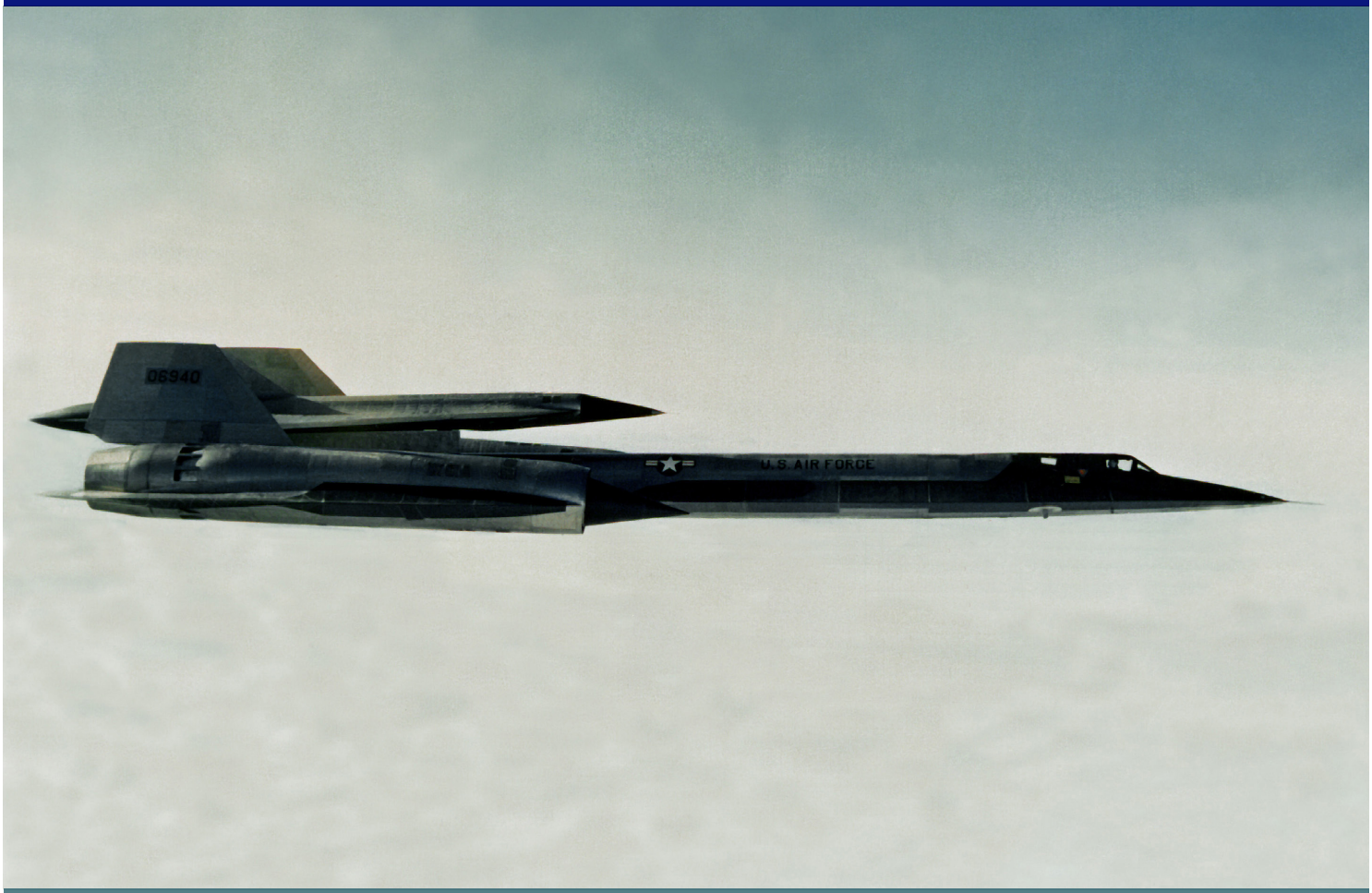
FlightPlan

A VOLUNTEER NEWSLETTER BY VOLUNTEERS



EVERGREEN AVIATION & SPACE MUSEUM

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BILL KOLB
FLIGHTPLAN EDITOR, MONDAY DOCENT

Greetings from the Editor's Desk. This month's emphasis is on drones, which seemed topical given the way Ukraine has responded to Russia's invasion with an asynchronous use of drones against a very structured post-Soviet military doctrine.

A comment on terminology. The most common term for this type of craft is drone. However, there are more precise definitions like:

- **UAV:** Unmanned Aerial Vehicle
- **UAV:** Uncrewed Aerial Vehicle
- **UCAV:** Unmanned Combat Aerial Vehicle
- **RPAS:** Remotely Piloted Aircraft Systems
- **UAS:** Unmanned Aircraft System

In this issue of FlightPlan we are sticking with **drone**, but keep your eyes out for these other terms as you read articles outside of this publication.

And finally, what topics would you like to see explored in future editions? Please send recommendations and comments to flightplan@evergreenmuseum.org.

Thank you!

- Bill

MONTHLY THEMES

We are assigning themes to each month of the FlightPlan. These are not exclusive of other topics, but perhaps they may motivate you to make a contribution.

OCTOBER .....COLLECTIONS
NOVEMBER .....HOWARD HUGHES
DECEMBER.....THE DC-3

GUIDELINES FOR SUBMITTING ARTICLES TO FLIGHTPLAN

1. The FlightPlan (FP) is published on the 1st of each month
2. Stories for the next issue can be filed up to the 10th of the prior month
3. Articles should be associated with an artifact at the Museum
4. Sources for specific information in the article should be provided
5. Stories should be approximately 500 words long
6. If appropriate, include one or two photos for publication with the article
7. Include name, day, and title at the bottom of each article submitted
8. Email articles to: **flightplan@evergreenmuseum.org**
9. Feedback is encouraged; submit to **flightplan@evergreenmuseum.org**

CAPTAINS CORNER

DAN OVEN
SUNDAY DAY CAPTAIN

August 6, 2025, BOC meeting was productive with many topics before the Board. Topics are presented below; to avoid a multi-page report, anyone with further questions regarding the discussions can contact their Day Captain.

