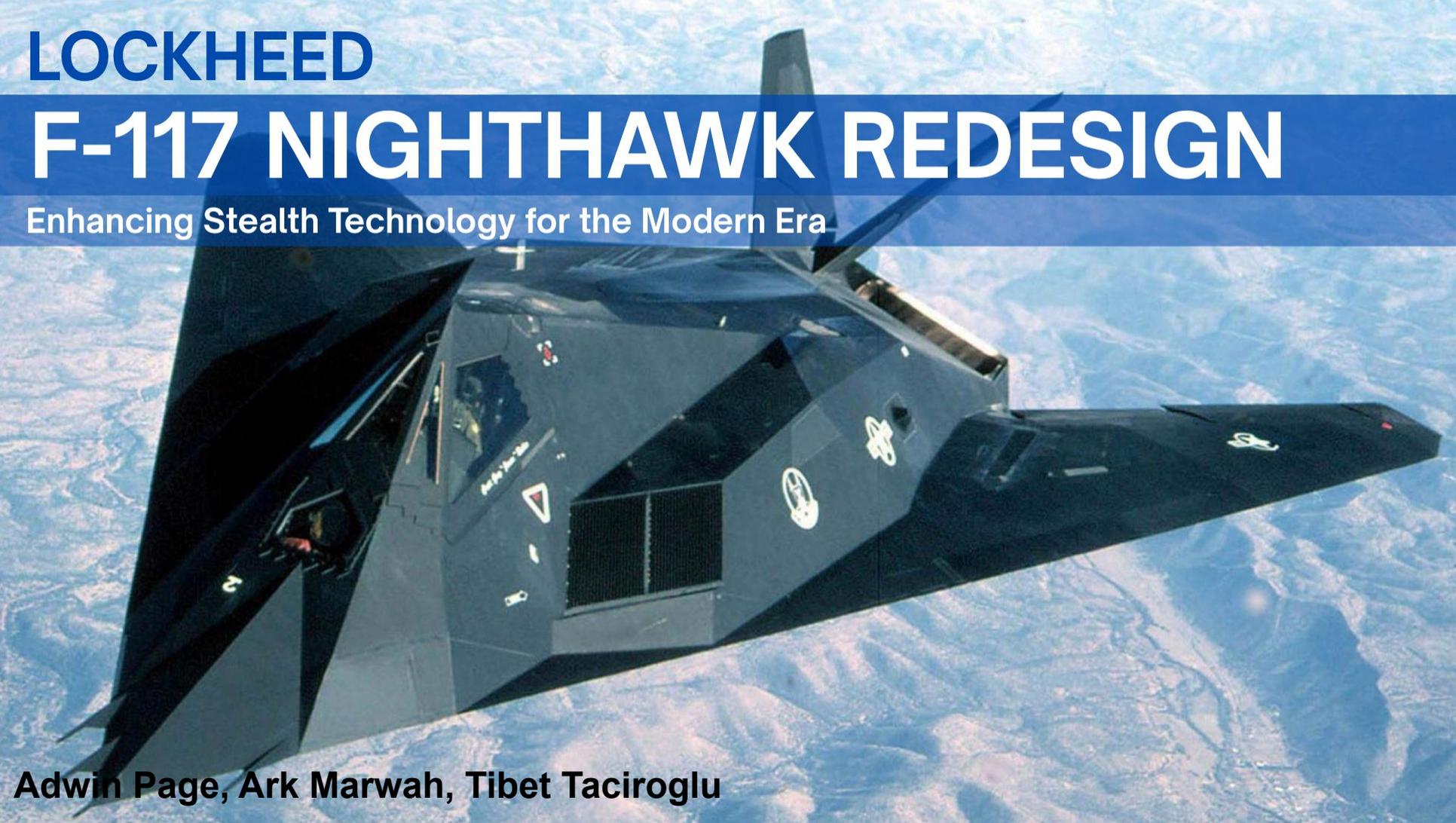


**LOCKHEED**

# **F-117 NIGHTHAWK REDESIGN**

Enhancing Stealth Technology for the Modern Era



**Adwin Page, Ark Marwah, Tibet Taciroglu**

# Why the F-117 Nighthawk?

**Dated Design:** Created in 1983 and retired in 2008, the F-117 represents first-generation stealth technology with significant room for improvement

**Shared Interest:** Our team has a collective passion for stealth technology and aircraft design

**Significant Potential:** The angular design of the F-117 offers substantial opportunities for enhancement using modern aerodynamic principles

**Technological Advancement:** Modern materials, computing power, and manufacturing techniques can dramatically improve the original design



# Background

**1964** - Soviet mathematician Pyotr Ufimtsev publishes a foundational paper, Method of Edge Waves in the Physical Theory of Diffraction.

