# UAV Concept V1

## Conceptual design of a Fixed-Wing Unmanned Aerial Vehicle (UAV)

## Project Report

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(Independent Aerospace Engineering Portfolio Project)

### Software Used:

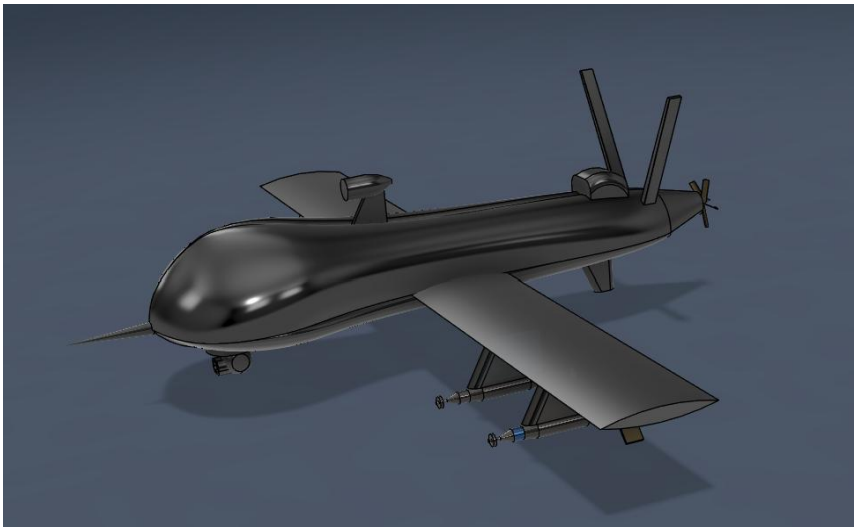
- Autodesk Fusion 360
- GitHub
- Microsoft Word

### Project Type

Conceptual Aircraft Design

### Project Category

Aerospace Engineering Portfolio Project



### Key Features

- Fixed-Wing UAV Configuration
- Constant-Chord Main Wing
- Rear Pusher propulsion Layout
- V-Tail configuration
- Nose-Mounted Sensor Turret
- Modular Payload Stations

### Design Specifications

| **Parameter** | **Value** |
|---|---|
| Wingspan | 1900 mm |
| Length | 1280 mm |
| Wing Chord | 190 mm |
| Wing Area | 0.361 m^2 |
| Aspect Ratio | 10.0 |

Date: 6th July, 2026

### Author Statement

This Project was developed as part of a self-directed aerospace engineering learning program focused on aircraft design, computer-aided engineering, and engineering documentation. The objective was to gain practical experience in conceptual UAV development while building a professional engineering portfolio.


## Abstract:-

The Development of unmanned aerial vehicles (UAVs) has become increasingly important in both civilian and military applications. UAVs are widely used for surveillance, reconnaissance, mapping, environmental monitoring, infrastructure inspection, and research activities. The objective of this project was to develop a conceptual experience in aircraft configuration development, computer-aided design (CAD), and engineering documentation.

The aircraft was designed using Autodesk Fusion 360 and incorporates a fixed-wing configuration with a rear pusher propulsion system and a V-tail arrangement. The design also includes a nose-mounted sensor turret and underwing payload stations to represent a realistic mission-oriented UAV platform. During the development process, emphasis was placed on creating a geometrically consistent aircraft layout while considering aerodynamic efficiency, structural simplicity, and future expandability.

Basic geometric calculations were performed to determined key aircraft parameters such as wing area and aspect ratio. The final design has a wingspan of 1900 mm, a fuselage length of 1280 mm, a wing chord of 190 mm, and an aspect ratio of approximately 10.0. These characteristics indicate that the aircraft concept is more suitable for endurance and surveillance missions rather than high-speed manoeuvring applications.

This project serves as a foundation of future work involving propulsion system, weight estimation, centre of gravity analysis, aerodynamic evaluation, flight simulation, and structural optimization. The report demonstrates the complete process of conceptual UAV development from initial design requirements to preliminary engineering analysis and documentation.


## Objective

### Primary Objective

The primary objective of this project was to design and document a conceptual fixed-wing unmanned aerial vehicle using professional engineering workflows and CAD tools.

### Project Goals

The project was developed with the following goals:

- To improve proficiency in Autodesk Fusion 360 for aerospace applications.
- To understand the major components and configuration of a fixed-wing UAV.
- To gain experience in engineering documentation and technical reporting.
- To develop a portfolio-quality aerospace engineering project.
- To establish a foundation for future UAV simulation and flight-control projects.

## Learning Outcomes

Through this project, practical experience was gained in:

- Aircraft configuration development.
- Conceptual aerospace design.
- CAD modelling and assembly creation.
- Engineering calculations and analysis.
- Technical report preparation.
- Project documentation and portfolio development.

## Mission Requirements

Before designing any aircraft, it is important to define its intended mission. The mission profile determines the aircraft configuration, propulsion system, payload capacity, aerodynamic characteristics, and overall design philosophy.

For this project, the UAV was conceived as a surveillance and reconnaissance platform capable of carrying sensors while maintaining stable and efficient flight characteristics.

**Intended Mission**

The aircraft is intended to perform:

- Aerial surveillance
- Reconnaissance operations
- Environmental monitoring
- Infrastructure inspection
- Educational and research missions
- Future autonomous flight experiments

**Mission Profile**

The conceptual mission profile consists of the following stages:

1. Take-off
2. Climb to operating altitude
3. Cruise flight
4. Mission execution and data collection
5. Return flight
6. Landing

## **Mission** Priorities

The primary priorities of the aircraft are:

| Priority | Importance |
|---|---|
| Flight Stability | High |
| Endurance | High |
| Simplicity | High |
| Payload Capability | Medium |
| Speed | Low |
| Manoeuvrability | Medium |

The Aircraft was therefore designed as an endurance-oriented UAV rather than a high-speed platform.

