area, but the company wanted to avoid this if possible.

Wind Tunnel

Wind tunnel investigation of a twin-tail design found that it restored single-engine control at the expense of directional stability which was lost due to propwash effects. The addition of a third fin and rudder proved to be the answer to both problems, and still maintain manual control.

Grumman, in designing a STOL aircraft, came up with a 5.3 aspect ratio wing, large flap area and wing slats. The hydraulically-actuated slats work in conjunction with the flaps. The flaps have three positions: up; 25 deg. down for takeoff and 45 deg. down for land-

AO-1 Specifications

Wing span	42 ft.
Over-all length	41 ft.
Tail height	12 ft. 8 in.
Wing area	330 sq. ft.
Aspect ratio	5.35
Takeoff gross weight	10,423 lb.
Empty weight	8,000 lb.
Powerplant (2)	Lycoming T53-L-3
Takeoff power	1,005 eshp. each
Maximum speed at 5,000 ft., military power, level flight	275 kt.
Stall speed, landing configuration, power on	55 kt.
Single engine control speed	64 kt.
Service ceiling	32,500 ft.
Rate of climb	3,000 fpm.
Rate of climb, single engine	1,050 fpm.
Endurance at 200 kt., 5,000 ft.	2 hr.

ing. The propeller diameters cover about 50% of the total wing span.

Increased lateral stability with the flaps down was provided by making the flaps outboard of the engines serve as auxiliary ailerons. These flaps, called inboard ailerons, do not extend more than 25 deg. The inboard ailerons move through 50 deg. of arc from 25 deg. down at neutral aileron to 25 deg. up at full up aileron. These inboard ailerons are the only hydraulically-boosted control surfaces on the aircraft. Other flight controls, including trim tabs, are manually operated.

Speed Brakes

In addition to flaps and wing slats, the YAO-1 is fitted with hydraulically-actuated speed brakes which extend from the sides of the fuselage. The speed brakes will permit the aircraft to plummet from its economical cruise altitude of 25,000 ft. to tree top level. This maneuver will be the Mohawk's most effective evasive action in the event of attack by enemy fighters.

The straight and level top speed of the Mohawk will be approximately 275 kt. and the designed service ceiling is 32,000 ft. Structurally the aircraft can withstand positive 5g up to its design limit speed of 390 kt. Rolling pullups are limited to 4g. The flight-test program has not progressed to the point where any maximum limits can be tested, but preliminary results are quite promising.

Design stall speed of the AO-1 is 63 kt. power off and 55 kt. at 10% normal rated power both at landing weight of 9,423 lb. Flight experience indicates that these speeds are on the high side.

Grumman guaranteed takeoff over a 50-ft. obstacle at 10,423 lb. gross weight and 64 kt. single-engine control speed in a distance of 655 ft. Landing over a 50 ft. obstacle at 9,423 lb. gross weight is guaranteed to be within 776

ft. Again performance of YAO-1 numbers one and two indicate that these estimates are conservative. The guaranteed cruise of the Mohawk is 2 hr. at 200 kt.

The Lycoming T53-L-3 turbine which powers the Mohawk is rated at 1,005 eshp. This power range is more suitable for helicopter application, for which the T53 was chiefly intended, rather than for military aircraft, but the engine suited the AO-1 design well. Selection of the T53 for the Mohawk, the engine's only fixed-wing application, resulted in a $7.6 million production contract for Lycoming.

Engine Details

Grumman engineers have, thus far, been pleased with the engine's performance and reliability. The T53-L-3 is a single-stage free-type power turbine with an axial-centrifugal compressor driven by a single-stage turbine and an external annular vaporizing combustor. The turbine develops 960 shp. and approximately 100 lb. of jet thrust on takeoff at a gas producer speed of 26,390 rpm. and a prop shaft speed of 1,678 rpm. Gear ratio between the power turbine and propeller drive is 12.46:1.

Engine anti-icing is accomplished by passing hot compressor bleed air through the engine inlet struts and inlet guide vanes. The three-bladed Hamilton Standard Hydromatic propeller is full-feathering and has reversible pitch. Prop swath diameter is 10 ft. The complete engine and propeller powerplant package is interchangeable between the left and right wings.

The YAO-1 prototype aircraft are built with two methods of starting engines—the primary one a connection for attaching an air hose from a ground turbine, and an electric starter-generator for inflight starts. In practice, however, the starter-generator powered by a 24 v. nickel-cadmium battery proved so effective that the production AO-1s will be built without the air hose fitting.

The cockpit is designed to provide maximum visibility forward and downward. Seating is side-by-side and engine controls are mounted on a center pedestal. The AO-1 is fitted with a control stick and rudder pedals on the left side only. However, control linkage and a stick socket are located on the right side so that the aircraft can be quickly converted to a dual-control aircraft for training or checkout purposes. In operational aircraft, location of surveillance scopes on the right side necessitates removal of the control stick. Dual instrumentation also is available for training.

