



SAE Aero Micro: Final Testing Results

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Design Requirements



Engineering Requirements

- ER1 – Wingspan
- ER2 – Cost
- ER3 – Battery Life
- ER4 – Thrust
- ER5 – Cargo Bay
- ER6 – Lift
- ER7 – Drag
- ER8 – Weight
- ER9 – RC Signal Range
- ER10 – Center of Gravity
- ER11 – Ground Control
- ER12 – Flight Control

Customer Requirements

- CR1 – Flight Time
- CR2 – Payload
- CR3 – Turning Radius
- CR4 – RC Signal Range
- CR5 – Take Off
- CR6 – Land
- CR7 – Unload Payload



QFD

Customer Needs	Customer Weights	Wingspan	Cost	Battery	Thrust/Motor	Cargo Bay	Lit	Drag	Thrust	Weight	T/O velo	RC Signal Range	CG Marking	Ground Control	Flight Control	Durability	1 Poor	2	3 Acceptable	4	5 Excellent
Flight Time	9	9	3	1	9	3	9	9	9	3	9	3		3	9			AB	C		AB
Payload	9	3		3	9	9	9	1	3	9			9		3	9	AB				C
Turning Radius/Maneuverability	3	3			3	1	1	1	9	1	9	3			3				C		AB
RC Signal Strength (2.4 GHz)	3		1	3								9									ABC
Spare Parts	1	1	3	1												9					
Launch T/O	3	9	1		3	1	9	9	9	9	9			9	3			C		AB	
Landing	3	9	1		1	1	3	3	3	3	3			9	3				C		AB
Unloading Time	9	1												3			AB				C
Technical Requirement Units		in	\$	time	lb/Ft watt	ms	N	N	N	kg	m/s	ft	in								
Technical Requirement Targets		48	2000	2:40	450	144	75	5	20	1.5	22	800	26								
Absolute Technical Importance		181	39	46	183	117	201	129	171	147	144	63	81	108	135	82					
Relative Technical Importance		3	12	11	2	9	1	8	4	5	6	4	6	10	7	7					



Top Level Testing Summary

Experiment/Test	Relevant DRs
Takeoff Test	Thrust (ER4), Max Lift (ER6), Drag (ER7), Weight (ER8), Take-off Speed (ER9), Takeoff (CR6)
Landing Test	CG (ER11), Ground Control (ER12), Durability (ER14), Ability to land (CR7)
Flight Test	Wingspan (ER1), Battery Life (ER3), RC Signal Range (ER10), Flight Control (ER13), Flight Time (CR1), Turning Radius (CR3), RC Signal (CR4)
Maintenance Test	Max Lift (ER5), Carry Payload (CR2), Spare Parts (CR5), Unload Payload (CR8)
Crash Test	Cost (ER2), Battery Life (ER3), Weight (ER8), CG (ER11), Durability (ER14), Landing Distance (CR5)



Detailed Testing Plan

- Takeoff Test: Tests the airplane's ability to takeoff from a standstill on the ground.
- Flight Test: Tests the maneuverability of the airplane. Ensures that all control surfaces and the motor are functioning.
- Landing Test: Tests the ability to land the aircraft in a designated 200-foot strip.
- Maintenance Test: Tests the ability of the team to change batteries and load or unload the payload in under 60 seconds.
- Crash Test: Tests the durability of the aircraft in a controlled crash.