## Design Requirements

Based on the mission objectives, a number of design requirements were established before developing the aircraft geometry.

### Aerodynamic Requirements

The aircraft should:

- Generate sufficient lift for stable flight.
- Maintain efficient cruise performance.
- Possess a favourable lift-to-drag ratio.
- Demonstrate predictable flight characteristics.

### Structural Requirements

The aircraft structure should:

- Be lightweight.
- Be simple to manufacture.
- Allow future modifications.
- Support payload integration.

### Propulsion Requirements

The propulsion system should:

- Provide adequate thrust for take-off and climb.
- Maintain efficient cruise flight.
- Be compatible with electric propulsion.

### Payload Requirements

The UAV should provide provisions for:

- Sensor integration.
- Camera systems.
- Experimental payloads.
- Future avionics development.

### Future Development Requirements

The design should be capable of supporting:

- Flight controller integration.
- Telemetry systems.
- GPS navigation.
- Autonomous flight modes.
- Additional engineering analysis.

## Design Philosophy

A simple and expandable design philosophy was adopted throughout the project. Instead of maximizing performance in a single area. The objective was to create a balanced UAV platform that could serve as a foundation for future engineering development.

The design prioritizes:

- Simplicity
- Modularity
- Stability
- Ease of Modification
- Educational Value

The philosophy makes the aircraft suitable as a conceptual aerospace engineering project while aso providing opportunities for future improvements and analysis.

## Aircraft Configuration Selection

The selection of an aircraft configuration is one of the most important stages of conceptual aircraft design. Different configurations offer different advantages in terms of aerodynamic performance, structural complexity, stability, payload integration, and manufacturing requirements.

For this project, a fixed-wing UAV configuration with a V-tail and rear pusher propulsion system was selected after considering the intended surveillance and reconnaissance mission.

## **Why a Fixed-Wing Aircraft?**

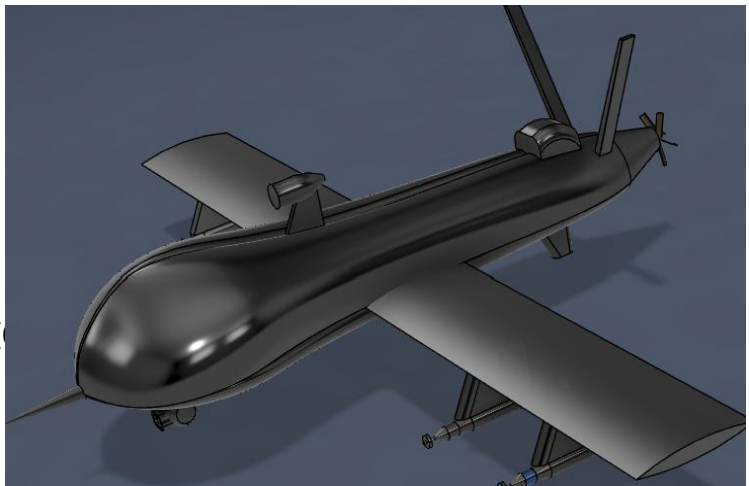
Two primary UAV configurations were considered:

- Multirotor UAV
- Fixed-Wing UAV
- A fixed-wing configuration was selected because it provides significantly greater aerodynamic efficiency during cruise flight. Unlike multirotor aircraft, which continuously expend power to generate lift, a fixed-wing aircraft uses its wings to produce lift more efficiently.

### Advantages of a Fixed-Wing UAV

- Greater flight endurance
- Improved energy efficiency
- Longer operational range

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- Better cruise performance
- Larger area available for payload integration

### Disadvantages

- Requires forward motion to generate lift
- More complex take-off and landing operations
- Reduced hovering capability

Because the primary mission of the aircraft is surveillance and reconnaissance, the advantages of the fixed-wing configuration outweigh its limitations.

## Why a V-Tail Configuration?

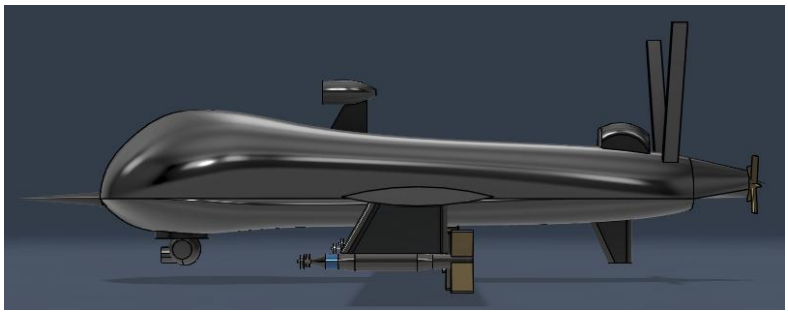
The tail configuration plays a major role in aircraft stability and control.

Instead of using a conventional tail arrangement consisting of separate horizontal and vertical stabilizers, a V-tail configuration was selected.

In a V-tail system, two inclined surfaces perform the functions of both the horizontal and vertical stabilizers.

### Advantages of a V-Tail

- Reduced number of aerodynamic surfaces
- Lower structural weight
- Potential reduction in aerodynamic drag
- Improved visual appearance
- Simplified rear fuselage integration



### Disadvantages

- More complex control mixing
- More complicated flight-control implementation
- Potentially reduced control authority compared to conventional tails

Despite these challenges, the V-tail configuration was chosen because it aligns with the project's goal of creating an efficient endurance-oriented UAV concept.

