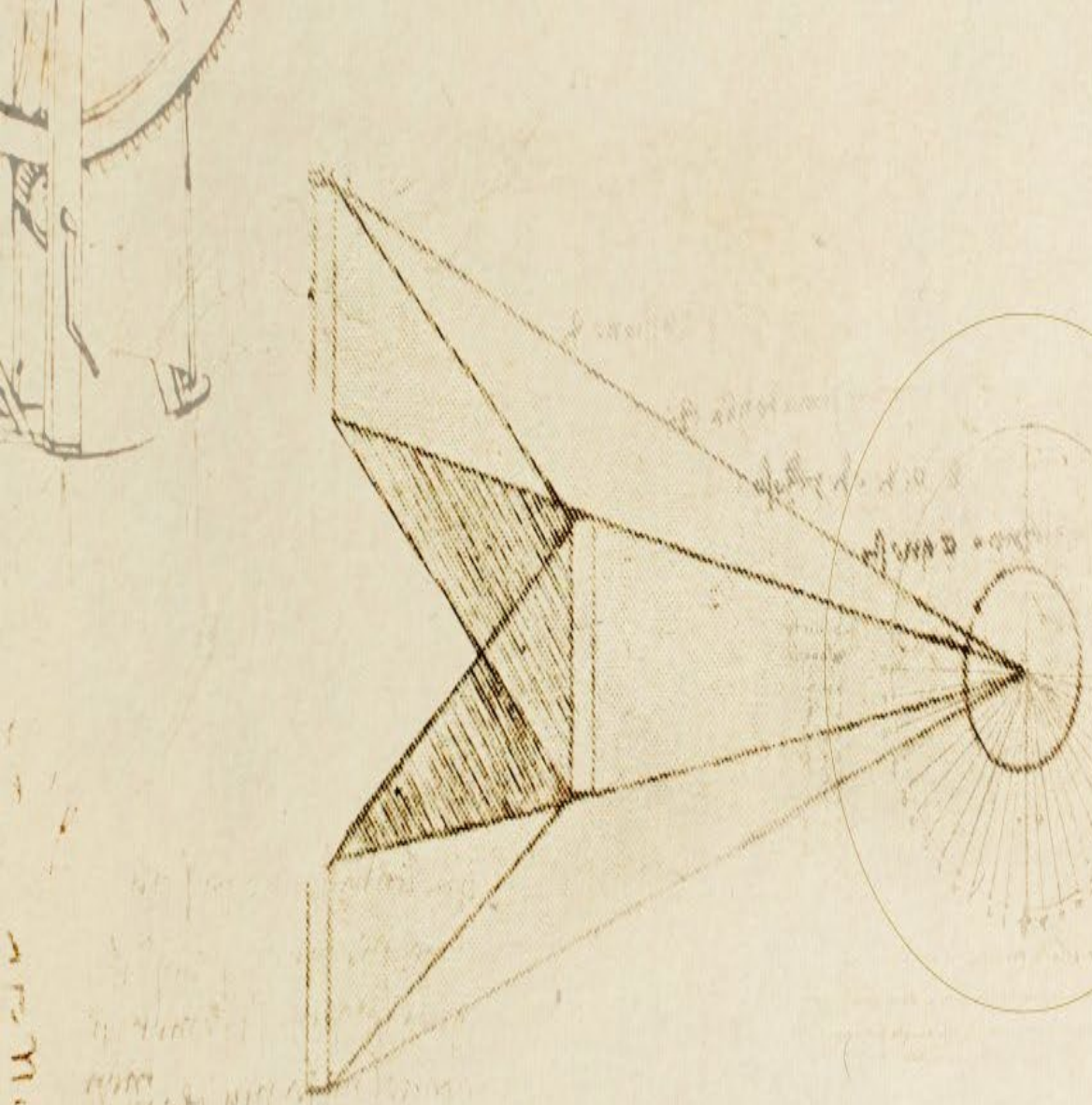


ON FUTURE WAR

The Future of Warfare

1. All information and material that is presented today is Unclassified and comes from Open Sources such as the Internet, Corporate Websites, Publicly Released Videos and Public Websites associated with the Defense Industry.