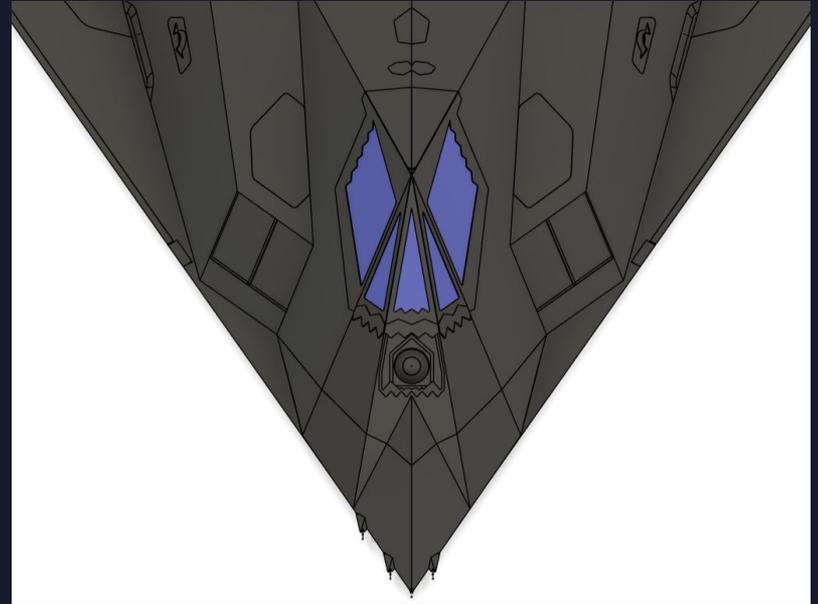
**1970s** - Development began under Lockheed's "Have Blue" program

**1981** - First flight of production F-117

**1983** - Officially entered service with the USAF

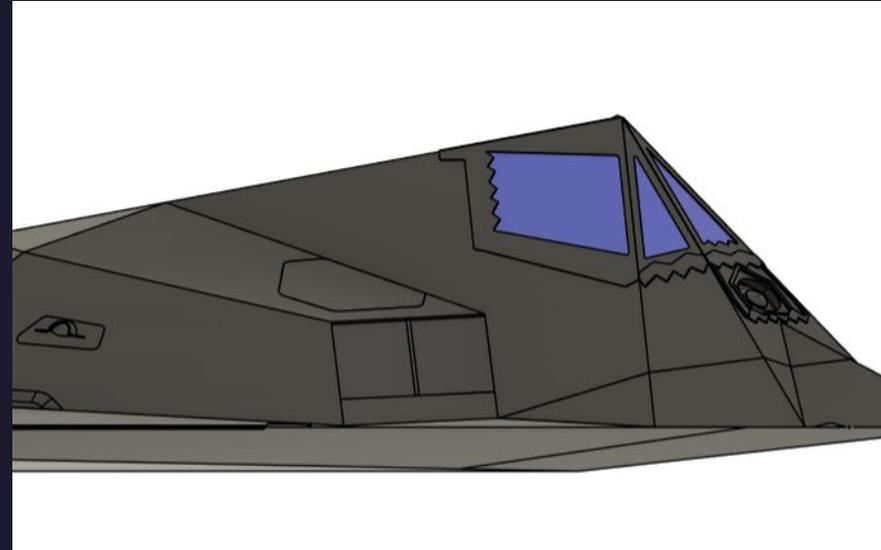
**1991** - Combat debut in Operation Desert Storm

**2008** - Officially retired from active service



# Background

Category	Specification
Crew	1
Role	Stealth attack aircraft
First Flight	June 18, 1981
Introduction	October 1983
Manufacturer	Lockheed Martin
Powerplant	2 × General Electric F404-F1D2 turbofan engines
Thrust (each)	10,600 lbf (47.2 kN)
Length	65 ft 11 in (20.09 m)
Wingspan	43 ft 4 in (13.21 m)
Height	12 ft 5 in (3.78 m)
Wing Area	780 sq ft (72.4 m <sup>2</sup> )
Empty Weight	29,500 lb (13,381 kg)
Max Takeoff Weight	52,500 lb (23,814 kg)
Maximum Speed	High subsonic (approx. 646 mph or 1,040 km/h)
Service Ceiling	45,000 ft (13,716 m)
Range	Unlimited with aerial refueling; mission radius of about 550 miles (885 km) with a weapons load.