## Why a Rear Pusher Propeller?

The propulsion system location has a significant influence on aircraft layout and mission capability.

For this design, a rear-mounted pusher propeller arrangement was selected.

In a pusher configuration, the propeller is positioned behind the fuselage and pushes the aircraft forward.

### Advantages of a Pusher Configuration

- Unobstructed forward field of view
- Improved placement of cameras and sensors
- Reduced risk of propeller interference with payload systems
- Cleaner aircraft appearance
- Better suitability for surveillance missions



Disadvantages

- Reduced airflow over the propeller due to fuselage interference
- More challenging motor cooling
- Potential structural vibration issues

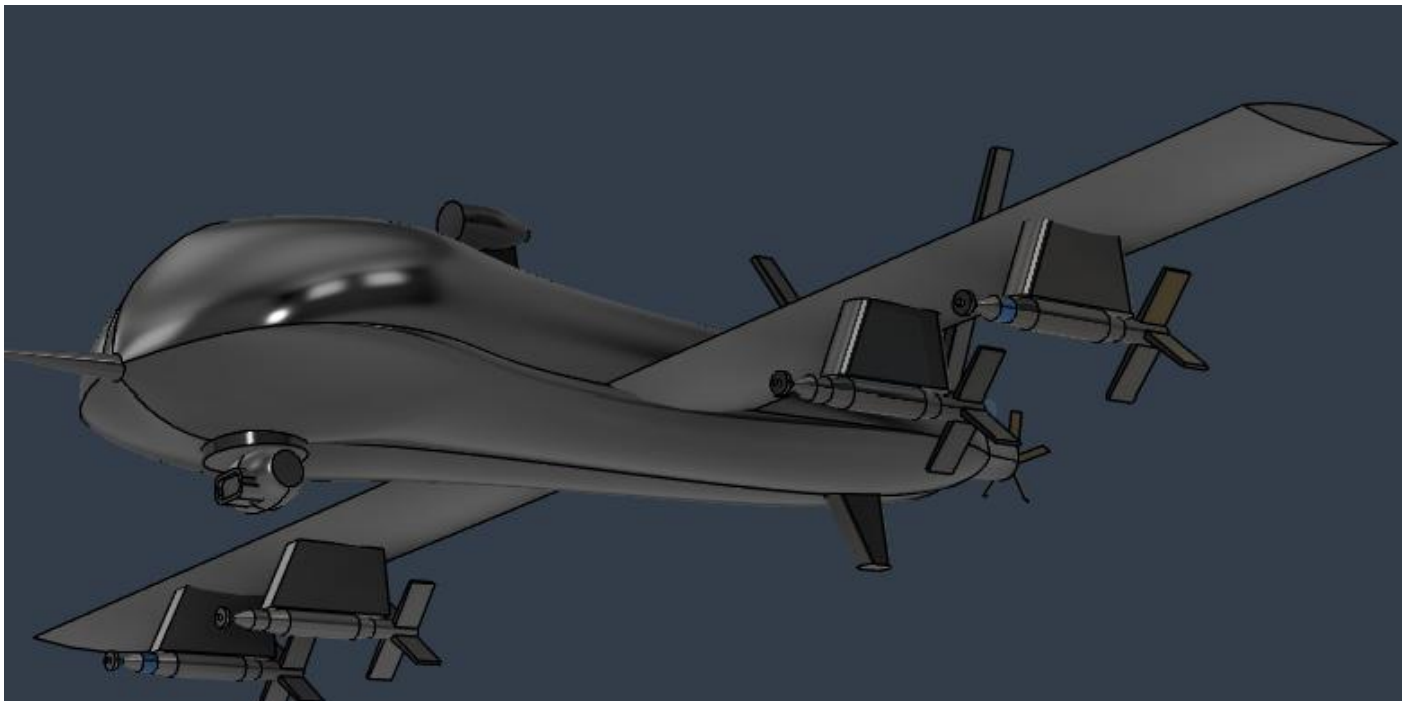
For surveillance and reconnaissance missions, the improved forward visibility and sensor integration capabilities make the pusher configuration particularly attractive.

## Configuration Summary

The final aircraft configuration consists of:

| **Component** | **Selection** |
|---|---|
| Aircraft Type | Fixed-Wing UAV |
| Wing Type | Constant-Chord Wing |
| Tail Type | V-Tail |
| Propultion Layout | Rear Pusher |
| Payload Location | Nose and Underwing |
| Mission Type | Surveillance/ Reconnaissance |

The selected configuration provides a balance between aerodynamic efficiency, structural simplicity, payload integration, and future expandability. It represents a practical conceptual platform for further development and engineering analysis.



## CAD Design Process

The UAV Concept V1 was developed using Autodesk Fusion 360 as part of a self-directed aerospace engineering portfolio project. The objective was not only to create a visually realistic UAV model but also to understand the relationship between aircraft components, geometry, and overall configuration.

The design process followed a progressive approach in which major aircraft structures were created first, followed by secondary systems and configuration refinement. Throughout the project, multiple design iterations were performed to improve the appearance, proportions, and functionality of the aircraft.