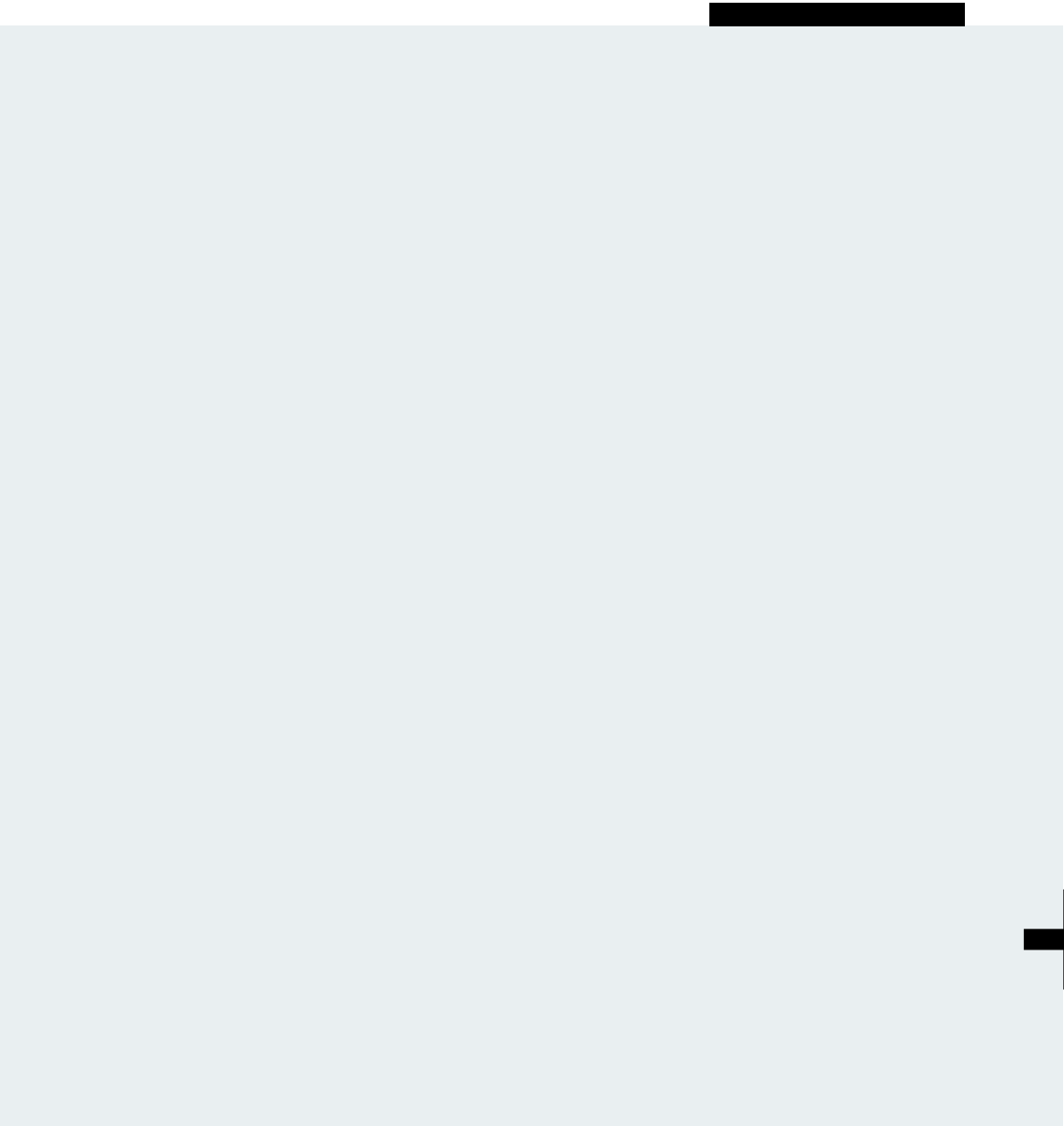
Specification Sheet Preparation

Engineering Requirement		Target	Tolerance	Measured/Calculated Value	ER Met?	Client Acceptable
Wingspan	ER1	45in	2in	45in	Yes	Yes
Cost	ER2	\$1,500	--	\$738	Yes	Yes
Battery Life	ER3	120s	60s	150s	Yes	Yes
Thrust	ER4	20N	2N	18.33N	Yes	Yes
Cargo Bay	ER5	6x6x4 in ³	--	6x6x4 in ³	Yes	Yes
Max Lift	ER6	30N	5N	38.47N	Yes	Yes
Drag	ER7	3N	2N	6.52N	No	Yes
Weight	ER8	1.2kg	1kg	2.5kg	No	Yes
Take off Speed	ER9	25m/s	2m/s	14.47m/s	No	Yes
RC Signal Range	ER10	1000ft	200ft	5000ft	Yes	Yes
CG	ER11	10in from nose	8in from nose	8in	Yes	Yes
Ground Control	ER12	N/A	N/A	N/A	No	No
Flight Control (Turning Radius)	ER13	120ft	--	--	No	Pending
Durability	ER14	N/A	N/A	N/A	Yes	Yes
Landing Distance	ER15	200ft	--	--	No	Pending
Flight Distance	ER16	800ft	0ft	5ft	No	Pending
Flight Time	ER17	60s	10s	3s	No	Pending



CR Summary

Customer Requirement	CR Met?	Client Acceptable?
Flight Time	Y	N
Payload	Y	Y
Turning Radius	N	N
RC Signal Range	Y	Y
Takeoff	Y	N
Land	Y	N
Unload Payload	Y	Y
RC Signal Range	Y	Y
Steering Ability	N	N



