Aircraft Concept Design for a Survivable Autonomous Tanker

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Abstract

The purpose of this concept design is to assess the performance of a survivable and autonomous tanker aircraft that would augment the current U.S. Air Force tanker fleet as a low-cost solution for delivering fuel to fighter aircraft in high-risk combat environments. The design process started with research of the performance parameters and mission profiles of current tanker and fighter aircraft, which was leveraged to create a mission profile and a set of specifications for the conceptual design. The tanker aircraft was required to have a flight range of 3,000 miles, cruise at 35,000 feet at Mach 0.85, and offload 36,000 pounds of fuel amongst two fighter aircraft. The next step was to iterate through aircraft weight and engine performance estimates until the calculated performance values met a basic set of mission specifications. Once the basic parameters for the aircraft were decided, various software tools, such as Open Vehicle Sketch Pad, were used to refine the shape, aerodynamics, and stability of the aircraft to fulfill the remaining mission requirements. Weighing just over 100,000 pounds at takeoff, the autonomous tanker aircraft carries about 66,000 pounds of fuel, has a range of 3,500 miles, and cruises at 35,000 feet at Mach 0.85. Novel features were incorporated into the design such as a flying wing body, engines embedded within the body, and a retractable refueling boom to increase survivability. Military researchers might consider developing low-cost, expendable, unmanned aircraft that augment the capabilities of existing military aircraft while taking risk away from pilots.

Mission Objectives

Performance Objectives	
Range	3,000 miles
Fuel Offload Capacity	36,000 lbs
Cruise Speed	Mach 0.85
Cruise Altitude	35,000 ft
Service Ceiling	40,000 ft
Survivable in combat airspace	
Low cost	

Design Methodology

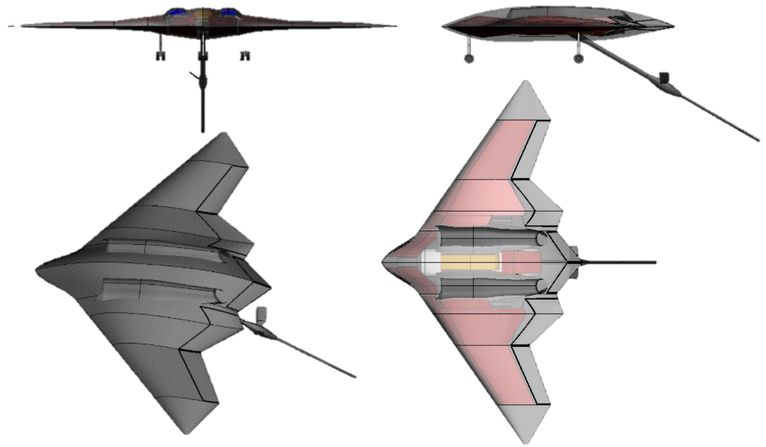
Design Philosophy

- Save fuel by refueling fighters inside combat zones
- Reduce costs by designing smaller aircraft using legacy components
- Mitigate risk by using multiple unmanned aircraft per mission
- Increase survivability by using similar geometries to stealth aircraft and allocating space for electronic countermeasure equipment
- Increase capabilities by reconfiguring cargo bay for various missions

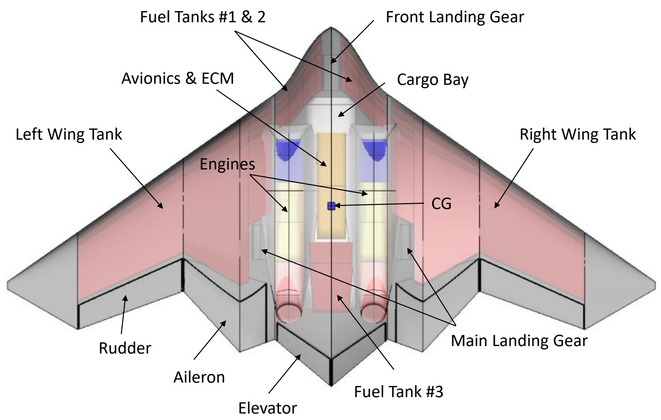
Design Process

1. Research current and past aircraft with similar missions and capabilities
2. Estimate aircraft weight and performance requirements
3. Iterate through various configurations until performance objectives are met
4. Match existing equipment that satisfy performance needs
5. Create aircraft geometry in a CAD model
6. Analyze and fine-tune aerodynamic and stability characteristics
7. Validate final design meets mission objectives

Aircraft Design



Design Specifications	
Wingspan	92 ft
Aspect Ratio	4.1
Length	50 ft
Height	10
Powerplant	2x PW TF33
Sea Level Thrust	2x 17,000 lbs
Airfoil	MH-60
$C_{L,max}$	1.3



Design Features

- Inspired by the B-2 stealth bomber, this autonomous tanker has a flying wing design for reduced electromagnetic detectability and improved aerodynamic efficiency.
- The refueling boom is completely retractable to further reduce detection and drag while travelling between refueling areas.
- A relatively large space is allocated for electronic equipment to include avionics, flight controllers, communication, and electronic warfare equipment.
- The engines are embedded inside the aircraft to reduce heat signatures.
- The cargo bay is intended to be modular, capable of swapping out equipment for different missions like reconnaissance or aerial defense.
- The MH-60 is a reflex airfoil, made specifically for flying wings, that has a positive pitching moment to assist with longitudinal stability of the aircraft.

Conclusions

Final Performance Specifications	
Range	3,500 miles
Total Fuel Capacity	66,130 lbs
Fuel Offload Capacity	36,000 lbs
Cruise Speed	Mach 0.85
Cruise Altitude	35,000 ft
Service Ceiling	40,000 ft
Takeoff Speed	110 mph
Takeoff Climb Rate	2,472 ft/min
Takeoff Distance	3,000 ft
Takeoff Gross Weight	103,220 lbs
Sea-level Thrust	34,000 lbs

The conceptual aircraft meets or exceeds the mission objectives. Its survivability features allow it to withstand enemy warning systems as the aircraft enters into contested airspace. The legacy engine and relatively small design reduce overall production costs. Risk is mitigated by using an autonomous flight system and using multiple aircraft per mission.

A typical mission would have two or four of these aircraft accompany a traditional tanker, like a KC-10. Two drone tankers would top off their fuel tanks and fly into the combat zone where a team of 4 fighters are conducting a combat mission. The total refueling time is reduced because two fighters can be refueled at a time. After refueling the fighters the drone tankers will return to the main tanker and top off again. For as along as the main tanker remains in the air, the drone tankers can shuttle fuel out to the fighters.

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