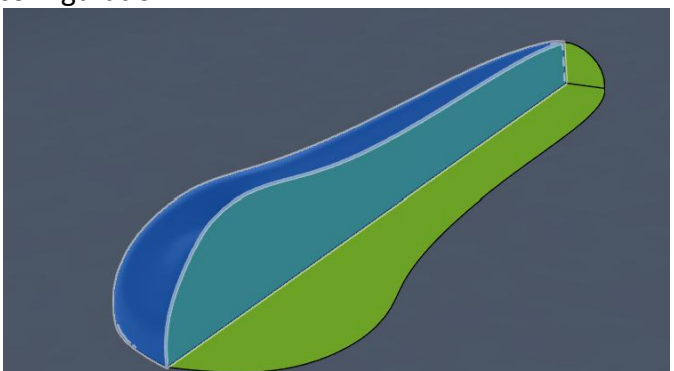
## Development Stages

### Stage 1 – Initial Concept Layout

The first stage focused on establishing the overall aircraft configuration.
At this stage, the following decisions were made:

- Fixed-wing aircraft layout
- Rear pusher propulsion concept

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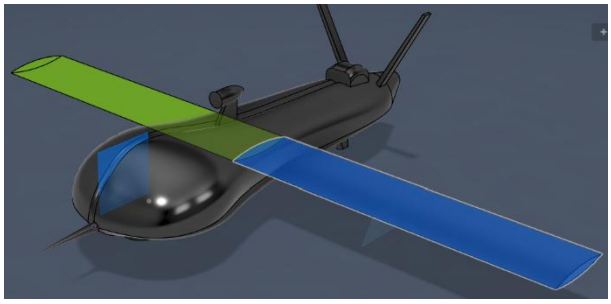
- V-tail configuration
- Sensor turret integration
- Underwing payload capability

The objective was to create a general aircraft shape before developing detailed geometry.

## Stage 2 – Fuselage Development

The fuselage was created as the primary structural body of the aircraft.

Design considerations included:



- Aerodynamic appearance
- Internal volume availability
- Payload accommodation
- Structural continuity

The nose section was shaped to allow installation of a surveillance sensor turret while maintaining a streamlined appearance.

## Stage 3 – Wing Integration

After the fuselage was established, the main wing was developed and integrated into the aircraft.

A constant-chord wing configuration was selected because of its:

- Simplicity
- Ease of manufacturing
- Predictable aerodynamic behaviour
- Educational value

The wing geometry was adjusted until the overall aircraft proportions appeared balanced.

## **Stage 4 – Tail Assembly Development**

The tail assembly was designed using a V-tail arrangement.

The V-tail was integrated into the rear fuselage section and positioned to provide adequate clearance from the propeller system.

Special attention was given to:

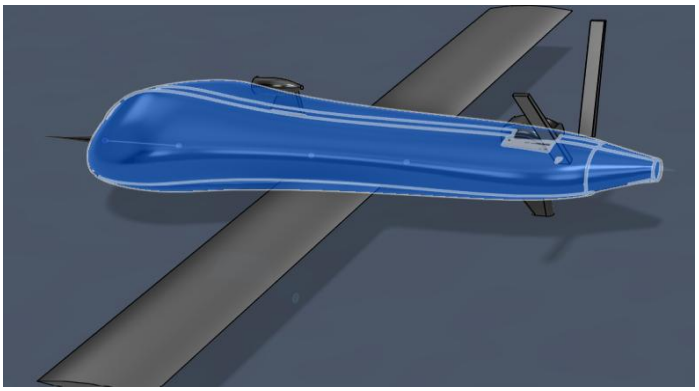
- Tail symmetry
- Visual balance
- Structural integration

### Stage 5 – Propulsion Integration

A rear-mounted pusher propulsion layout was incorporated into the design.
The motor location was selected to:

- Keep the nose area clear
- Improve sensor placement opportunities
- Maintain a realistic UAV appearance

The propulsion system currently represents a conceptual layout and will be refined in future design iterations.



### Stage 6 – Payload and Sensor Integration

The final stage involved adding mission-related features.
These included:

- Nose-mounted sensor turret
- Underwing payload stations
- External mission equipment provisions

These additions were intended to represent realistic surveillance and reconnaissance capabilities.

## Challenges Faced

Several challenges were encountered during the development process.

### Determining Aircraft Proportions

One of the most difficult tasks was establishing realistic proportions between the fuselage, wing, and tail assembly.

Initially, the aircraft geometry appeared either oversized or undersized in certain areas, requiring multiple revisions before achieving a balanced configuration.

## Component Placement

Positioning the wing, tail, and propulsion system while maintaining a realistic aircraft appearance required several design iterations.

Small geometric changes often affected the overall visual balance of the aircraft.

## Lack of Initial Reference Data

At the beginning of the project, limited knowledge was available regarding typical UAV dimensions and aircraft configuration practices.

As the project progressed, additional research and observation of real UAV platforms helped improve the design.

## Balancing Simplicity and Realism

A key challenge was determining how much detail should be included in a conceptual project.