# Project Goals

*Our team's goal is to redesign the F-117 Nighthawk to enhance its capabilities with modern technology while preserving its stealth mission profile. We aim to:*

## ↑ Increase Lift Efficiency

Redesign the angular airframe to improve aerodynamic performance while maintaining radar-deflecting geometry

## 🔧 Implement Modern Technology

Integrate advanced avionics, materials, and propulsion systems to enhance overall capabilities

## \$ Lower Cost

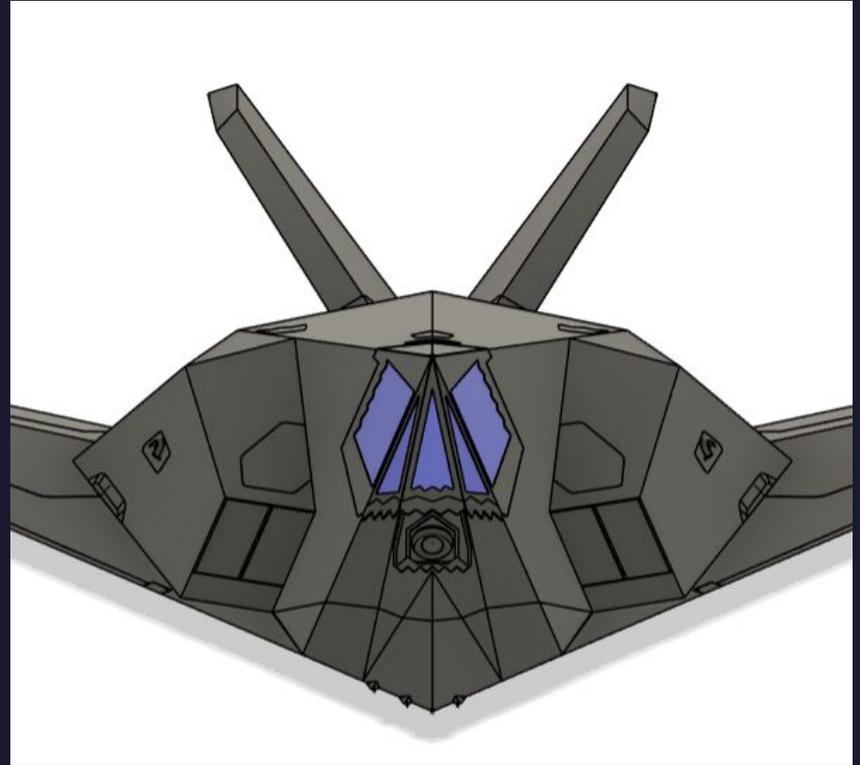
Utilize modern manufacturing techniques and materials to reduce production and maintenance expenses

## 📏 Increase Range

Enhance fuel efficiency and capacity to extend operational range without refueling