Scot Laney – Chief Executive Officer

- A list of volunteers who wish to do Restoration Tours is being collected. Tours will begin on August 15 and will start at 3pm. There will be no charge temporarily. A tour outline was passed out, suggesting ideas to be a part of the tours. Visitors going on the tours will wear special vests.
- Reemphasized the need to use the Museum's chain of command for ideas, questions, complaints, etc. Please go through your Day Captain/Lead.
- Created and distributed a list of jobs and placements for docents in the West and East Pavilions. The document will be given to docents for analysis and comment, resulting in a final draft soon.
- The Museum has begun a radio and onsite advertising campaign. Advertising will be on 101.9 FM, KINK. Onsite advertising will be at the Zoo, OMSI and other locations in addition to the Market of Choice, New Seasons and similar grocery outlets. The campaign will last for 3 months.

Terry Howell – Chief Operating Officer

- The Century Series aircraft are now aligned in front of the West Pavilion, and "Century Drive" signs in place. It was suggested to move the F-102 and F-106 aircraft to more visible locations.
- The Bell 206 JetRanger helicopter has been moved to the corner of the West Pavilion in place of the F-5.
- A VJ Day (Victory over Japan) exhibit will replace the Howard Hughes display in the West Pavilion. It will be on the West Pavilion floor for two or more weeks.
- The new Museum brochures are near completion. They will include a map, and QR codes that will allow translations in 8 languages for foreign visitors.
- The T-33 and F-94 Lockheed aircraft will be moved from the front of the East Pavilion to the parking lot north of the building for eventual use as a part of the planned outdoor aircraft display in that area.
- The VC-9 "Air Force Two" will be moved to the circle landing area outside the East Pavillion for easier access and tours.
- FlightPlan issues, including archive issues, are now on the RADAR information system available to all. Go to **http://www.evergreencrew.squarespace.com**, password ***easmcrew***, for access.
- New janitorial crews are now on the job. Their hours are from 9am and 5pm daily. If the need arises for janitorial services, please go through the chain of command, as previously stated. For emergencies, contact the West Pavilion front desk crew.
- Safety on Goose Tours was discussed, emphasizing the primary goal of docent safety, particularly on hot days.

Lee Ngo – Education Director

- Has just completed his first year as Education Director.

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CAPTAINS CORNER

(CONTINUED FROM PREVIOUS PAGE)

- 60% of Education's revenue is earned between March and August. This year's revenue is up.
- There are now more self-guided groups. Most have been successful, but occasionally the younger children have gotten out of control because of inattentiveness from the chaperones.
- Education is working on new types of tours.
- This year's and future camps have been expanded. There were 8 this year. There will be 8 special camp days for McMinnville school attendees.
- The department is looking into resumption of outreach presentations to schools, libraries, etc.

Old Business:

- The Day Captain training outline was reviewed by the board. A suggestion was made to assign a mentor to newly appointed Day Captains, when needed.
- The FlightPlan newsletter email distribution has been updated. Any errors or missed emails should be sent to your Day Captain/Lead. Articles for the September edition should be submitted as early as possible. Normal deadline is the 10th of the prior month.
- A new weekend docent assistance schedule to complete calendar year 2025 was passed out.

New Business:

- All scheduled new business was covered during meeting discussions.

The meeting was adjourned at 11:32am.

Scot's Notes

SCOT LANEY
MUSEUM CEO

As many of you know, the Museum recently completed the purchase (100% supported by donations) of four 1:1 drone composite aircraft from CMR-D, the company that manufactures fully functional versions of the foreign-made drones currently reshaping the very nature of warfare. These drones are then flown and detonated by the DoD as part of the arduous task of developing new methods of defense against them. As of today, unofficial reports suggest that of the 31 M-1 Abrams battle tanks the U.S. arranged to send to Ukraine, all but four have been destroyed by drones. So, a gaggle of M-1 Abrams, the most capable battle tanks ever developed, has been reduced to piles of slag by drones that probably cost about what a dinner out for a party of four costs here at home.

Clearly, something needs to be done and done quickly.

Although the term "Drone" tends to be a catch-all for many different types of aircraft, our collection is firmly in the Military Hunter-Killer sub-group and is significant in several ways.

First, they represent the current "state of the art" in Level 1, 2, and 3 threats. Drone threat levels are defined by the capability of the drone, with Level 1 being light, commercially available drones fitted with an explosive charge. Level 3 is reserved for the larger drones capable of delivering a robust explosive load over great distances. The smallest drone of ours is the Mark 4 7" FPV, the largest is the Shahed 136. The Lancet 3 and Qasef 1 round out the collection. Between all of these types, hundreds of thousands of people, both civilian and combatant, have been killed in Ukraine and Russia. Many more have been killed in the current hot spots in the Middle East. An untold number of military vehicles and aircraft have been destroyed.

Frankly, the entire concept of warfare has been rewritten, all by some very basic and often even crude disposable aircraft.

More importantly for our Museum is that we are the only museum in the world to possess these aircraft. Currently, we plan to debut the drones to the public in mid-September to generate excitement during a period when our foot traffic typically declines.

Droning On About Drones

ALDEN SKINNER
TUESDAY & WEDNESDAY COLLECTIONS, SATURDAY DOCENT

Drones have exploded—some literally—in proliferation, from tiny toys to the feared MQ-9 Reaper, to the in-development Collaborative Combat Aircraft—CCA.

While many of our guests may consider that any craft lacking a pilot is a drone, this oversimplifies the category of Unmanned Aerial Vehicles (UAVs). We have a broad mix of UAVs, which can be differentiated by some basic categories like fixed-wing (most of them) or rotary-wing, like the Northrop Fire Scout and Boeing Hummingbird. There are big ones like the Global Hawk and small ones like the Insight. But the key differentiation is their *role*.

Roles include: target, intelligence, surveillance, and reconnaissance (ISR), target acquisition, loitering munition, one-way attack, armed strike-capable, and collaborative combat aircraft. The Museum has examples of all but the last two.

One other sub-variation would be the service aircraft that were *converted* to target drones. These unfortunates include the Century Series F-100, 102, and 106, and even the Curtiss N-2C Fledging that became a target in the late 1930s.

Two of the roles mentioned above that can be hard to separate are the loitering munition and one-way-attack types.

A loitering munition is a type of UAV specifically designed to fly to a target area, loiter (circle or hover), search for targets, and strike by self-destructing on impact. Key features are operational flexibility: it can loiter for extended periods, abort attacks, re-engage, return if safe, or be redirected as needed. Loitering munitions carry sensors for real-time target identification and can be used for dynamic target selection. An example of this type is the grey "x-wing" Russian Lancet E that currently lives on a pallet near the PBY's tail.