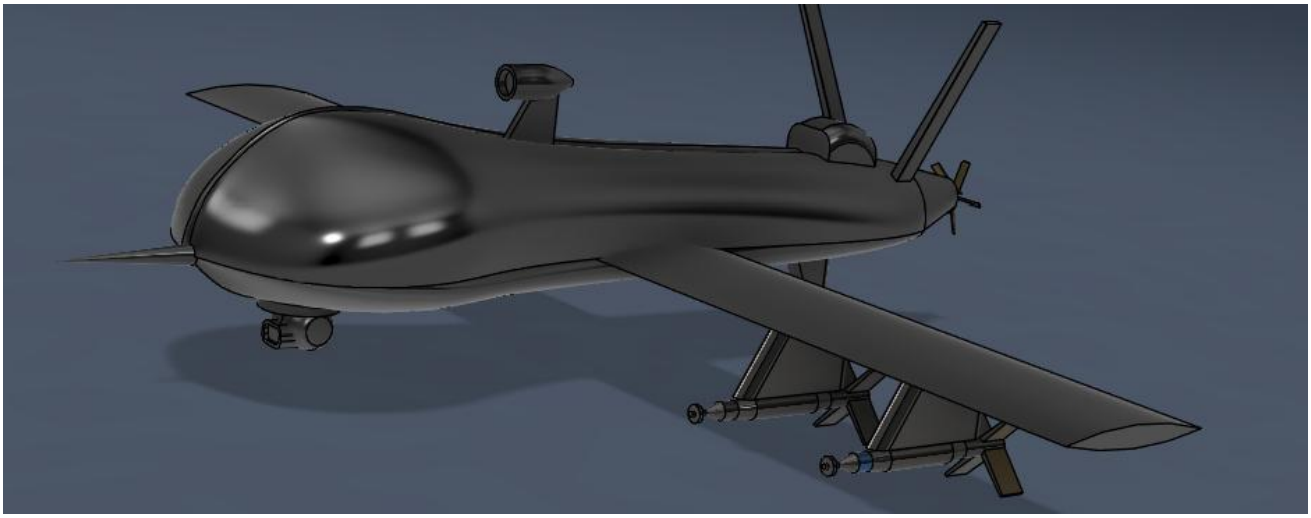
The objective was to create a model that looked realistic while remaining manageable as a learning project.

### Lessons Learned

The project provided valuable experience in:

- Aircraft geometry development
- CAD modelling workflows
- Aerospace design thinking
- Engineering documentation
- Design iteration and refinement

It also demonstrated the importance of defining requirements before creating geometry and highlighted how configuration choices influence the overall aircraft design.



### Aircraft Dimensions

The final UAV Concept V1 geometry was developed to achieve a balanced relationship between wing area, fuselage size, payload capacity, and overall aerodynamic appearance.

The dimensions were selected during the conceptual design process and refined through multiple design iterations within Autodesk Fusion 360.

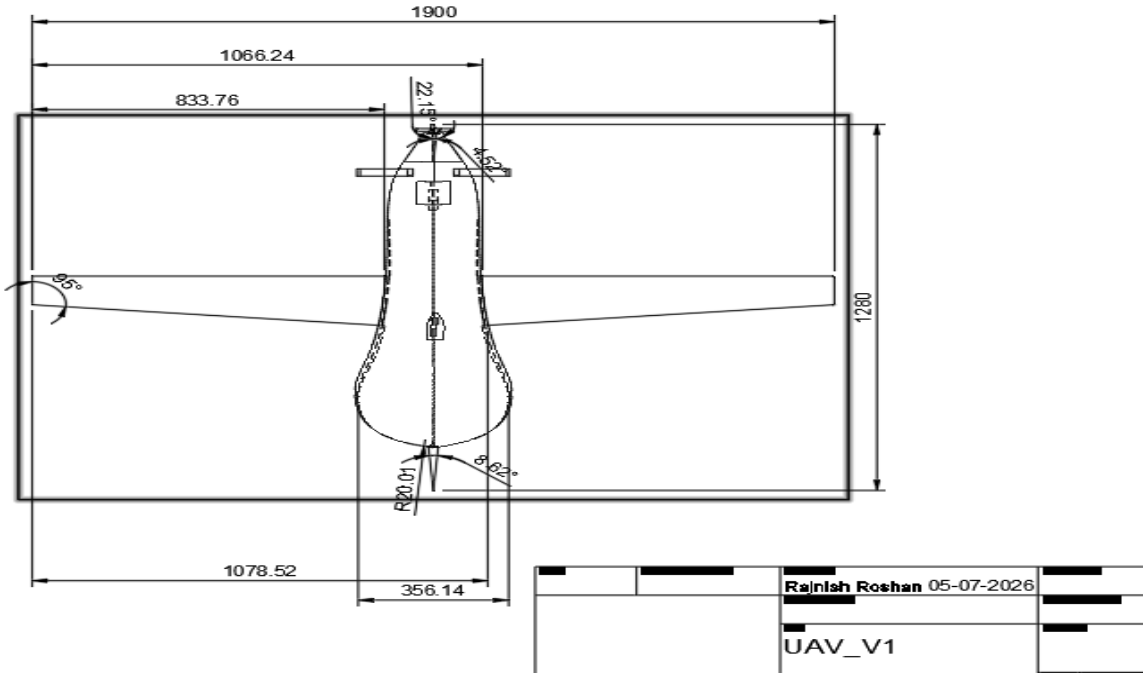
## Main Dimensions

| Parameter | Value |
|---|---|
| **Wingspan** | 1900 mm |
| **Length** | 1280 mm |
| **Wing Chord** | 190 mm |
| **Wing Area** | 0.361 m² |
| **Aspect Ratio** | 10 |
| **Maximum Fuselage Width** | 356.14 mm |
| **Maximum Fuselage Height** | 200 mm |
| **Maximum Overall Height** | 419.52 mm |
| **Tail Angle** | 22.15° |

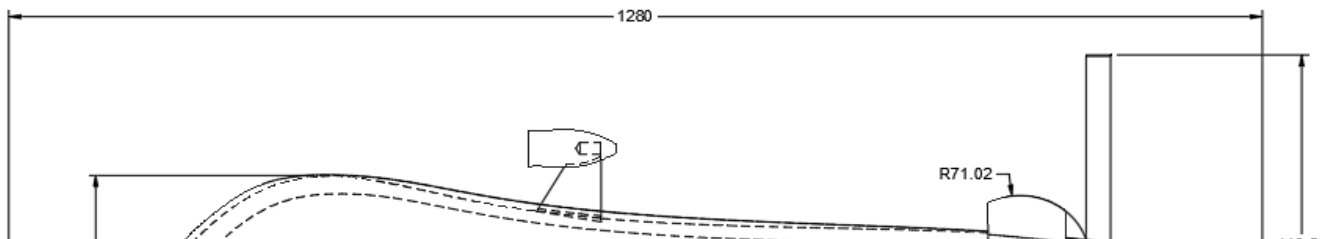
## Orthographic Views

The following orthographic views are provided to illustrate the aircraft geometry and overall layout.