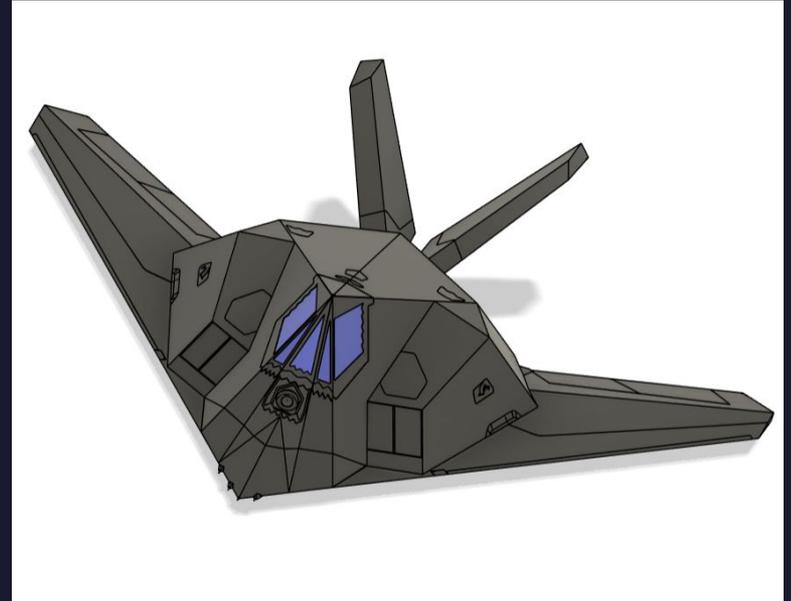
## 👁️ Improve Stealth Capabilities

Reduce radar cross-section using contemporary stealth technology and materials



# Our Process

1. Analyze Existing Components: First, we examine the original F-117's parts—like the landing gear and avionics—to understand their materials, how they were made, and their functions. This helped us identify areas that could be improved.
2. Create 3D Models: Next, we used solidworks to build detailed 3D models of these components with existing and public images.
3. Outsider information: Utilizing studies done on the aerodynamics of the original F-117, we focused on areas causing the most drag, such as the nose cone and the rear fins, and redesigned them using inspiration from other planes with similar shapes to create a more optimal design
4. Upgrade Materials and Technology: We redesigned the components using new, lighter, and stronger materials like carbon fiber composites. We also incorporate modern technologies such as fly-by-wire control systems and new avionics to boost performance.



# Modern Technology & Cost Reduction

## 🔧 Advanced Materials & Manufacturing

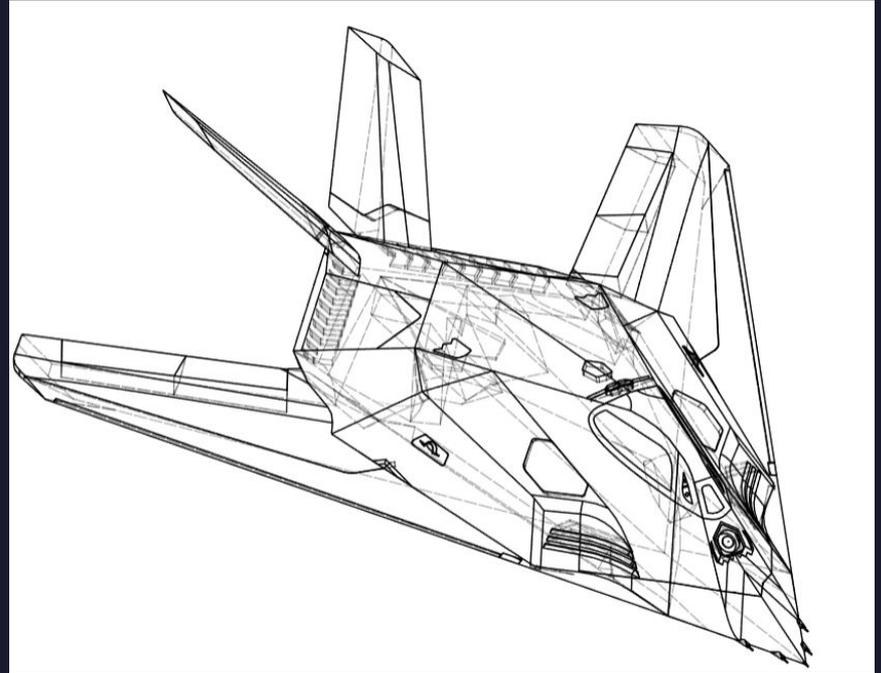
- We will replace heavy metal structures with carbon fiber composites to reduce weight.
- Advanced radar-absorbing materials with improved durability will be used.

## ✈️ Enhanced Avionics & Systems

- Modern fly-by-wire control systems will be implemented for improved handling.
- Advanced sensor fusion will provide better situational awareness.
- An updated electronic warfare suite will reduce maintenance needs

## 💰 Cost Reduction Strategies

- A modular design will make maintenance and upgrades easier.
- We will streamline the production process with fewer unique parts and integrate with existing supply chains.
- Using components with longer lifespans will reduce the frequency of replacements.



# The Current Engine

## Background

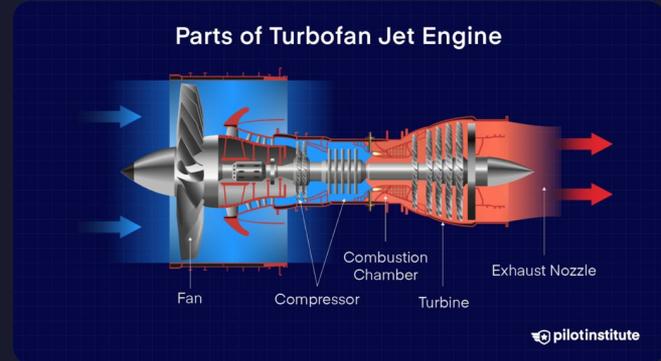
The F-117 Nighthawk was powered by two General Electric F404-F1D2 turbofan engines.