2. Neither I nor Mercer Engineering Research Center endorse any product shown or mentioned during this presentation.

3. Everything discussed today or shown via a video is either in production or being developed by the military or industry. The product or employment of the devices may be at different levels of Technology Readiness Levels (TRL).

The Future of Warfare

- A future Great Power (United States, Russia, China, India) engagement will include Land, Air, Seaborne, **Space and Cyber** forces.

- The war will be prosecuted in line with current military doctrine, with the addition of Space, Cyber, and an increased role of Information Operations.

- Information Operations (I/O) will play a major role to influence the friendly and opposition forces, civilian population and world opinion.

- The pace of warfare will be exponentially greater that what was envisioned in a Cold War fight.
  - Addition of precision munitions at all levels of combat.
    - Fly faster, farther and are accurate down to 1 meter.
  - Consumption of munitions will be at an unsustainable rate after the first 72hrs of conflict.
  - The amounts of Data, both military source and open source will overwhelm the Tactical and Strategic Operations Centers.
  - The loss of personnel, equipment will exceed anyone's imagination.
  - Legacy equipment has a place in modern warfare

The Future of Warfare

- It is *my opinion* that we are not in a Revolutionary Phase of Warfare but a final Evolution of existing equipment and tactics.

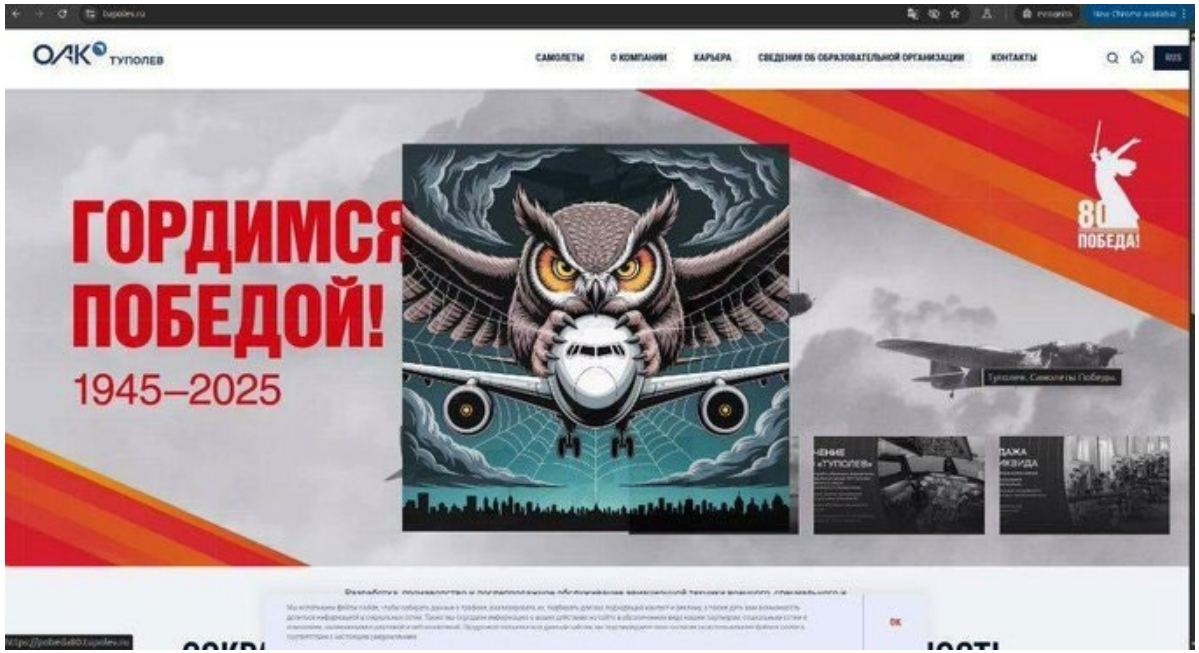
- Much of the modernization and changes that exist are in the form of Software integration, modifications and updates to existing equipment.