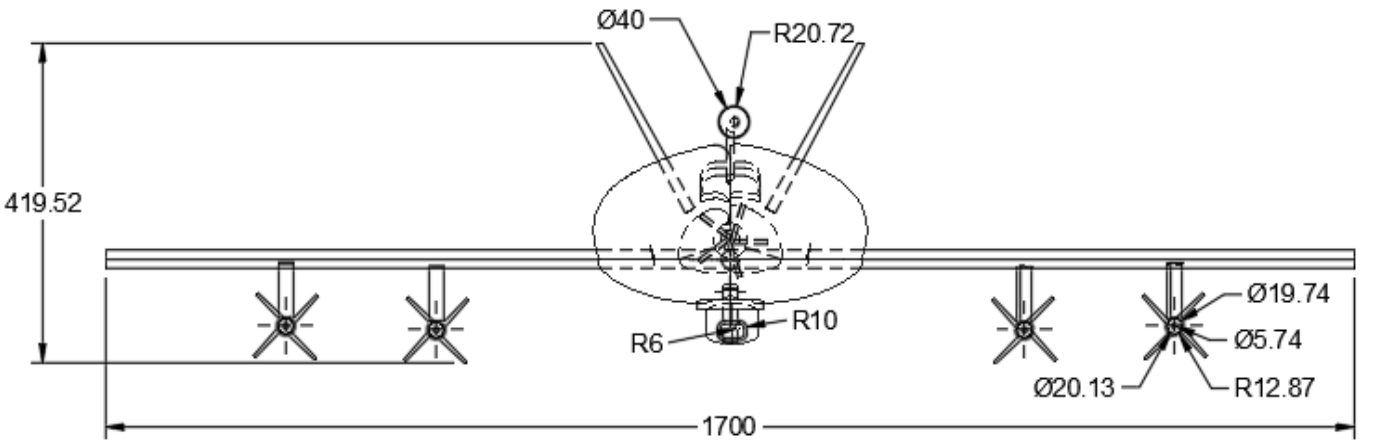
### Top View




### Side View

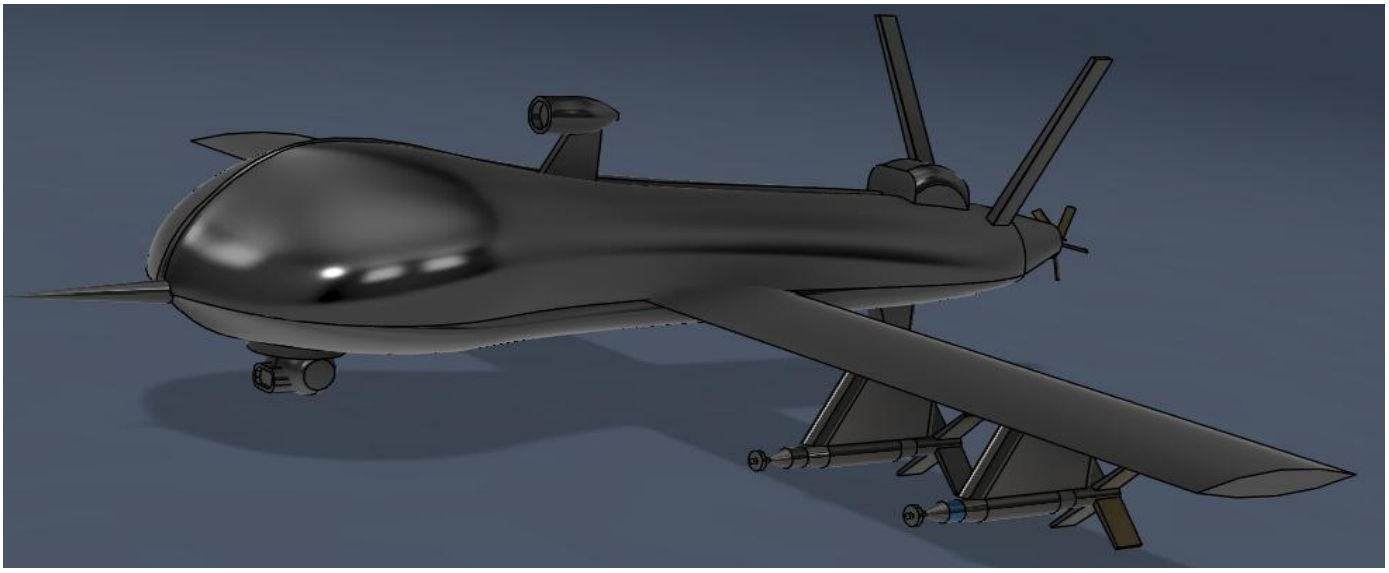


**Front View**




The front view demonstrates wing symmetry, fuselage proportions, and V-tail configuration.

**Isometric View**



Major Components

The UAV consists of the following primary assemblies:

### Fuselage

The fuselage serves as the central structural body of the aircraft and provides space for future avionics, propulsion, payload, and battery integration.

### Main Wing

The aircraft utilizes a constant-chord wing with a span of 1900 mm and a chord length of 190 mm.