A one-way-attack UAV (sometimes called a "kamikaze drone" or "suicide drone") is a broader term for any unmanned system built or modified for a one-way, self-destructive attack—meaning it is launched with the intent to strike a target and is not expected to return. These are often simpler, may not possess advanced loitering or sensor capabilities, and are usually pre-programmed for attack or minimally guided by the operator. An example of this type is another recently acquired craft, the Shahed-136 (the Iranian original)/ Geran-2 (the Russian version). It's the larger of the two black UAVs near the PBY's tail.

Of our twelve UAVs, the most common role represented is that of ISR. This role is represented by—in order of date of introduction— Lockheed D-21B "Tagboard" 1964, Tadiran Mastiff III 1973, Northrup Grumman Global Hawk 1998, Northrup Grumman Fire Scout 2000, and the diminutive Insitu Insight—year unknown.

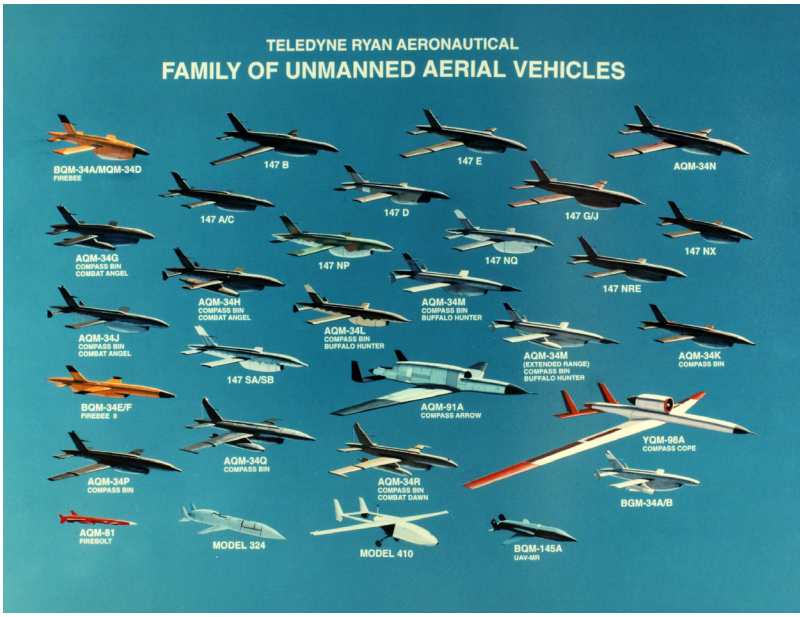
As new aircraft are being developed, some will introduce a new category of optionally-piloted vehicle—OPV. Lockheed Martin is developing an OPV variant of the F-35, and Northrop Grumman's B-21 Raider will be an OPV. Throw in the coming collaborative combat aircraft, and air superiority is going to look very different in the near future.

The Teledyne-Ryan AQM-34N Firebee

BILL KOLB
MONDAY DOCENT

The Teledyne-Ryan AQM-34N Firebee, a variant of the Ryan Model 147 series, was a remotely piloted vehicle (RPV) developed in the mid-1960s to meet U.S. Air Force needs for high-altitude reconnaissance without risking aircrews. Evolving from the Ryan Firebee target drone, first introduced in 1951, the AQM-34N was designed for intelligence-gathering missions, particularly during the Vietnam War era. The AQM-34N, also known as the Model 147H, was powered by a Teledyne CAE J100-CA-100 turbojet engine, which provided enhanced performance for high-altitude operations compared to earlier Firebee variants. This allowed the drone to conduct reconnaissance missions at altitudes that reduced the risk of detection and interception. Launched from a DC-130 Hercules aircraft and controlled remotely, the AQM-34N was equipped with advanced cameras and sensors to capture photographic and electronic intelligence. After completing its mission, the drone would deploy a parachute and descend to a predetermined recovery area, typically over water, for retrieval.

The Firebee series, including the AQM-34N, was notable for its versatility and success as one of the most widely used unmanned aircraft of its time. The AQM-34N specifically flew high-altitude missions between 1969 and 1970, though only a limited number were conducted due to mission requirements shifting toward lower-altitude operations.



The drone's design incorporated features like radar-absorbing materials and anti-radar paint to minimize its radar signature, enhancing its survivability. These modifications built on the earlier Q-2C Firebee's framework, which included a specially designed engine intake screen and radar-absorbing blankets on the fuselage. The AQM-34N's role was critical during a period when manned reconnaissance flights faced significant risks over hostile territories like North Vietnam. Its ability to gather intelligence without endangering pilots marked a considerable advancement in unmanned aerial technology.

The Firebee series' adaptability led to its continued use in various roles, including target drone operations, with Northrop Grumman taking over production after acquiring Teledyne Ryan in 1999.

In summary, the AQM-34N Firebee was a pivotal development in unmanned reconnaissance, showcasing the potential of RPVs in modern warfare. Its high-altitude capabilities, stealth features, and remote operation made it an asset for the U.S. Air Force during the Vietnam War, contributing to the evolution of drone technology.

Pushing The Envelope of What's Possible: The Lockheed D-21B

ALAN DEUTMEYER
MONDAY DOCENT

Trivia question: What does the Evergreen Aviation & Space Museum have in common with the China Aviation Museum in Beijing?

Answer: Both display a Lockheed "Skunk Works" designed D-21B drone!

But why is one displayed in China?

First, some background about the D-21 and D21B: In the early 1960s, the United States sought a new method of obtaining imagery of the Soviet Union without risking a pilot being shot down. Lockheed conceived a pilotless plane capable of flying a preprogrammed route at a speed of Mach 3.35, at an altitude of 95,000 feet and with a range of 3,000 nautical miles. Development of the D-21 drone then began in October 1962 under the CIA-funded program named Project Tagboard. The D-21 was to be launched from the back of a modified A-12 (the predecessor to the SR-71), fly its route over enemy territory, photograph target(s), fly back over neutral territory, eject a film cartridge to be collected by a modified C-130, and then self-destruct. The modified A-12 was redesignated the M-21, "M" designating "mother." "D" designated the drone as "daughter."