- Trust is the highest concern when dealing with Machine Learning and the use of Artificial Intelligence. Defenses Advanced Research Projects Agency (DARPA) programs such as Skyborg investigate the integration of AI onto combat aircraft and pilot/AI interaction as well as the Army's Project Maven whose goal is to integrate multiple data sources – geolocation, satellite imagery, intel intercepts into a unified interface for battlefield analysis and is being tested at Project Convergence Capstone 5.

- Brown's Thought - The next Revolution of tactics, techniques and procedures (TTPs) will occur with those who will enter our military after the year 2040.

The Future of Warfare

Recent Headlines



Ukraine's GUR hacked the Russian aerospace and defense company Tupolev, stealing 4.4GB of highly classified internal data.

The Future of Warfare

Recent Headlines

Norway's Historic In-Flight Bomb Takeover Signals a New Era for Networked Weapons and Allied Warfare

The strike, code-named Jotun Strike, took place off the jagged northwest coast of Norway on May 14. Two US Air Force F-15E Strike Eagles, each carrying a GBU-53/B StormBreaker glide bomb, flew towards Andøya. After releasing the bombs, something remarkable occurred: Norwegian troops, through a secure combat network, took control of the bombs in mid-air. Employing sensor information such as feeds from a Norwegian P-8A Poseidon maritime patrol plane Norwegian operators guided the bombs against targets of their selection, making trajectory changes and even switching targets as battlefield intelligence developed.

Open Source Information

Open Source Information – Derived from data and information that is available to the General Public. Internet, cell phone video, user content, blogs, TicToc, Instagram, etc.,

Global live camera feeds: https://www.wsav.com › weather › live-cams

- Ukrainian intelligence analysts use Palantir's MetaConstellation tool to quickly access commercial satellite data through AI-assisted searches, providing crucial information when and where it's needed. It utilizes Palantir's AI software to analyze open-source data, satellite imagery, and drone footage, creating reports from the ground that present military options to commanders

- Gpsjam.org – provides updated information on electronic jamming and interference.

- Oryx – Provides equipment losses for both Russia & Ukraine
  Attack On Europe: Documenting Ukrainian Equipment Losses During The Russian Invasion Of Ukraine - Oryx

Open Source Information

- Example of information provided from the Oryx website on Ukrainian loses of U.S. provided equipment as well as all equipment lost during the war:

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Team Awareness Kit (TAK)

- TAK is a tactical situational awareness solution that provides communications, coordination and real time data & information that can be generated, visualized and shared across multiple users to achieve common tactical awareness.
- Users include Department of Defense, Department of Homeland Security, Foreign Militaries and other government & local agencies.

What is it ?

- Developed by Air Force Research Laboratory (AFRL)
- TAK is an Android Smartphone military situation and geospatial Infrastructure app.
- It allows for precision targeting, situational awareness, navigation, and data sharing.
- ATAK is available to the Open Source Community
  - Improve functionality
  - Add features
- Uses Google Earth and Google Maps

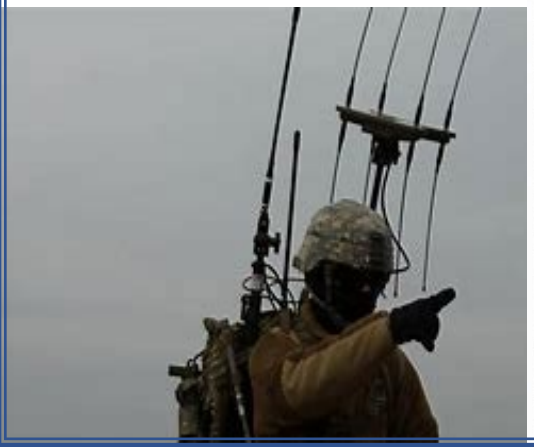
- Civilians can download the ATAK-CIV app.
- Military utilize the ATAK-MIL app.
- USG use the ATAK-GOV app.