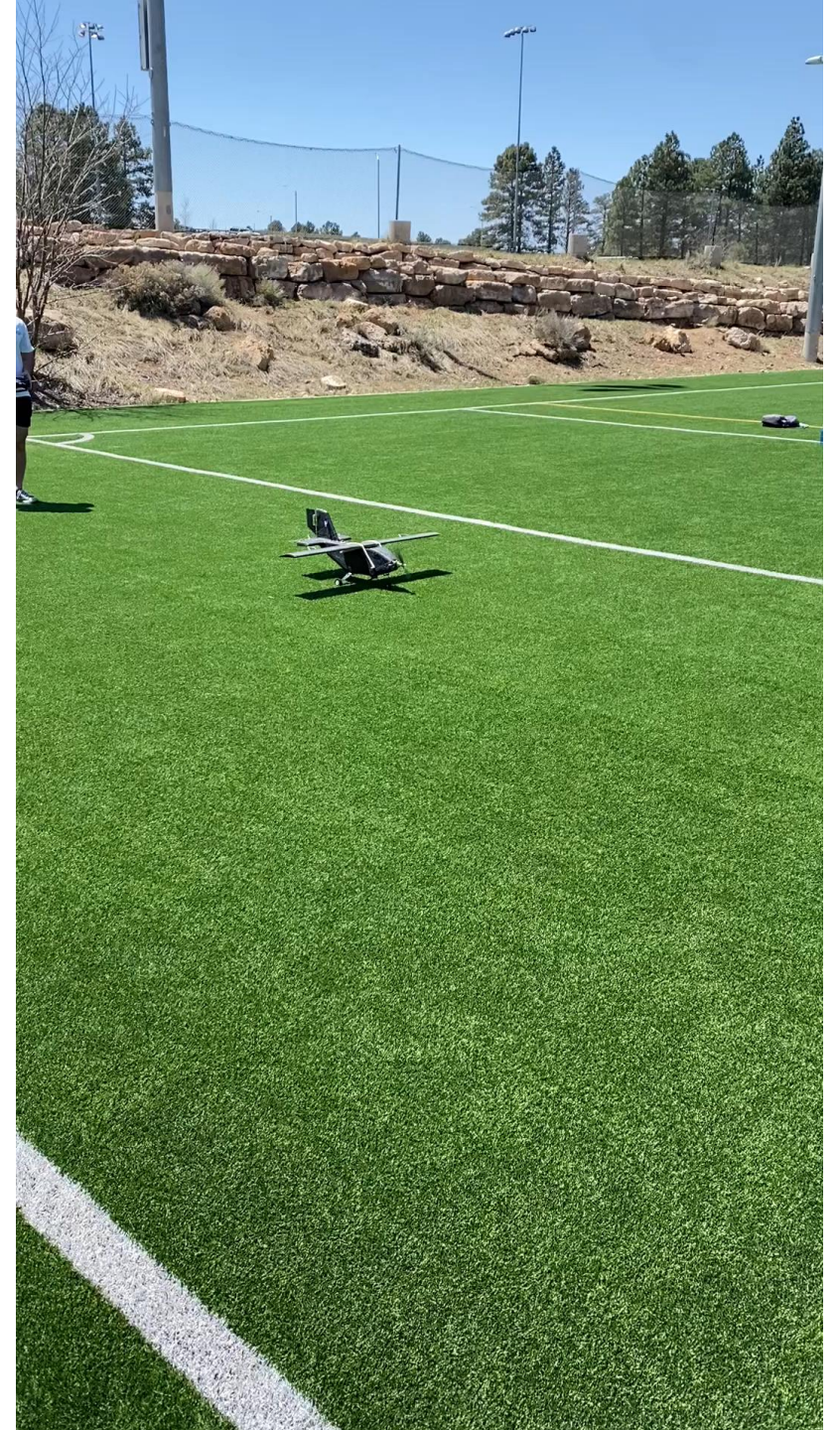
Takeoff Test

- Objectives: Test the airplane's ability to takeoff from a standstill.
- Status: Successful
- Results: Plane was able to lift off the ground and leave ground effect. Once it was out of ground effect, the AoA was too high and it went into an accelerated stall.
- Technique: The proper takeoff procedure was determined to emphasize higher speed, and lighter up-elevator movement, as opposed to a lower speed, full-deflection of the elevator.



Flight Test

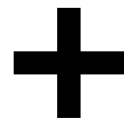
- Objectives: Test the airplane's ability to fly the competition circuit.
- Status: Partial Success
- Reasons for outcome:
 - Plane is heavy, and the initial power to weight ratio was not as accurate as calculated
 - Motor we were using was down on power, and beginning to overheat due to so many runs
 - Pilot technique needs adjusted. Instead of focusing on AoA, the airplane's nose needs to be pitched down after rotation to allow speed to build and less induced drag





Landing Test

- Objectives: Ensure plane is capable of landing within the specified 200ft competition requirement
- Status: Partial success
- Reason for outcome: The rule reads come to a landing from “stable flight”. Landing was achieved, but it is guaranteed when the airplane flies