These were non-afterburning turbofans.

Each engine produced 10,600 lbf (47.2 kN) of thrust.

## Main Idea

The redesign will replace the original twin General Electric F404 engines with two cutting-edge three-stream adaptive cycle engines. These new engines can change their bypass ratio in flight, essentially switching between two modes for optimal performance.



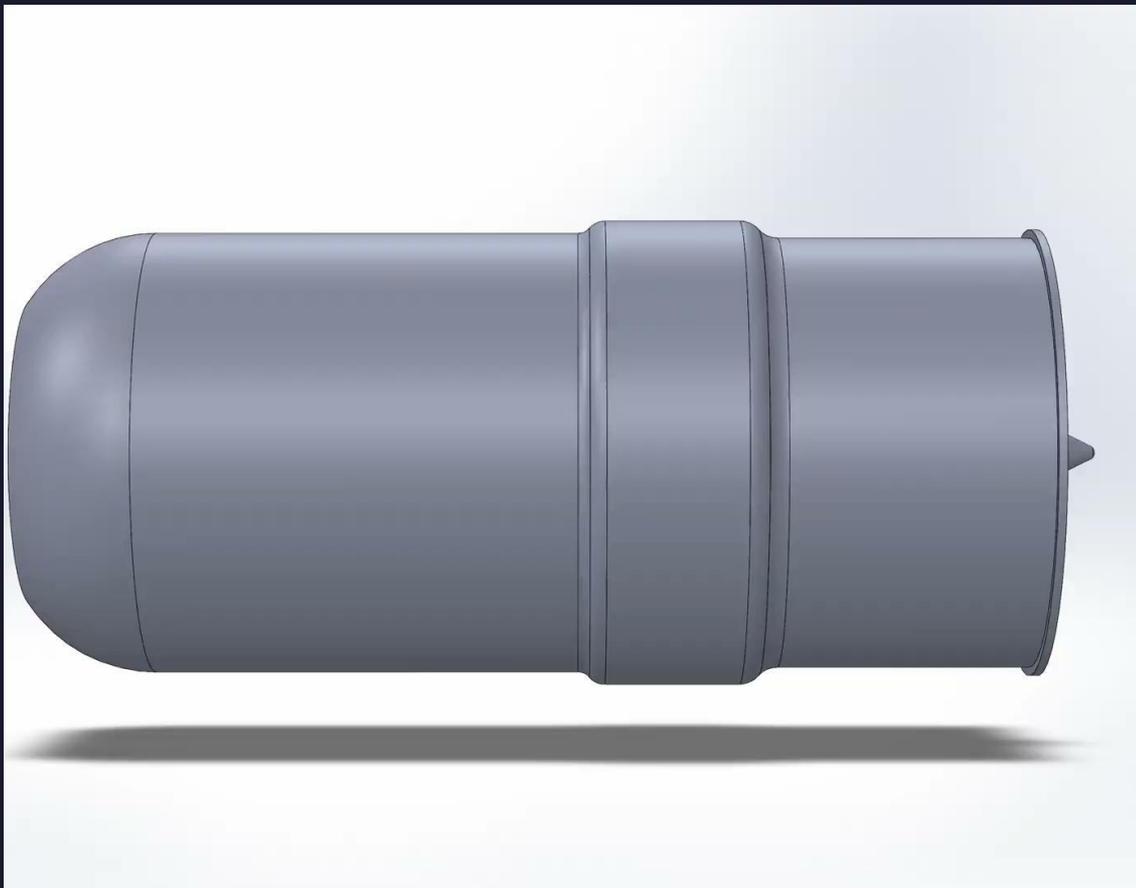
# Our Engine Improvements

## Benefits

- High-Efficiency Mode: The engine will act like a high-bypass turbofan for subsonic cruise, providing an estimated 25-30% improvement in SFC. This will extend the aircraft's range and allow for longer missions without refueling.
- High-Thrust Mode: For combat or escape, the engine will shift to a low-bypass, turbojet-like mode, providing a substantial increase in thrust. With the most prominent example of cycle engines designed to operate in a 45,000 lbf thrust class

## Impact

- This engine upgrade will improve the aircraft's survivability by reducing exposure time in hostile airspace and allowing for faster escape after weapon deployment.