Launching the D-21 from the M-21 proved problematic. In a test on July 30, 1966, a D-21 collided with an M-21 at launch, destroying both aircraft and resulting in the death of the M-21 crew member, Ray Torick.

While launching the D-21 from an M-21 was dangerous, Kelly Johnson of Lockheed believed the D-21 could be launched from a modified B-52. The D-21 was redesignated as a "B" version, modified with a rocket booster. The attached rocket would boost the drone up to a high enough speed (over Mach 1.6) where the drone's ramjet engine could ignite, with the booster then jettisoned. Tests proved this launching method to be more reliable and less risky.

With these improvements, Operation Senior Bowl was initiated in 1969 with a flyover of the nuclear test facilities near Lop Nor in northwest China. Senior Bowl was not successful, with control and guidance problems plaguing the D-21B. One was lost when it went off course; another crashed in China on March 20, 1971. With satellite technology evolving and the disappointing results of the drone program, Senior Bowl ended in July 1971. The remaining drones were then placed in storage, never to be flown again.

Whatever happened to the D-21B that disappeared over China? Chinese authorities recovered the wreckage of D-21B #527 and now display it in their museum. If you are interested in seeing our intact D-21B #534 in the East Pavilion, it's located near the SR-71, on loan from the National Museum of the United States Air Force.

Northrop Grumman RQ-4 Global Hawk Drone

BILL KOLB
MONDAY DOCENT

Imagine a high-flying, long-endurance marvel that's transforming intelligence, surveillance, and reconnaissance, or ISR. Built by Northrop Grumman for the U.S. Air Force, the RQ-4 Global Hawk first flew in 2001, designed to provide near-real-time intelligence over large areas (Northrop Grumman, n.d.). It's a jet-powered, unmanned aircraft that flies at altitudes above 60,000 feet, remaining aloft for over 34 hours, and can cover up to 12,300 nautical miles in a single mission. The Global Hawk is operated by the 12th Reconnaissance Squadron at Beale Air Force Base, California, and the 348th Reconnaissance Squadron at Grand Forks AFB, North Dakota, but aircraft are rotated among operational detachments worldwide.

Three remote operators control Global Hawk: an operator located at its launch point, an operator that flies the mission, and a sensor operator. However, they are there more to monitor the aircraft, as it can take off, perform its mission, and land autonomously.

In the RQ-4 name, the "R" is the Department of Defense designation for reconnaissance, and "Q" means unmanned aircraft system. The "4" refers to the series of purpose-built remotely piloted aircraft systems.

What makes the Global Hawk unique is its advanced sensor suite. It is equipped with synthetic aperture radar, electro-optical, and infrared sensors, enabling it to capture high-resolution images day or night, in any weather (U.S. Air Force, 2023). These capabilities allow it to monitor everything from troop movements to disaster zones, transmitting data to ground stations or via satellites for quick analysis. Its range and endurance enable it to cover entire regions, such as the Indo-Pacific, without needing to refuel or land (Federation of American Scientists, 2020). The drone's versatility includes multiple variants. The RQ-4A was the original, but the RQ-4B Block 30 and 40 models feature upgrades like increased payload capacity and signals intelligence (Air Force Technology, 2022).

The RQ-4 Global Hawk stands as a pinnacle of high-altitude, long-endurance ISR technology, delivering unparalleled surveillance capabilities with its advanced sensor suite and global reach. Its ability to cover vast areas and provide real-time intelligence has made it a critical asset for military and strategic operations worldwide. As unmanned systems evolve, the Global Hawk continues to set the standard for persistent, high-altitude reconnaissance.

The Museum RQ-4A hanging from the ceiling of the East Pavilion is a mock-up and was donated by Northrop-Grumman in 2010.

Qasef-1

BILL KOLB
MONDAY DOCENT

The Qasef-1, an Iranian-designed loitering munition, also known as a kamikaze drone, was developed by the Houthis in Yemen with Iranian support, primarily for low-cost, precision strikes against ground targets. The drone, which resembles the Iranian Ababil-2, has a delta-wing design with a pusher propeller, measuring approximately 8.2 feet in length with a 6.6-foot wingspan. It weighs about 99 pounds, including a 66-pound warhead, typically a high-explosive fragmentation payload. The Qasef-1 cruises at speeds of 93–124 mph and has a range of 93–124 miles, powered by a small gasoline engine, making it suitable for medium-range engagements. Its guidance system relies on GPS/INS (Inertial Navigation System) for autonomous navigation, though it lacks advanced AI or real-time target acquisition, limiting its adaptability during flight. The drone's low cost, estimated at $10,000–$20,000 per unit, and simplicity allow for mass deployment, often launched in salvos from basic racks to overwhelm defenses.

While the Qasef-1 has been primarily associated with Houthi operations in Yemen, notably the 2019 attack on Saudi Arabia's Abqaiq and Khurais oil facilities, there is no definitive evidence of its widespread use by Russia in the Russia-Ukraine conflict as of August 2025. Russia has heavily relied on Iranian-supplied Shahed-136 (Geran-2) drones for long-range strikes against Ukrainian infrastructure, with over 26,000 Geran-2s produced in Russia by spring 2025. Some reports speculate that Russia may have acquired Qasef-1 drones alongside other Iranian systems like the Shahed-131/136, given their shared design lineage and Iran's role as a key supplier. However, unlike the Shahed-136, which Russia has adapted and mass-produced domestically, the Qasef-1's use remains unconfirmed in Ukraine, with most sources citing the Shahed series as Russia's primary loitering munition. The Qasef-1's limited range and payload compared to the Shahed-136 (600–1,600 miles, 66–110-pound warhead) make it less suited for Russia's strategic deep-strike operations against Ukrainian cities and energy grids.

If deployed, the Qasef-1's role in Ukraine would mirror its use in Yemen: targeting military assets like radar stations or troop concentrations in contested areas. Its low radar cross-section and affordability could challenge Ukrainian air defenses, though its simpler guidance system makes it vulnerable to electronic warfare and jamming, which Ukraine has increasingly employed. Ukraine's layered defenses, including acoustic sensors and mobile anti-air units, would mitigate the Qasef-1's impact, as seen with Shahed drones, where interception rates range from 50–85%.

We are fortunate to have a copy of the Qasef-1 here at the Museum.