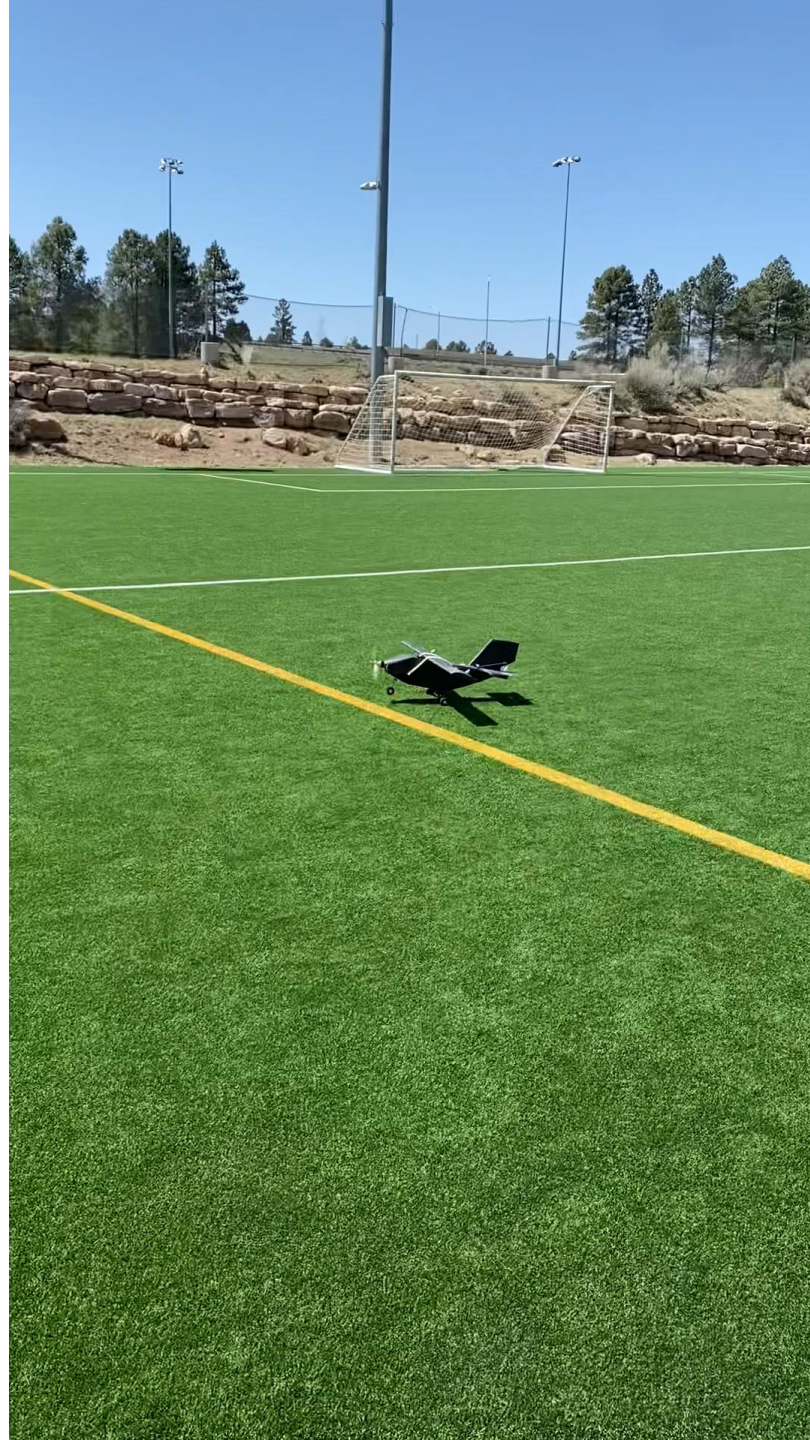
Maintenance Test

- Objectives: Remove wing, replace battery, insert payload, reattach wing.
- Status: Successful
- Average time: 52 seconds
- Competition requirement: <60 second



Crash Test

- Objectives: Crash airplane to ensure it can withstand crashing
- Status: Successful
- Original Results: Nose landing gear failed, motor has debris inside housing, and elevator detached.
- Final Testing Results: Cracked vertical stabilizer, holes in carbon, detached wing, loss of rudder, loss of push rods, snapped propeller
- All issues proved fixable. The durability allowed for reusability



Additional Crash Test Videos



Corrected Issues

- Fixed ground stability. The aircraft is now able to maintain directional control with a solid nose wheel aided by the rudder. The rudder is ineffective at low speeds, so the stability was needed for stages when the rudder was not applicable
- Moved center of lift over the center of gravity. Instead of having to offset weight, the wing now picks the airplane up directly over the CG



Control Surfaces Test



Wake Vortex Visualization