# Stealth / Aerodynamic Improvements

## Material improvements

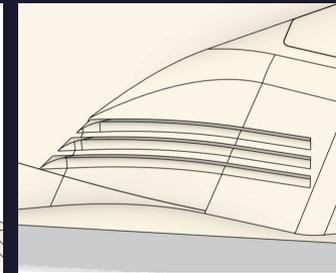
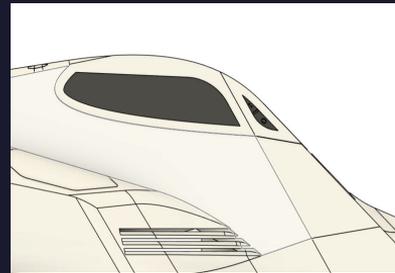
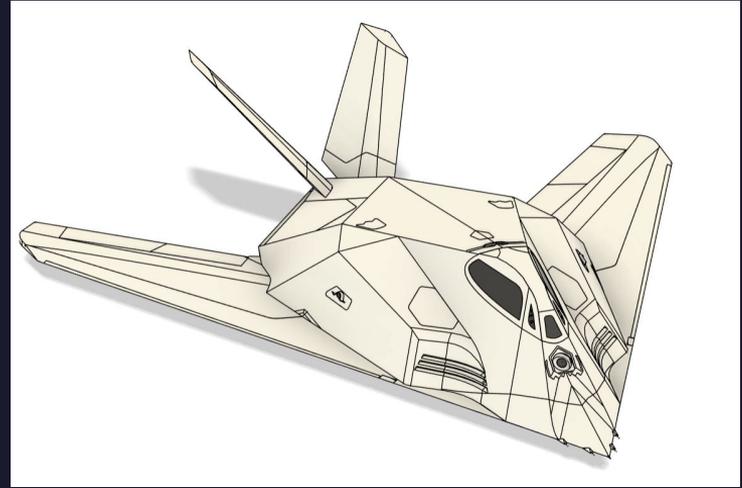
Some weaknesses that the original model had was its angular surface allowing for marginal areas for detection. Replacing the outer coating with the composite material coating used for the B-21 raider, the weight and radar absorption will be drastically improved

## Aerodynamic Refinements

Smoothing of angular surfaces while maintaining radar-deflecting properties to reduce drag and improve fuel efficiency by an estimated 15-20%.

## Intake / exhaust improvements

The original f-117 had large grill plates that slammed into the oncoming air for intake, creating lots of drag and slowing the air down. By changing the intake method to scoop air that slides along the surface, the drag is reduced and more air can be taken in for the engine. The exhaust now has many separate chutes to funnel out the hot air from the engine, cooling it down along its path and distributing it over a wider area



# Landing Gear improvement Concept

## Current Issue:

- High weight of existing landing gear assemblies reduces aircraft fuel efficiency and increases maintenance demands.
- Limited shock absorption during hard landings increases stress on airframe structure.



## Proposed Improvements:

- Lightweight Composite Materials:
  - Replace select cast iron and /titanium components with stainless steel and carbon composites to reduce weight without compromising load capacity, as well as apply advanced anti-corrosion and anti-wear coatings to extend service life.



# Landing Gear Improvements



- Modular Design:
  - Design components to be easily removable for rapid inspection and replacement, reducing downtime.
  - Implement a sleeker hinge-style release for the landing gear, allowing it to deploy simultaneously with the other landing gear with added space between the dampener and tire

# Current Manufacturing Methods for F-117 Nighthawk

## Primary Materials:

- a) Aluminum and titanium alloys for structural strength.
- b) Specialized radar-absorbing composite materials for stealth.

## Manufacturing Techniques:

1. **Precision Machining:**
  - CNC milling and turning for landing gear structural parts.
2. **Forging & Heat Treatment:**
  - Forged titanium components for strength-critical areas, followed by heat treatment to optimize mechanical properties.
3. **Composite Layup & Curing:**
  - Manual and automated layup of carbon fiber-reinforced polymer in molds, followed by autoclave curing.
4. **Surface Treatments:**
  - Application of corrosion-resistant coatings and stealth radar-absorbing surface materials.
5. **Quality Control:**
  - Non-destructive testing (ultrasonic, dye penetrant) to ensure structural integrity of parts before assembly.



