Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2003 and Spring 2004

1.0 Information

1.1 Project Title

Morphing Wing (MoW) Design for the Aerosonde UAV.

1.2 Project Customers

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2.0 Background and Context

Airplanes are often designed for a particular task, thus their wing shape increases performance for a single flight condition. Control surfaces are incorporated into a wing design to allow for changes in flight conditions and tasks. Unfortunately, these control surfaces often increase the drag on the aircraft, compromising the effectiveness of the wing. Morphing the shape of the wing would allow the wing to be optimized for various flight phases and mission requirements.

Morphing wing technology is considered to be a key technology especially in next generation unmanned aerial vehicles (UAV). In particular, the Aerosonde UAV could benefit from the introduction of a morphing wing design. The current Aerosonde wing is rigid and stiff, optimized for cruising at a relatively high speed. Unfortunately, the aircraft's wing cannot easily support lower speeds, such as those required for landing and loitering. A morphing wing would allow the Aerosonde to optimize flight in both cruise and loitering phases of flight.

3.0 Objectives

3.1 Overall Objective

The overall objective of the proposed project is to conceive, design, fabricate, integrate and verify a wing that is able to morph its shape for different flight conditions. The method used to morph the wing will be selected based on feasibility and effectiveness.

3.2 Flight Phase Optimization

3.2.1 Objective

The wing will morph its airfoil shape to change aerodynamic characteristics for cruise conditions and loiter conditions of flight.

3.2.2 Discussion

This defines the basic conditions for which the wing shape will be optimized.

3.3 Material

3.3.1 Objective

The wing skin will be fabricated using a material that will allow for flexibility in design to morph the wing while retaining an aerodynamic shape.

3.3.2 Discussion

This defines the basic constraints on the material selection for the morphing wing.

3.4 Structure

3.4.1 Objective

The structure of the wing will be able to withstand the loading on the wing in flight conditions.

3.4.2 Discussion

This is required to ensure that the wing does not fail due to lack of rigidity of the skin material.

3.5 Mechanical Interface

3.5.1 Objective

The wing will include a device that will be used for mounting in a wind tunnel during testing.

3.5.2 Discussion

For proper data collection and safety purposes, the wing must be stabilized inside the wind tunnel at various wind speeds.

3.6 Measurements

3.6.1 Objective

Aerodynamic properties of the wing will be measured in a wind tunnel.

3.6.2 Discussion

This is required to analyze the performance improvements gained from the morphing wing design.

3.7 Actuation

3.7.1 Objective

A device will be included that will actuate and change the design of the wing.

3.7.2 Discussion

This is required to control the shape change of the wing.

3.8 Control

3.8.1 Objective

A ground station will control the actuation system by a system that has yet to be determined.

3.8.2 Discussion

This ensures that the actuation of the wing shape change can be controlled during flight.

4.0 Anticipated Engineering Expertise

Technical Expertise	How Applied
Mechanism and Structural Design	Develop structural model and perform structural testing of the model
Actuators	Actuator system
Aerodynamics	Shape of wing in each flight phase
Flight Mechanics	Determine optimal flight characteristics
Control	Control actuation system from ground station
Data Acquisition Software	Wind tunnel aerodynamic data collection
Control Software	Real-time control subsystem
Mechanical Fabrication	Part machining
Electronic Fabrication	Analog and digital electronic subsystems
Simulation Software	Simulate fluid dynamics

5.0 Resources

5.1 Facilities

The project will have access to the Air Force Academy low speed wind tunnels.

5.2 Additional Advisors

Prof. Brian Argrow, Cory Dixon, Matthew Allen.

5.3 Funds

Funding for the project is provided by the Aerospace Engineering Department for the Senior Design Project Course. Additional funds may be available from outside sources.