Lancet-3: The Midsized Kamikaze Drone in the Russian Armory

BILL KOLB
MONDAY DOCENT

The Lancet-3, developed by ZALA Aero Group, a subsidiary of Kalashnikov Group, is a Russian loitering munition, or kamikaze drone, designed for precise strikes against high-value targets. Unveiled in June 2019 at the Military Technical Forum near Moscow, it is the largest version in the Lancet family, optimized for reconnaissance and attack missions. The drone's compact design measures about 4.9 feet in length with an 8.2-foot wingspan, featuring a dual X-wing configuration to improve lift, structural rigidity, and maneuverability. It has a maximum takeoff weight of 26.5 pounds, carries a 6.6-pound payload (upgradable to 11 pounds in newer models), and reaches a cruising speed of 50–68 mph, with a terminal dive speed of up to 186 mph. Its endurance is 40 minutes, covering a range of 25–50 miles, with recent upgrades increasing this to 43–50 miles. The Lancet-3 uses advanced optical-electronic and TV guidance systems, supported by a U-Blox navigation module with anti-jamming features, and AI-driven image processing through an NVIDIA Jetson module for autonomous target tracking. It is launched via catapult and operated by a portable station, incorporating composite materials to lower radar detectability.

In the Russia-Ukraine conflict, the Lancet-3 has been widely used since July 2022, targeting Ukrainian artillery, armored vehicles, and air defense systems. By January 2025, over 2,800 Lancet drones were launched, with a 77.7% hit rate, destroying 738 targets and damaging 1,444, mainly howitzers (760 strikes) and self-propelled artillery (517 strikes). Notable strikes include a Ukrainian T-84 tank in February 2023, a British Stormer HVM in March 2023, and a MiG-29 fighter in September 2023, demonstrating its extended range and accuracy. Often paired with Orlan-10 reconnaissance drones for target acquisition, the Lancet-3's small size and low heat signature make it hard to intercept, although Ukraine counters with electronic warfare, anti-aircraft systems like Strela-10M4, and protective netting. Despite sanctions that limit foreign component supplies, Russia has tripled its production by using stockpiles and alternative suppliers. The drone's affordability, at $20,000–$35,000 per unit, and its ability to neutralize high-value targets have made it a key asset, prompting Ukraine to seek improved air defenses.

We have a Lancet-3 on display in the West Pavilion.

Mark 4 7” FPV Drone

BILL KOLB
MONDAY DOCENT

The Mark 4 7” FPV drone serves primarily as a low-cost, expendable weapon in the Russo-Ukrainian War, repurposed from civilian hobbyist frames for asymmetric warfare by Ukrainian forces and volunteers. Assembled with a 7-inch propeller setup in a True-X carbon fiber frame measuring about 7.6 x 8.8 inches and weighing 4.3-4.6 ounces bare, it is equipped for kamikaze strikes or bombing missions. Typical configurations include brushless motors, a SpeedyBee flight controller, Caddx Ratel 2 camera, 1.6W VTX, and 915MHz ELRS receivers, speeds up to 112 mph, and ranges of 1.9 - 3.1 miles. Payloads up to 3.3 pounds, such as RPG-7 warheads or grenades, enable precision attacks on Russian trenches, armored vehicles, artillery, and personnel, often via drop systems or direct impact. Ukrainian initiatives, like Social Drone UA and private manufacturers, produce these at $300-840 per unit, donating them to frontline units to minimize soldier exposure while targeting high-value assets.

In practice, Mark 4-based FPVs are launched from 1-3 miles behind lines, guided via goggles to hover, adjust, and strike moving or fortified targets like bunkers and buildings, often in “double-tap” sequences following artillery. They have become Ukraine’s primary anti-tank tool, destroying multimillion-dollar vehicles with sub-$500 drones, and account for 60-70% of casualties in sectors like Donbas. Innovations include fiber-optic controls for jam-resistant ranges up to 31 miles, AI targeting for autonomous strikes, and “mothership” carriers releasing swarms of FPVs. Ukraine deployed over 1 million FPVs in 2024, aiming for 4.5 million in 2025, including for counter-drone intercepts (e.g., ramming Russian Orlans) and rare naval operations off Crimea. Russia mirrors this, using similar FPVs for interdiction, creating 6.2-mile “kill zones” with thermobaric payloads to disrupt Ukrainian logistics and movements.

Despite effectiveness, limitations abound; success rates are 20-43% due to jamming (31% failures), technical faults (25%), weather vulnerabilities, and lack of navigation aids or night vision. Procurement delays, component shortages from China, and training needs (70+ hours) hinder scaling, while countermeasures like anti-drone shotguns evolve. This civilian tech’s militarization has shifted the conflict to a “drone war,” emphasizing swarms, electronic warfare, and innovation in attrition battles.

The Museum recently acquired a copy of a Mark 4 drone.

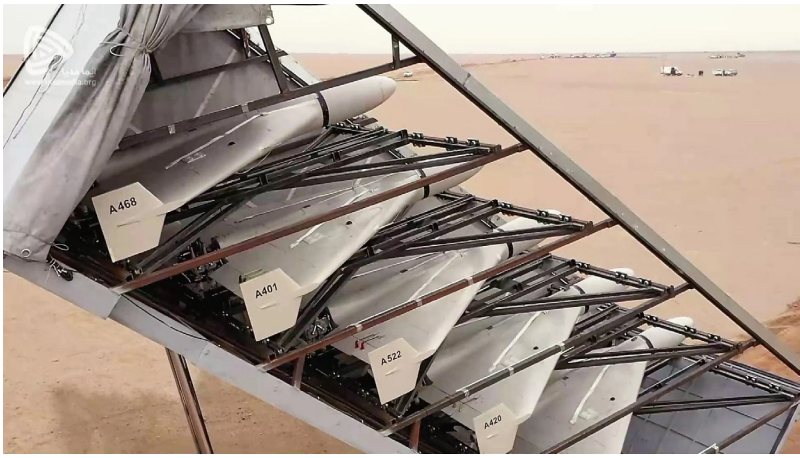
The Shahed-136: Iran's Cost-Effective Kamikaze Drone

BILL KOLB
MONDAY DOCENT

The Shahed-136, developed by Iran's HESA (Iran Aircraft Manufacturing Industrial Company), is an affordable, long-range kamikaze drone designed for precision strikes. It has become well-known for its use in modern conflicts, particularly Russia's war in Ukraine. This unmanned aerial vehicle (UAV), often referred to as the Geran-2 by Russian forces, features a delta-wing design optimized for cost-effectiveness and swarm tactics, earning it the nickname "the poor man's cruise missile".