# Performance Impact + Risk Assessment Tables

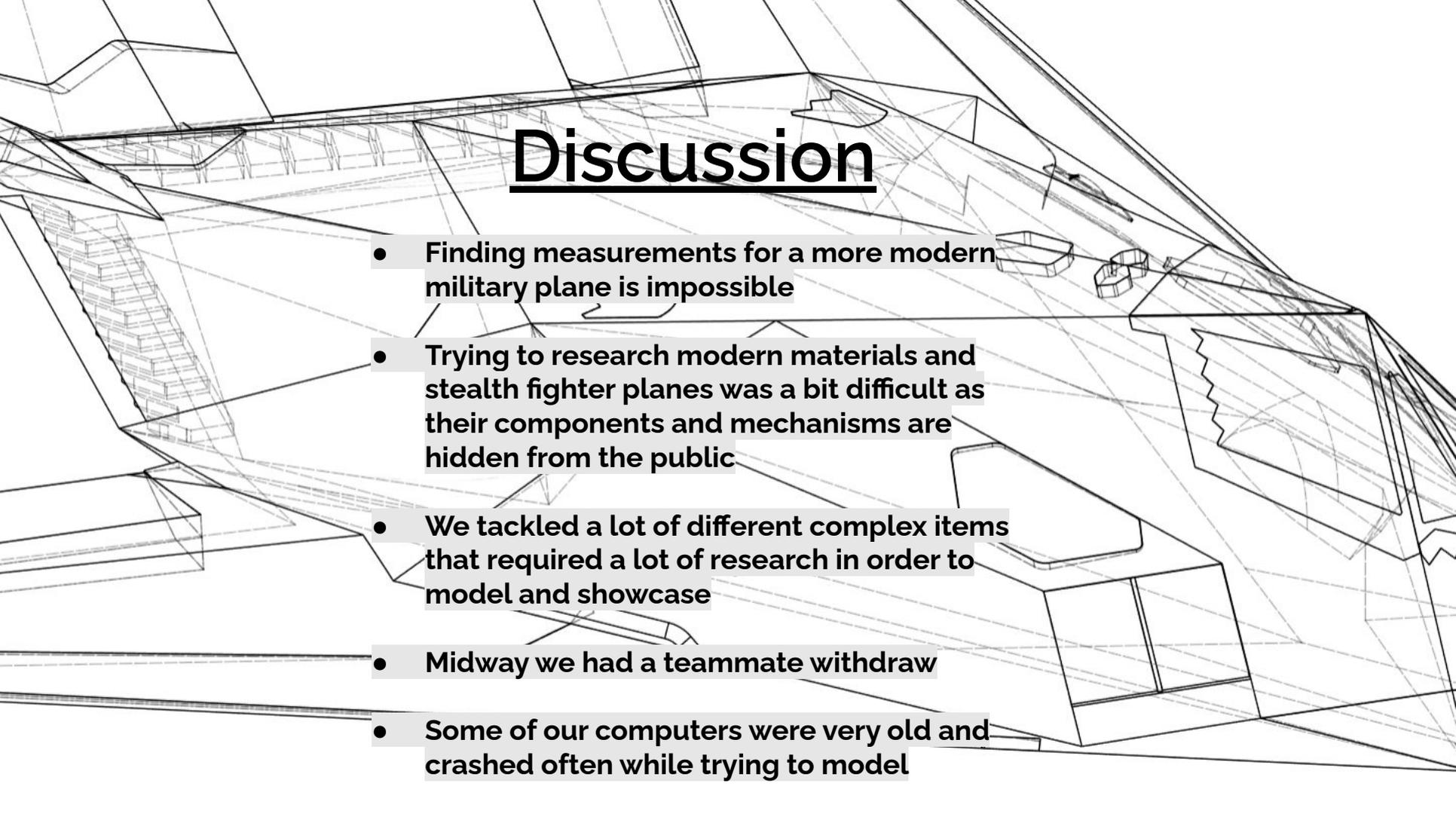
## Performance Impact Table

Improvement	Expected Benefit	Expected Quantifiable Impact
Lightweight composite materials	Reduce landing gear weight	~5–10% weight reduction → +1–2% fuel efficiency
Adaptive damping shock struts	Reduce stress on airframe	Up to 20% reduction in peak landing loads
Modular component design	Speed up inspections & repairs	30% reduction in downtime during maintenance
Corrosion-resistant coatings	Extend component lifespan	+4–5 years average service life