ATAK 3.6 Promo (youtube.com)

Electronic Warfare

- The Ukrainian War has spawned the re-birth of Electronic Warfare (EW).
  - New capabilities with AI enabled/Machine Learning to adapt to new threats or changing environment (Spy vs Spy)
  - Reconfigurable Software Defined Radio (SDR) Technology
  - Operates in the 30MHz to 3800Mhz range
  - Integrated wireless mesh network for EW coordination
  - UPDATE: Anduril secures $250M contract to supply DoD with 500 Roadrunner interceptors and Pulsar EW Systems

[Introducing Pulsar: Family of Electromagnetic Warfare Systems (youtube.com)]



3D Printing/Additive Manufacturing

xCell

HIGH-VOLUME, DISTRIBUTED MANUFACTURING FOR UAS, SPARE PARTS, AND MORE

Two 20-ft containers or one 40-ft container form factor

50 unit / month production capacity

Deploy to remote locations or disguise and hide in plain sight

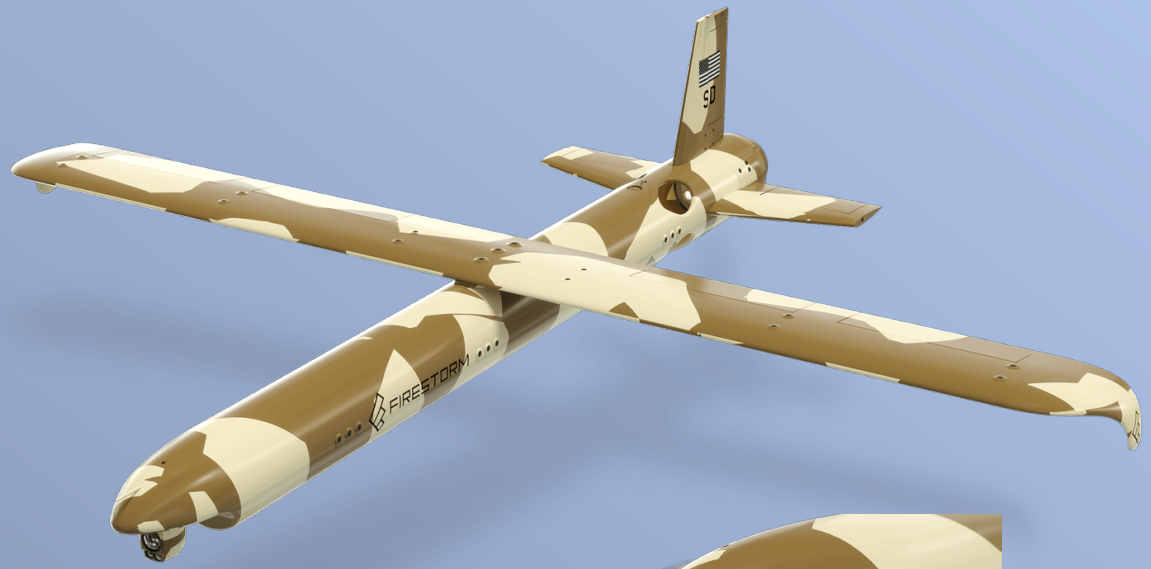
AS THE US AND ALLIES LOOK TO THE PACIFIC, ADDITIVE MANUFACTURING RELIEVES LOGISTICAL BURDENS.
xCell is a semi-automated, expeditionary manufacturing cell that can be operated with limited human-in-the-loop engagement and powered by generators off-the-grid.

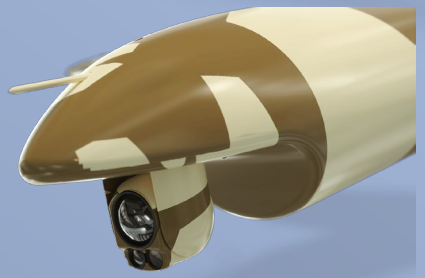
Additive manufacturing, automation, and robotic-assisted assembly enable a future where expeditionary factories quickly produce large volumes of Firestorm vehicles.