### V-Tail Assembly

A V-tail configuration was selected to combine the functions of vertical and horizontal stabilizers while reducing the number of aerodynamic surfaces.

### Propulsion Section

A rear-mounted pusher propulsion arrangement was adopted to maintain a clear forward field of view for surveillance equipment.

### Sensor Turret

A nose-mounted sensor turret was incorporated to represent surveillance and reconnaissance payload capability.

### Payload Stations

Underwing payload stations were included to allow future integration of sensors, research payloads, or experimental systems.

## Dimensional Summary

The final geometry represents an endurance-oriented fixed-wing UAV concept featuring a relatively high aspect-ratio wing, modular payload capability, and a configuration suitable for future aerodynamic and flight-control studies.

## Engineering Calculations

The purpose of this section is to perform preliminary engineering calculations based on the aircraft geometry developed during the conceptual design phase. These calculations provide an initial understanding of the aerodynamic characteristics of the UAV and establish a foundation for future design refinement.

## Assumptions

At this stage of development, several parameters such as aircraft mass, propulsion system, battery selection, and payload weight have not yet been finalized.

Therefore, the following assumptions are made:

- Aircraft is designed for surveillance and reconnaissance missions.
- Constant-chord wing configuration.
- Electric propulsion system.
- Moderate cruise speed.
- Stable flight characteristics prioritized over manoeuvrability.
- Preliminary analysis based solely on geometry.

These assumptions will be refined during future development stages.

## **Wing Area Calculation**

The wing area is calculated using the wingspan and wing chord dimensions.

Given:

Wingspan = 1900 mm
Wing Chord = 190 mm

Formula:

Wing Area = Wingspan × Wing Chord

### **Calculation:**

Wing Area = 1900 × 190
Wing Area = 361,000 mm²

Converting to square meters:

Wing Area = 0.361 m²

**Result**

Wing Area = 0.361 m²

## Aspect Ratio Calculation

Aspect ratio is one of the most important aerodynamic parameters of a fixed-wing aircraft.

A higher aspect ratio generally improves aerodynamic efficiency and reduces induced drag during cruise flight.

Given:

Wingspan = 1.9 m
Wing Area = 0.361 m²

Formula:

Aspect Ratio = Wingspan² / Wing Area

Calculation:

Aspect Ratio = $1.9^2$ / 0.361
Aspect Ratio = 3.61 / 0.361
Aspect Ratio = 10

**Result**

Aspect Ratio ≈ 10

## Aerodynamic Interpretation

An aspect ratio of approximately 10 indicates that the aircraft possesses a relatively long and narrow wing.

Benefits include:

- Improved lift-to-drag ratio
- Better cruise efficiency
- Reduced induced drag
- Increased endurance potential
- Improved suitability for surveillance missions

These characteristics are commonly desirable in fixed-wing UAVs designed for long-duration flight and observation tasks.

## Preliminary Design Assessment

Based on the geometric analysis, the aircraft appears suitable for:

- Surveillance missions

- Reconnaissance missions
- Research and educational applications
- Future autonomous flight experiments

The selected configuration aligns with the original design goals established during the mission definition phase.

## Current Limitations

The following analyses have not yet been completed:

- Weight estimation
- Wing loading calculation
- Thrust-to-weight ratio
- Center of gravity analysis
- Stability margin analysis
- Airfoil selection
- Structural analysis
- Flight performance prediction

These areas represent future development opportunities for the project.

## Summary

The preliminary engineering calculations indicate that the aircraft geometry is consistent with an endurance-oriented fixed-wing UAV concept. The calculated wing area of **0.361 m²** and aspect ratio of **10** suggest that the aircraft configuration is suitable for efficient cruise flight and surveillance operations.

## Design Evaluation

Engineering design requires continuous evaluation and improvement. This section analyses the strengths, limitations, and trade-offs associated with the current UAV configuration.

The purpose of this evaluation is to identify areas where the design performs well and areas that require future refinement.

## Strengths of the Design

### High Aspect Ratio Wing

The aircraft possesses an aspect ratio of approximately 10.

Advantages include:

- Improved aerodynamic efficiency
- Reduced induced drag
- Better cruise performance
- Increased endurance potential

These characteristics make the aircraft suitable for surveillance and reconnaissance missions.

### Modular Aircraft Layout

The aircraft incorporates:

- Nose sensor turret
- Payload stations
- Rear propulsion section

This modular arrangement allows future modifications without major redesign efforts.

### Pusher Propeller Configuration

The rear-mounted propulsion system provides several benefits:

- Clear forward visibility
- Better sensor integration

- Cleaner aircraft appearance
- Reduced interference with surveillance payloads

### V-Tail Configuration

The V-tail contributes to:

- Reduced component count
- Lower structural complexity
- Potential drag reduction
- Improved aesthetic appearance

## Weaknesses of the Design

### Lack of Airfoil Optimization

The current project focuses primarily on external geometry.

The wing airfoil has not yet been selected or analyzed.

Consequences include:

- Unknown lift characteristics
- Unknown stall behavior
- Unverified aerodynamic performance

### No Structural Analysis

The structural capability of the wing, fuselage, and tail has not yet been evaluated.

Unknown factors include:

- Maximum loading conditions
- Wing bending stresses
- Structural safety margins

### No Weight Estimation

Aircraft mass remains unknown.

Without mass estimation it is impossible to accurately determine:

- Wing loading
- Flight endurance
- Stall speed
- Thrust requirements

### No Stability Analysis

The following parameters remain unverified:

- Center of gravity location
- Center of pressure location
- Static margin
- Longitudinal stability

## Design Trade-Offs

Every aircraft design requires compromises.