Measuring 11.5 feet in length with an 8.2-foot wingspan, the Shahed-136 weighs approximately 441 lbs and carries a warhead weighing between 88 and 110 lbs. It is powered by a Mado MD550 four-cylinder piston engine, which is a reverse-engineered version of a German Limbach L550E. The drone achieves a cruising speed of 115 mph and has a range of up to 1,550 miles, allowing it to strike deep into enemy territory. Its low radar cross-section and swarm capabilities enable it to overwhelm air defenses, making it a persistent threat despite its slow speed and noisy engine, often compared to that of a "lawnmower".

The drone's guidance system combines commercial satellite navigation, providing accuracy within five meters, and is enhanced by anti-jamming technologies such as CRPA antennas. Priced between $20,000 and $50,000 per unit, its affordability facilitates mass deployment, with Russia launching thousands against Ukrainian infrastructure since 2022. The design of the Shahed-136 includes a honeycomb structure to minimize radar detection, and Russia has upgraded it to feature larger warheads (up to 200 lbs) and extended range.



Despite its effectiveness, the drone's slow speed and vulnerability to electronic warfare present significant weaknesses. Ukrainian forces have managed to shoot down many of them using countermeasures like the Gepard systems, although about 14% of the drones penetrate defenses, causing considerable damage. The proliferation of the Shahed-136, including its use by Houthi rebels and in Sudan, underscores its role in asymmetric warfare and its impact on global conflict dynamics.

Not only does the Museum have a mock-up of the Shahed-136, but we also have the actual wreckage of one that was shot down over Ukraine (at left).

The Osa FPV Drone in Ukraine's Operation Spider's Web

BILL KOLB
MONDAY DOCENT

On June 1, 2025, Ukraine executed Operation Spider's Web, a bold drone attack targeting Russian air bases deep within enemy territory. The operation, orchestrated by the Security Service of Ukraine (SBU), relied on the117 Ukrainian-made **Osa ("Wasp")** first-person-view (FPV) drone, produced by **First Contact**, a domestic defense technology company.

The Osa drone was designed for precision and stealth. Each unit carried a 1.6-kilogram (3.5-pound) high-explosive warhead, sometimes configured with dual charges to penetrate aircraft skin and detonate internally. With a maximum speed of 150 km/h (93 mph) and a flight time of up to 15 minutes, the Osa was ideal for short-range strikes from covert launch sites near Russian air bases. Unlike typical FPV drones with open frames, the Osa featured a sealed, robust design housing all electronics, with a front-placed antenna for enhanced durability during transport and operation.

Advanced technology underpinned the Osa's effectiveness. It incorporated ArduPilot, an open-source autopilot system, ensuring stable flight and navigation despite potential communication disruptions. Artificial intelligence, trained on images of Russian aircraft like the Tu-22M3, enabled autonomous target recognition, allowing the drones to strike critical components such as fuel tanks and avionics. Operators in Ukraine controlled the 117 drones via Russian 4G/LTE networks, embedding signals in civilian data traffic for stealth.

In the operation, Osa drones were smuggled into Russia, concealed in truck-mounted cabins with retractable roofs, and launched simultaneously near five air bases: Olenya, Belaya, Dyagilevo, Ivanovo Severny, and Ukrainka. Their precision strikes damaged or destroyed up to 41 aircraft, including Tu-95 and A-50 planes, costing Russia an estimated $7 billion.

Conclusion

The Osa FPV drone, manufactured by First Contact and costing $600 to $1,000, was the cornerstone of Ukraine's Operation Spider's Web, combining affordability, durability, and cutting-edge technology to execute a historic strike. Its AI-assisted targeting, ArduPilot navigation, and integration with Russian telecom networks enabled precise, devastating attacks on high-value Russian assets, redefining drone warfare and highlighting Ukraine's innovative approach to asymmetric conflict.

Operation Spider's Web: Ukraine's Audacious Drone Strike on Russian Air Bases

BILL KOLB
MONDAY DOCENT

On June 1, 2025, Ukraine executed one of the most daring and innovative military operations in modern warfare: Operation Spider's Web (also referred to as Operation Spiderweb). This covert drone attack, carried out by the Security Service of Ukraine (SBU) under the direct oversight of President Volodymyr Zelenskyy, targeted Russian Long-Range Aviation assets deep inside Russian territory. The operation struck five air bases—Olenya in Murmansk, Belaya in Irkutsk, Dyagilevo in Ryazan, Ivanovo Severny in Ivanovo, and Ukrainka in Amur—spanning multiple time zones and thousands of kilometers from Ukraine's borders. By emphasizing asymmetric tactics, Ukraine aimed to degrade Russia's ability to launch cruise missile strikes against Ukrainian cities, showcasing how ingenuity and low-cost technology can challenge a superior military power.

Planning: A Meticulous 18-Month Preparation

The foundations of Operation Spider's Web were laid over 18 months prior to its execution, beginning in late 2023 or early 2024. This extended timeline allowed Ukrainian intelligence to address the logistical challenges of operating deep within enemy territory, where direct launches from Ukraine would be vulnerable to Russia's extensive air defense systems. The SBU, led by Vasyl Maliuk, orchestrated the effort, with Zelenskyy personally supervising key aspects to ensure secrecy and alignment with broader war objectives.

Central to the planning was the covert smuggling of resources into Russia. Ukrainian agents established a fake logistics company in Chelyabinsk to facilitate the movement of 150 small first-person-view (FPV) drones, 300 explosive payloads, and modular launch systems without arousing suspicion. These drones were compact quadcopters equipped with high-explosive warheads weighing about 1.6 kilograms each, designed for precision strikes. To bypass Russian customs, operatives bribed officials to import necessary equipment like EcoFlow batteries and solar panels for recharging the drones. The SBU also scanned Russian bombers using military intelligence to train artificial intelligence (AI) algorithms for target recognition, enabling autonomous guidance during the final approach.

Secrecy was paramount: only Zelenskyy and one senior SBU official knew the full details until the final hours. Components were manufactured and assembled by

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teams unaware of their ultimate purpose, reducing the risk of leaks. Operatives infiltrated Russia to set up camouflaged "hunting cabins" as charging stations, powered by autonomous batteries. This phase involved recruiting unwitting Russian civilians, such as truck drivers, to transport the disguised payloads, ensuring deniability and minimizing exposure for Ukrainian agents. All Ukrainian personnel were withdrawn from Russia before the strikes, safeguarding human assets.