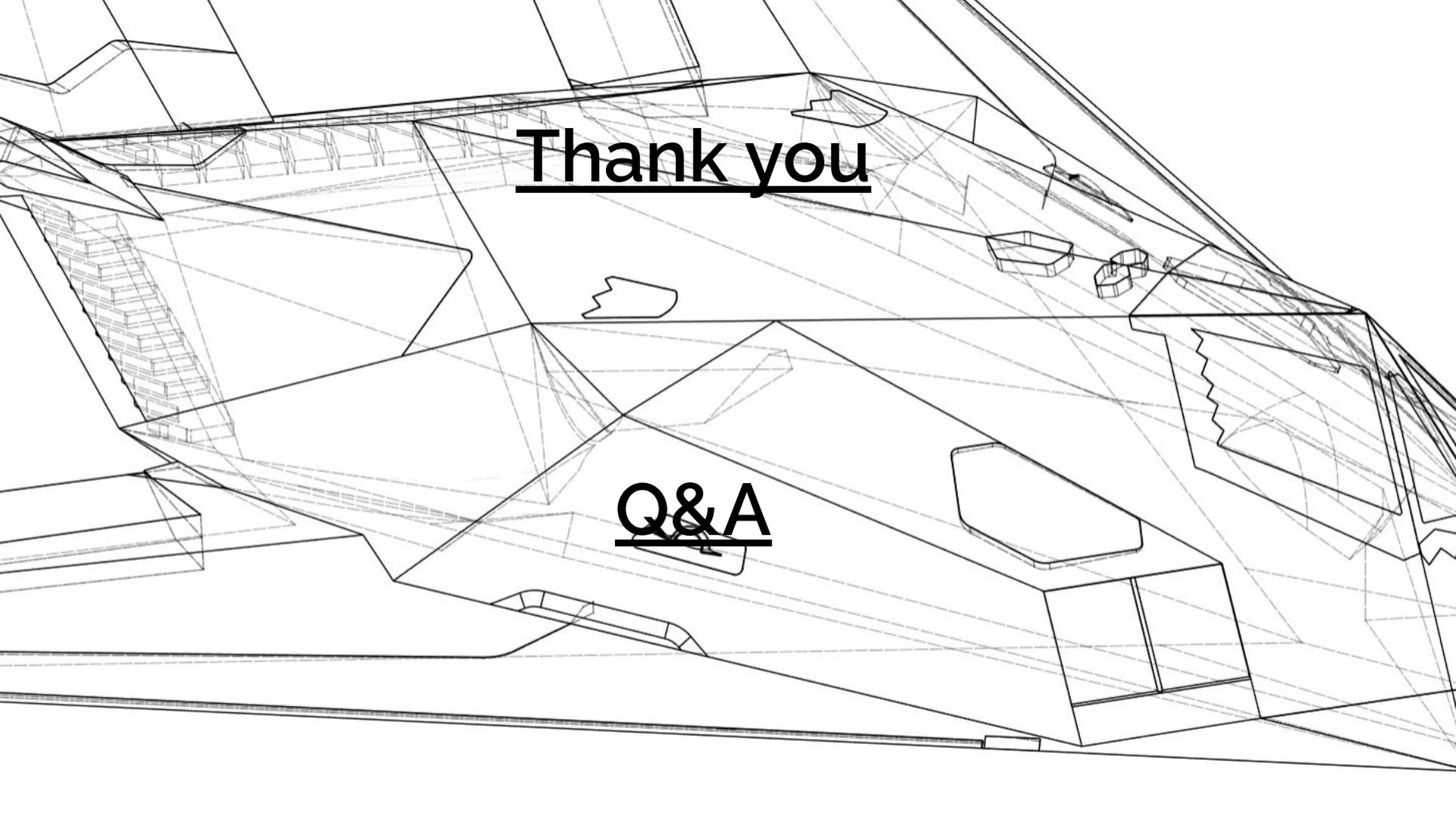
## Risk Assessment Table

Risk	Likelihood (Low/Med/High)	Impact (Low/Med/High)	Mitigation Strategy
Composite material fatigue over time	Medium	High	Rigorous fatigue testing & scheduled inspections
Adaptive damping malfunction	Medium	Medium	Manual override option during maintenance checks
Coating degradation in extreme environments	Low	Medium	Annual coating inspections & reapplication
Supply chain delays for advanced materials	Medium	High	Multiple suppliers & stockpiled critical parts



# Discussion

- Finding measurements for a more modern military plane is impossible
- Trying to research modern materials and stealth fighter planes was a bit difficult as their components and mechanisms are hidden from the public
- We tackled a lot of different complex items that required a lot of research in order to model and showcase
- Midway we had a teammate withdraw
- Some of our computers were very old and crashed often while trying to model

A complex architectural wireframe drawing of a building's interior, showing various rooms, corridors, and structural elements in a perspective view. The lines are black on a white background, creating a technical and geometric aesthetic.

Thank you

Q&A