UAVs and Drones

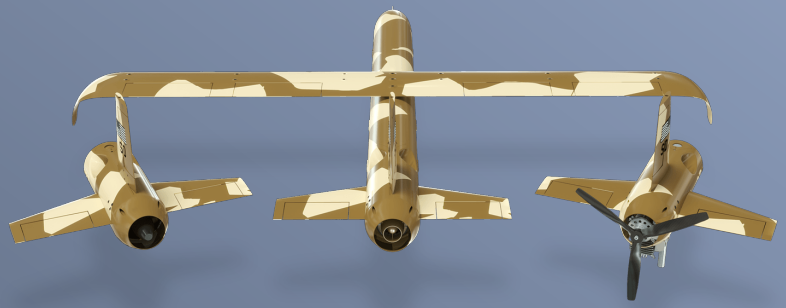
Firestorm Tempest Drone
INTEGRATIONS & CAPABILITIES

- AI autopilots
- GPS denied navigation
- Terrain following
- Automatic target recognition
- Broad payload offerings





- Wide and expanding array of sensor options
- Numerous data links / communications integrations
- Bolstered by component multi-sourcing



Specifications:

MTOW: 55 lbs.
Payload Capacity: 10 lbs.
Wingspan: 7 ft
Length: 6 ft
Configuration-dependent range, loitering time, and cruise speed

UAVs and Drones

Can be 3D printed

- Reconnaissance
- Armed Strike
- Supply Delivery
- Counter-Drone

Kamikaze Drones

[Ukrainian FPV Drone Destroys Russian T-90 Tank in Seconds - YouTube]

Anduril Industries

- **Roadrunner and Roadrunner-Munition**
- **VTOL autonomous, recoverable, air vehicle**
- **Roadrunner-M is a ground based, high explosive Interceptor**
- **One operator can manage multiple Roadrunner & Roadrunner-M systems**
- **If the target doesn't need to be destroyed, the Roadrunner can return to base and land vertically to be refueled and ready for re-use.**
- **Low cost system vs typical inceptor missile systems**

[Anduril unveils Roadrunner & Roadrunner-M (youtube.com)]

Loitering Drones

Altius-600

Best in class range, payload, and endurance, Altius-600 launches from a variety of platforms and altitudes, providing increased capabilities to any mothership.

Weight - Up to 27 lbs.

Endurance - Up to 4+ Hours

[Anduril & Textron Systems Show Interoperability of Aerosonde® & Lattice for Mission Autonomy - YouTube]

Kamikaze Drones

Continuous Evolution:

- Replacement of traditional radio electronic components with fiber optic wire, up to a 12 mile range.
- First Person Viewing (FPV) helmets/goggles
- Integration of AI – Trained to identify objects, vehicles, buildings, etc., and will eventually operate autonomously with AI.
- Russia is responding in kind with its new Shahed-136 suicide drones that use GPS technology to navigate. Packed with 4G data modems and Ukrainian SIM cards, *they can travel using Ukrainian cell-phone towers* and Chinese satellite navigation antennas, helping them to dodge Ukrainian electronic warfare (EW) defenses. Russia hopes to launch autonomous drone salvos in the future.

Air Launched Swarm Drones

- Launched from C-130J, C-17 or other cargo aircraft
- Flying Ammo Dump
- Ramp Launch
- Troop Door Launch

Air Force Research Laboratory is researching the use of palletized munitions aboard C-130J and C-17 aircraft.

AC-130W & J Gunship Munitions

Collaborative Combat Aircraft

AI Piloted Fighter Aircraft

- On the morning of December 1, 2022, a modified F-16 fighter jet codenamed VISTA X-62A took off from Edwards Air Force Base, roughly 60 miles north of Los Angeles. Over the course of a short test flight, the VISTA engaged in advanced fighter maneuver drills, including simulated aerial dogfights, before landing successfully back at base.
  A fighter pilot was not at the controls but, for the first time on a tactical aircraft, it was AI.