The aircraft is fitted with rocket-propelled Martin-Baker ejection seats capable of safely ejecting personnel from 60 kt. to the Mohawk's maximum airspeed. Seat is fitted with automatic deployment and seat separation devices.

Ejection seats are dictated by both the low-altitude tactical flying for which the aircraft was planned and the engine location aft of the cockpit which makes a conventional bailout with the engines running virtually impossible.

Normal ejection in the Mohawk is right through the overhead canopy. The canopy can be jettisoned pneumatically, but it is not part of the firing sequence. Grumman demonstrated the effectiveness of this manner of ejection by ejecting anthromorphic dummies through a Mohawk canopy at the Navy Air Crew Equipment Laboratory, Philadelphia, Pa. Grumman says this method is safer than blowing off the canopy because if the canopy jammed and was only partially blown off, the pilot's head might contact a structural bow on the canopy, which would cause fatal injury.

The crew of the Mohawk is protected from ground fire by ¼-in. armor plate floor and removable flak curtains fore and aft in the cockpit. The plastic windshield is 1 in. thick. Total armor protection on the plane weighs 372 lb.

Production AO-1s will carry either side-looking radar (SLAR) or infrared mapping equipment. The side-looking radar, designed and produced by Motorola, Inc., will be carried externally on an 18-ft.-long cylinder mounted on the lower right side of the fuselage.

Mapping Equipment

Infrared mapping equipment, supplied by Haller, Raymond & Brown of the Singer Military Products Division, is carried internally. The two surveillance equipments can be interchanged between planes, but cannot be carried by one aircraft.

The Mohawk's aerial camera will be a standard KA-30 camera supplied by Chicago Aerial Industries, Inc., with controls by Topp Industries. The camera is located in the fuselage beneath the wing and can be rotated 15 or 30 deg. left or right oblique from the cockpit. Night photography can be accomplished with upward-ejecting flares carried by the aircraft. Two flare

pods can be carried on either side of the fuselage at the trailing edge of the wing with 52 flares installed in each.

Navigation equipment includes an electronic doppler navigation system being produced by Ryan for the AO-1 project under a $3.5 million contract. The Ryan 120A navigator displays ground speed and drift angle on an indicator and can supply electrical outputs of this data to mapping equipment. Other navigational equipment that will be standard on the aircraft is Tacan, automatic direction finder and IFF.

Fuel for the Mohawk is carried in one self-sealing fuel tank located in the fuselage over the wing. Tank capacity is 276 gal.; however, two Douglas 150-gal. drop tanks can be carried on the wings. Fueling is accomplished either by 3-in. filler caps in the tanks or by single point pressure fueling. Pilot and shutoff valves in the main tank control the flow of fuel from the wing tanks. When the transfer switch is on, the main tank remains full until both drop tanks are empty.

Fuel pressure is maintained by two boost pumps which charge a main fuel line feeding both engines. Grumman says both pumps are necessary to supply pressure in all attitudes; however, one pump will keep the aircraft flying.

The aircraft electrical system is 28 v.d.c. with two parallel connected 300-amp. starter-generators. The battery is a 24-v., 36-amp. hr. nickel-cadmium type. Either generator is capable of handling the electrical load. Alternating current is supplied by two inverters which furnish 115/200 v., 400 cps., a.c. power.

Grumman, in keeping with the combat area deployment of the aircraft, has attempted to design maximum serviceability and maintenance into the Mohawk. The avionic compartments of the plane are accessible through latched doors on the fuselage within easy reach of a man standing on the ground. The main fuel cell can be readily replaced by removing two panels on the upper fuselage.

In addition to providing ease of access, Grumman has designed all major assemblies to be interchangeable. Powerplant packages will fit left or right wings. Major landing gear components, stabilizer, elevator and outboard fins and rudders are interchangeable left and right.

The complete wing panel including engine nacelle is replaceable and wing tips, horizontal and vertical tails and fuselage nose and tail sections are replaceable as units.

Shipment by railroad or truck is possible by removing the wings at the wing root inboard of the engines. This is done by removing six bolts and bracing the main landing gear.

The landing gear is tricycle with a 360-deg. swiveling nose wheel. Normal actuation is hydraulic with one-shot pneumatic blowdown available in an emergency. When skis are fitted, the nose wheel doors are removed. The nose ski is then held closed by a spring bungee to cover the nose wheel opening. The main gear skis are more complex in that a hydraulic actuator rotates the gear 94 deg. inboard after takeoff and prior to gear retraction. Ski tests with the aircraft will take place at Grumman this winter.

The flight test program has not developed any serious problems thus far, the only difficulty being a slight tail flutter which required smoothing the surface of the vertical fins. Some work also is being done on balancing the controls to trim out any heavy stick forces.