The planning phase underscored Ukraine's shift toward hybrid warfare, blending espionage, technology, and deception to compensate for conventional disadvantages. By targeting irreplaceable Soviet-era aircraft like the Tu-95 and Tu-22M3, which Russia cannot easily replace, the operation aimed to inflict long-term damage on Moscow's aerial capabilities.

Strategy: Asymmetric Innovation and Surprise

The strategic core of Operation Spider's Web lay in its asymmetric approach, leveraging low-cost drones—each costing around $600—to neutralize high-value targets worth billions. Ukraine's strategy addressed the limitations of long-range strikes by smuggling short-range FPV drones into Russia, bypassing air defenses and reducing flight times to minimize detection. The drones were concealed in wooden cabins mounted on trucks, disguised as ordinary sheds with remotely operable retractable roofs.

Coordination was key: the strikes were simultaneous across five regions to overwhelm Russian responses and maximize surprise during daylight hours, when defenses were least expectant of small-drone swarms. Drones were controlled remotely from Ukraine via Russian telecommunications networks or satellite links, with AI enabling autonomous homing on pre-identified targets like fuel tanks, avionics, and missile mounts for maximum destructive effect. Each of the 117 drones had a dedicated operator, ensuring precision despite potential jamming.

This strategy not only targeted physical assets but also aimed at psychological warfare, eroding Russian perceptions of rear-area invulnerability and forcing resource reallocations. By hitting nuclear-capable bombers, Ukraine signaled its willingness to escalate symmetrically against Russian aggression, while adhering to international norms by focusing on military targets.

Execution: Coordinated Strikes on June 1

The operation unfolded on June 1, 2025, coinciding with Russia's Military Transport Aviation Day for added symbolic impact. Trucks, driven by unaware Russian civilians, were positioned near the air bases. Remotely, the cabin roofs opened, releasing 116-117 drones that swarmed the targets. Pilots in Ukraine guided the drones to strike vulnerable points, causing massive fireballs as fuel tanks ignited--evidence that many aircraft were armed and fueled for imminent missions.

Videos and satellite imagery confirmed explosions at all sites, with drones emerging from containers and

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hitting aircraft like Tu-95s and A-50s. The SBU's elite "A" unit operated from a secure Kyiv location, with phones confiscated for security. The attack's daytime execution caught Russian defenses off guard, despite air defense systems in place.

Results: Significant Damage and Broader Implications

Ukraine claimed 41 aircraft damaged or destroyed, representing 34% of Russia's strategic cruise missile carriers and valued at $7 billion. U.S. officials confirmed about 20 hits, with 10 destructions, including Tu-95s at Olenya and A-50s at Ivanovo. OSINT analyses verified damage, such as four Tu-95s and one An-12 at Olenya, comprising 20% of Russia's long-range fleet.

Russia acknowledged fires at Murmansk and Irkutsk but claimed repels elsewhere, detaining "participants" and declaring emergencies at other bases. In response, Russia relocated bombers eastward, built shelters, and intensified strikes on Ukraine, but the operation disrupted their aerial tempo. Psychologically, it exposed Russian vulnerabilities, prompting doctrinal reviews and escalating tensions, though peace talks in Istanbul proceeded.

The operation boosted Ukrainian morale and demonstrated drone warfare's future, potentially influencing global conflicts by showing how accessible technology can level battlefields. However, it risks provoking harsher Russian retaliation, underscoring the war's precarious balance.

In conclusion, Operation Spider's Web exemplifies Ukraine's adaptive resilience, transforming defensive necessity into offensive innovation. Its success in planning, strategy, execution, and impact will redefine asymmetric warfare.

A-50

Tu-22M

Tu-95

James A. Lovell Jr. (1928–2025)

BILL KOLB
MONDAY DOCENT

James Arthur Lovell Jr., the renowned astronaut who commanded the intense Apollo 13 mission, died on August 7, 2025, at his home in Lake Forest, Illinois, at age 97. His extraordinary career and steady leadership during one of NASA's most critical missions secured his legacy as an American hero.

Born on March 25, 1928, in Cleveland, Ohio, Lovell's early life was shaped by the loss of his father in a car accident and a fascination with rockets, sparked by building makeshift models as a teenager. After studying at the University of Wisconsin, he graduated from the U.S. Naval Academy in 1952, becoming a naval aviator and test pilot. His precision and composure as a pilot foreshadowed his astronaut career.

Selected by NASA in 1962 as part of the "New Nine," Lovell flew four space missions, totaling over 715 hours in space—a record until the Skylab era. His first flight, Gemini 7 in 1965, lasted two intense weeks in a cramped capsule, demonstrating human resilience for long-duration spaceflight. In 1966, he commanded Gemini 12, where Buzz Aldrin's spacewalks confirmed crucial techniques for future missions.

Lovell's defining moments came with Apollo. As command module pilot for Apollo 8 in 1968, he joined Frank Borman and William Anders as the first humans to orbit the Moon. Their Christmas Eve broadcast, reading from Genesis, and the iconic "Earthrise" photo captured global attention, with Lovell describing Earth as a "grand oasis in the vastness of space."

Apollo 13, Lovell's final mission in 1970, was meant to land him on the Moon. Instead, an oxygen tank explosion 200,000 miles from Earth turned it into a fight for survival. Lovell's steady leadership, along with crewmates Fred Haise and Jack Swigert, transformed a potential tragedy into NASA's "successful failure." His calm radio call, "Houston, we've had a problem," became iconic. Using the lunar module as a lifeboat, Lovell guided the crew safely back, demonstrating ingenuity under pressure.

Post-NASA, Lovell co-authored Lost Moon (1994), which inspired the 1995 film Apollo 13, where Tom Hanks portrayed him. He made a cameo as the USS Iwo Jima's captain, insisting on his real-life rank. Awarded the Congressional Space Medal of Honor in 1995, Lovell's contributions extended beyond space, including business ventures and running Lovell's of Lake Forest restaurant.

Lovell is survived by his children, Barbara, James, Susan, and Jeffrey, as well as 11 grandchildren, and nine great-grandchildren. His wife, Marilyn, predeceased him in 2023. Lovell's legacy endures as a testament to courage, exploration, and the human spirit.