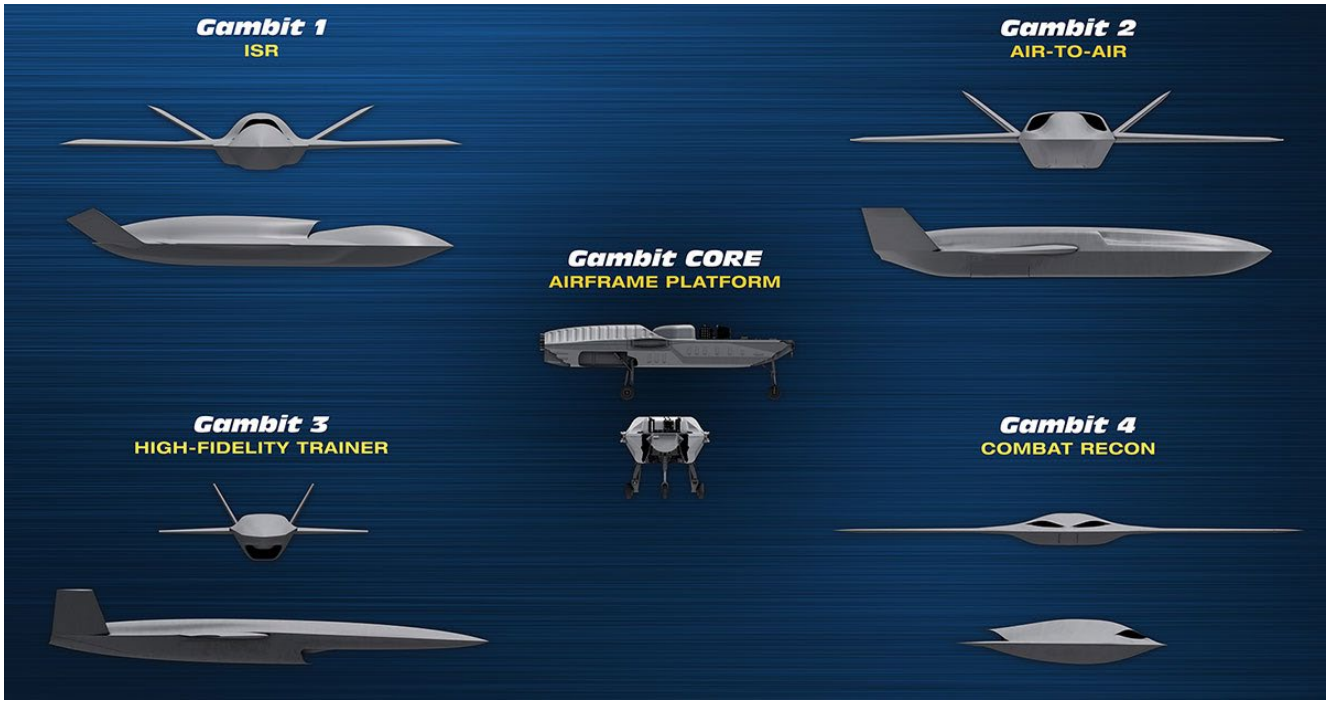
- In May, 2024 Sectary of the Air Force, Frank Kendall rode in the front seat of VISTA for an hour long series of air maneuvers.
- The Air Force plans to purchase hundreds of unmanned aircraft with Initial Operating Capability in 2028.