### Fixed-Wing vs Multirotor

Advantages:

- Greater efficiency
- Longer range
- Longer endurance

Disadvantages:

- Cannot hover
- More demanding takeoff and landing requirements

### V-Tail vs Conventional Tail

Advantages:

- Reduced drag
- Reduced weight
- Simpler appearance

Disadvantages:

- More complex control mixing
- Potentially lower control authority

### Pusher vs Tractor Configuration

Advantages:

- Better sensor placement
- Clear field of view
- Improved mission flexibility

Disadvantages:

- More difficult cooling
- Potential vibration concerns

## Engineering Assessment

From an engineering perspective, the project successfully demonstrates:

- Aircraft configuration development
- Aerospace CAD modelling
- Preliminary aerodynamic reasoning
- Engineering documentation practices

However, the design remains at the conceptual stage and requires additional engineering analysis before it can be considered flight-ready.

## Overall Evaluation

The project successfully meets its primary objective of developing a conceptual fixed-wing UAV platform.

Key achievements include:

- Complete aircraft geometry
- Realistic UAV configuration
- Preliminary aerodynamic calculations
- Professional engineering documentation

The project provides a strong foundation for future work involving aerodynamic analysis, propulsion sizing, structural evaluation, and flight testing.

| Category | Status |
|---|---|

| | |
|---|---|
| **CAD Design** | ✅ Complete |
| **Mission Definition** | ✅ Complete |
| **Configuration Selection** | ✅ Complete |
| **Wing Area Analysis** | ✅ Complete |
| **Aspect Ratio Analysis** | ✅ Complete |
| **Airfoil Analysis** | ⏳ Future Work |
| **Structural Analysis** | ⏳ Future Work |
| **CG Analysis** | ⏳ Future Work |
| **Flight Testing** | ⏳ Future Work |

## Future Development

Although UAV Concept V1 successfully demonstrates a conceptual aircraft design, several engineering tasks remain before the aircraft can be considered flight-ready.

Future development efforts will focus on transforming the conceptual design into a fully engineered UAV platform through aerodynamic, structural, propulsion, and flight-control analysis.

## Airfoil Selection

The current design focuses on external aircraft geometry and does not yet include a finalized airfoil.
Future work will involve:

- Selection of a suitable UAV airfoil
- Lift coefficient analysis
- Drag coefficient estimation
- Stall behavior investigation
- Airfoil comparison studies

The objective is to improve aerodynamic efficiency and flight performance.

## Weight Estimation

A complete mass breakdown must be developed.
Future calculations will include:

- Wing structure mass
- Fuselage mass
- Tail assembly mass
- Battery mass
- Motor mass
- Payload mass
- Avionics mass

This information will enable accurate performance predictions.

## Propulsion System Selection

The propulsion system remains conceptual.
Future development will include:

- Motor selection
- ESC selection
- Propeller sizing
- Battery sizing
- Power consumption analysis
- Endurance estimation

The final propulsion system should provide sufficient thrust while maintaining efficient cruise flight.

## Center of Gravity Analysis

Aircraft stability depends heavily on proper center of gravity placement.
Future work will include:

- Component placement planning
- Mass distribution analysis
- Center of gravity calculation
- Static margin evaluation
- Stability verification

## Structural Analysis

The aircraft structure must be verified before manufacturing.
Future structural studies may include:

- Wing bending analysis
- Tail loading analysis

- Fuselage strength assessment
- Material selection studies
- Safety factor calculations

## Flight Control System Development

Future versions of the UAV may incorporate:

- ESP32-based flight systems
- IMU integration
- Barometric altitude sensing
- GPS navigation
- Telemetry systems
- Autonomous flight capabilities

This stage would transform the project from a purely mechanical design into a complete UAV system.

## Prototype Manufacturing

After engineering validation, a physical prototype may be developed.
Potential manufacturing methods include:

- 3D printing
- Foam construction
- Composite structures
- Hybrid manufacturing techniques

Prototype testing would provide valuable real-world performance data.

## Long-Term Vision

Future versions of UAV Concept V1 may evolve into:

- Flight-tested UAV prototypes
- Autonomous aircraft platforms
- Research and educational UAV systems
- Aerospace engineering demonstration projects

The current design serves as the foundation for these future developments.

## Conclusion

This project successfully demonstrated the conceptual design and development of a fixed-wing unmanned aerial vehicle (UAV) using Fusion 360. The objective was to create a realistic aerospace engineering portfolio project while applying fundamental aircraft design principles.

The final aircraft configuration consists of:

- Fixed-wing layout
- V-tail configuration
- Rear pusher propulsion system
- Sensor payload integration
- Modular fuselage architecture

Throughout the project, multiple stages of the engineering design process were completed, including mission definition, design requirements, configuration selection, CAD development, dimensional analysis, and preliminary engineering calculations.

Key outcomes of the project include:

- Wingspan of 1900 mm
- Aircraft length of 1280 mm
- Wing area of 0.361 $m^2$
- Aspect ratio of approximately 10
- Complete 3D CAD assembly
- Professional engineering documentation

The project also highlighted areas requiring future investigation, including airfoil selection, structural analysis, propulsion sizing, center of gravity evaluation, and flight control system integration.

Most importantly, this project provided practical experience in aerospace design methodology, CAD modelling, engineering documentation, and systems-level thinking. The knowledge gained through this work establishes a strong foundation for more advanced UAV, propulsion, avionics, and aerospace engineering projects in the future.

## Author Statement

This project represents an independent aerospace engineering portfolio project developed for educational and professional growth. It serves as the first step toward building increasingly sophisticated aerospace systems and demonstrates a commitment to continuous learning, engineering excellence, and innovation.