Band of Brothers

The McMinnville, Oregon Band of Brothers meets on the **first Thursday of each month** in the large glass-walled room to the left of the primary admissions desk in the West Pavilion (formerly the Aviation Museum). **Meetings run from 11:30 am to 12:30 pm,** with coffee and cookies served. More details can be found at the group's **Facebook page: https://www.facebook.com/groups/838928846550343**

JOHN BURLESON

COLLECTIONS & SUNDAY DOCENT

SEPTEMBER 4

Our September 4th speaker will be **Emily Delo.** Emily is the **Veterans Affairs/Student Outreach Coordinator** at Linfield University. Emily will discuss how the university reaches out to veterans and offers support, as well as how to access education benefits such as the new GI Education Benefits Program. Emily's parents were Vietnam Era veterans; her mother was an Air Force nurse, and her father is an Air Force retired Lt. Colonel.

OCTOBER 4

Our October 2nd speaker will be Art Pohl. Art is a U.S. Navy veteran who served during the Cold War/Vietnam Era. Art's presentation will entail a little-known story regarding Willamette University's football team and Pearl Harbor.

The Wall That Heals

A replica of the Vietnam Veterans Memorial in Washington, D.C. is coming to Independence, Oregon. The national traveling Vietnam Veterans Memorial Replica & Mobile Education Center will assemble the replica wall in Independence on **September 18-21**, at the **Independence Sports Complex.**
Visit the event site for details: https://www.ci.independence.or.us/thewallthatheals2025/

The 2025 Oregon International Air Show

TERRY HOWELL

CHIEF OPERATING OFFICER

GENERAL AIR SHOW INFO:

September 26th thru 28th, featuring **The Royal Canadian Air Force's Snowbirds!**

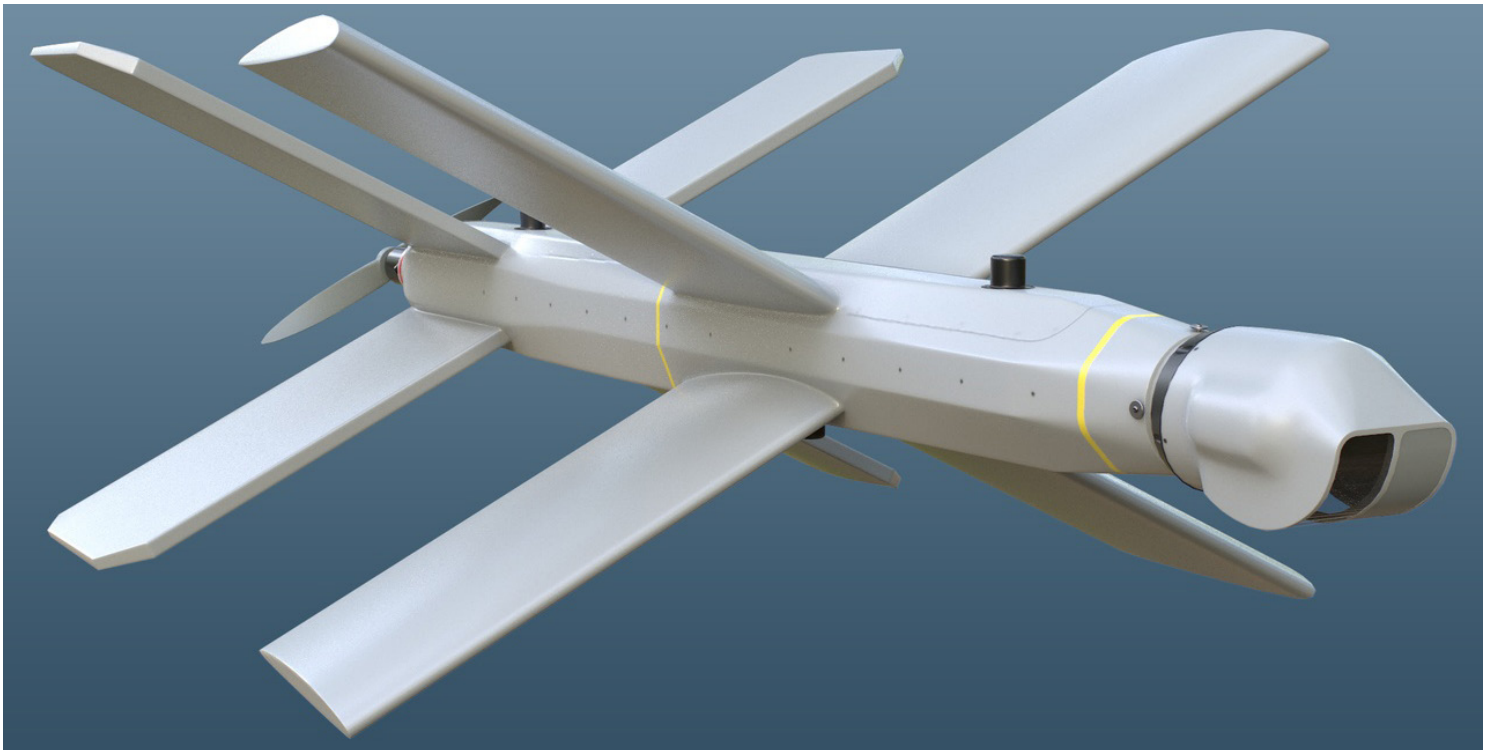
The Air Show kicks off at about 12:30 PM and runs to 4:15 PM each day (The Museum will be open to the public from 9 to 5 daily). This year we won't be having our typical full-scale Watch Party with food trucks, etc., but Museum guests are welcome to bring lawn chairs and watch the show and enjoy our outdoor exhibits.

Parking will be restricted to Museum guests, staff & volunteers only. **Members, Staff & Volunteers are free.** Members will have a reserved seating area to watch the air show.

Those who wish to attend the Oregon International Air Show may purchase their tickets at the official Oregon Airshow site **here**. We have arranged for a special Evergreen Museum Member/Volunteer discount for our members and volunteers that wish to attend the Air Show at the McMinnville Airport; the Promo Code is available on request.

MUSEUM MISSION

Evergreen Aviation & Space Museum is a force of curiosity and courage for kids of all ages to gain the confidence to take flight.



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