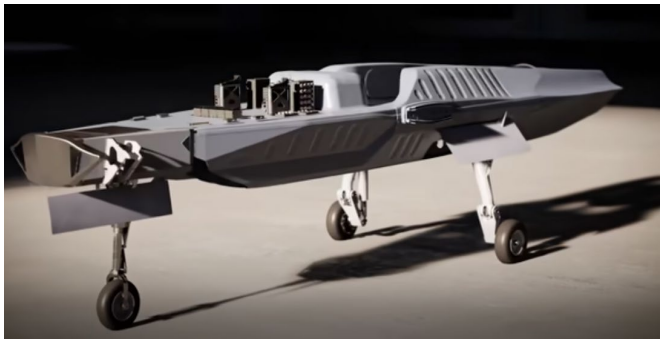
Collaborative Combat Aircraft

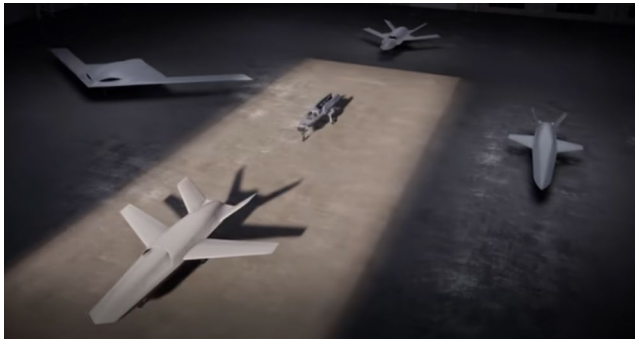
- A “Loyal Wingman” or Collaborative Combat Aircraft (CCA), which is an unmanned aircraft, provides complementary capabilities at 20% the cost of a F-35, lower maintenance cost, and can be manufactured at greater rates.
- Boeing has successfully conducted test of the MQ-28A Ghost Bat with the Australian Air Force. Using its artificial intelligence (AI) pilot ‘Hivemind’, Shield AI demonstrated multi-jet flight autonomy, using the Kratos MQM-178, in San Diego, California, according to a statement made on 21 August 2024.
- UPDATE: The USAF selected General Atomics Gambit, Air Force designated YFQ-42A and the Anduril Fury, YFQ-44A to proceed in the CCA program’s Increment 1 stage. (Y-Prototype, F-Fighter, Q-Drone).

Collaborative Combat Aircraft
General Atomics Gambit CCA

- Modular design built around a core airframe platform. Able to customize dependent on mission parameters – ISR, Air Superiority, Reconnaissance,







Australia invests $317M(US) to build drone fleet

- Australia is investing hundreds of millions of dollars into creating unmanned aircraft and drones to boost the nation's military capabilities.

- The MQ-28A Ghost Bat CCA. Working with Boeing, this aircraft is designed, engineered and built in Australia. It will integrate autonomous systems and artificial intelligence to create smart and effective man-machine teams.

- Eight Ghost Bats have been manufactured in the initial run of 10 aircraft with additional loyal wingman aircraft to be purchased. Cost of $8M - $10M per aircraft or 10% of a F-35 of which Australia has 72 aircraft. Three Block 2 aircraft are under production in Australia.

[Australia wants to build a cauldron of Ghost Bat drones with US (youtube.com)]

The Future of Warfare

1. The main driver of these and many other types of similar innovations is cost. With manned weapon systems such as the F-35 costing over $100M per copy and lifetime sustainment costing over $1T dollars are not sustainable.
2. The small automated weapons such as drones are inexpensive, lethal and effective against high cost weapons.
3. Economy of Scale – One person or a small team of operators can manage one, a dozen or hundreds of drones.
4. Speed of Combat – Machine Learning and Artificial Intelligent weapons and systems can sort through greater amounts of data and make decisions at a high rate of speed than their human counter-parts.
5. The future fight will be won by who can develop new and effective tactics for the teaming of man and machine.
6. It will also be won by who can adapt techniques and tactics quicker than their adversary.
7. Last, which side can out produce unmanned systems in greater numbers.

The Future of Warfare

The Oppenheimer Moment: The AI Military Race

The rise of AI-enabled warfare and autonomous weapons systems is being likened to the "Oppenheimer moment," drawing parallels to the creation of the atomic bomb. This comparison represents a pivotal point that could either mark the beginning of a new era of great power dominance or serve as a warning of potential catastrophic consequences. As investment in AI rapidly increases, experts caution that these technologies could profoundly change society's relationship with war and technology, potentially leading to greater reliance on machines for critical decision-making. The prospect of autonomous weapons raises fears of a dystopian future reminiscent of apocalyptic fiction. The substantial investments being made in autonomous weapons and AI targeting systems are increasing global threats. At the same time, AI may be the saving grace of humanity, making people smarter and more resilient.

Capture from: Dr Christina Schori Liang, Head of Counterterrorism and Preventing Violent Extremism at the Geneva Center for Security Policy, contributed to the Global Terrorism Index 2025 report on "Ten Lessons from the Russia-Ukraine War "

Link: Publication | Ten Lessons from the Russia-Ukraine War