DORIS Final Testing Results

Dylan Boeholt, Andre Bonillas, Connor Davidson, Jeremy Malmo, & Michael Zielinski

Design Requirements

Customer Requirements:

- CR1 - High Mobility – highly maneuverable
- CR2 – Small dimensions and still fit all essential components
- CR3 – Complete Recon Mission
- CR4 – Payload Capacity – carry a significantly heavy payload
- CR5 – Battery Capacity – efficient/large enough
- CR6 – Cost Efficiency – limited budget
- CR7 – Thrust Efficiency – high thrust to weight ratio

Engineering Requirements:

- ER1 – Thrust to weight Ratio – goal of 3:1
- ER2 – Compact design – 5x5x5 ft, under 50 lbs.
- ER3 – Payload Weight – 30% of total weight
- ER4 – Time of Flight – 10 minutes or more
- ER5 – Total Cost – 3300$ budget
- ER6 – Meet FAA regulations – under 55lbs, fly under 400 ft

Top Level Testing

Experiment/Test	Relevant DRs	Testing Equipment Required	Other Resources
Exp 1: Take-off Test	ER – 4 ER – 6 CR – 3 CR – 5	-Drone System -FlySky Remote -Recording Device (iPhone) -stopwatch	-Good weather or large indoor location -certified drone pilot -Level Ground
Exp 2: Landing	ER – 4 ER – 6 CR – 3 CR – 5	-Drone System -FlySky Remote -Recording Device (iPhone) -stopwatch	-Good weather or large indoor location -certified drone pilot -level ground
Exp 3: Thrust Dyno Testing	ER – 1 CR – 7	-Strain gauge test stand/dynamometer -Motor + propeller -Digital multimeter	-excel spreadsheet -Ear Protection -Eye Protection -Video Camera
Exp 4: Side-to-side mobility test	ER – 2 CR – 1 CR – 2	-Drone System -FlySky Remote -Recording Device (iPhone)	-Good weather or large indoor location -certified drone pilot
Exp 5: Payload pickup and deployment	ER – 3 CR – 4	-Drone System -FlySky Remote	-weighted payload (hand weight) -camera payload

Testing Plan

Flight & Thrust Tests

- **Main Objective:**
  - Determine if the drone can lift off with its intended payload
  - "Will it go up?" – baseline flight readiness
- **Testing Focus:**
  - Static thrust testing using custom thrust test stand
  - Payload lift reliability and consistency
- **Test Stand Setup:**
  - Motor mounted on linear rail
  - 10 kg load cell for thrust measurement
  - Arduino + ESC for throttle control
  - Powered by LiPo battery
  - Data collected: thrust (g), current draw(A)
- **Pass Criteria:**
  - Thrust output ≥ total weight (drone + payload)
  - Reliable, repeatable lift force across test runs

Magnetic Payload Engagement

- **Purpose:**
  - Test reliability of magnet-based payload attachment and release
- **Engagement Method:**
  - Electromagnet or magnetic latch triggered onboard switch
  - Engage during takeoff, release on landing
- **Testing Focus:**
  - Confirm payload stays securely attached during lift
  - Test repeatability of magnetic engagement and release
  - Observe any shifts or instability during hover and movement
- **Pass Criteria:**
  - Payload remains attached during full-thrust lift
  - Clean and controlled disengagement when triggered

Testing Results

Flight Tests (1,2,4)

Issue:

Two diagonal motors overheated and one failed during flight testing.

Cause:

Misconfigured motor directions in the flight controller caused the CW motors to overcompensate, leading to overheating.

Fix:

- Corrected motor rotation settings in software
- Verified direction and prop orientation
- Replaced damaged motor and retested successfully

Thrust Dynamometer Testing (3)

16x8 Propeller		
Percent Thrust (%)	Average Thrust (lbf)	Average Current (A)
0	0	0.31
15	0.747	3.65
30	5.984	12.5
45	12.449	29.89
60	14.946	54.61

Payload Deployment (5)

- **Payload Deployment System – Success**
- Magnetic switch system fully integrated and operational
- Payload deploys reliably on command
- Simple, lightweight mechanism with no mechanical failures observed

Testing Demonstration

Problem Definition: Delayed Motor Order from iFlight

- **March 31st** – Motors ordered from iFlight with an advertised **3–6 day lead time**.
- **No updates or shipping confirmation** after the expected delivery window passed.
- **Multiple follow-up attempts** to contact iFlight received **no response**.
- **April 7–10** – iFlight finally responded, stating:
  - Due to **tariffs**, they now required **125% additional payment**.
- A few days later, iFlight followed up again, stating:
  - They were **unsure if the motors were located in the U.S. or still in China**.
- **April 15th** – Latest update from iFlight:
  - Tariff cost has **increased to 145%**.
  - Motors have **not left their warehouse** (from China) yet.

Lessons Learned

- **Start testing earlier** to allow time for part failures, shipping delays, and replacements.
- **Budget for higher quality motors** to reduce failure points
- **Have backup vendors or parts identified** in case primary options fall through.
- **Communicate clearly and document everything** when dealing with overseas suppliers.
- **Be cautious with international orders** — factor in tariffs, customs, and potential miscommunications.

Course of Action

- **Researched and identified U.S.-made brushless motors** to avoid further international delays and tariff issues.
- Only viable option: **KDE7215XF-135 motors** at **$425 each**.
- Matching propellers cost **$535 for two**.
- **Total estimated cost** for motors and props: **$2,700+ (before shipping/tax)**.
- **Project budget: $3,300**
- This setup would consume **90%+ of total budget**, leaving no room for other components or adjustments.
- **Conclusion**:
- **KDE system is not financially viable** within current budget constraints.
- **Next steps:**
  - Ordered the last two available iFlight Xing 4214 in the USA from eBay ($81.47)
  - Test as soon as they arrive
  - Attempt to get money back from iFlight

Spec Sheet

Engineering Requirement	Target	Tolerance	Measured/ Calculated Value	ER met?	Client Acceptable
ER1 - Thrust to Weight Ratio	3:1	+/- 100 g			
ER2 - Compact Design	5X5X5 ft / <50 lbs	1 in/ 5lbs	4x4x4 ft / 23.6 lbs	Yes	Yes
ER3 - Complete Course in Time Limit	9 minutes	+/- 1 minute			
ER4 - Payload Weight	30% weight of the system	+/- 1 pound	6.9 lbs	Yes	Yes
ER5 - Time of Flight	10 minutes	+/- 30 seconds			
ER6 - Total Cost	$3000	+/- $717.70	$3,434.61	Yes	Yes
ER7 - Meet FAA Requirements	Met	N/a	N/a	Yes	Yes

Customer Requirement	CR met?	Client Acceptable
CR1 - High Mobility	TBD	TBD
CR2 - Small	Yes	Yes
CR3 - Complete Recon Mission	TBD	TBD
CR4 - Payload Weight	Yes	Yes
CR5 - Battery Capacity	TBD	TBD
CR6 - Cost Efficiency	Yes	Yes
CR7 - Thrust Efficiency	Yes	Yes

QFD

Thrust : weight > 3:1								
Compact Design under 3'x3'x3'								
Complete Course < 10 min		3						
Payload > 30% of weight		1		1				
Time of flight > 10 min		3		1	1			
Total Cost under $3,000			3			1		
Meets FAA requirements (weight < 55 lbs)		3	3		1	3	3	
		Technical Requirements						
Customer Needs	Customer Weights: 1-5	Thrust : weight > 3:1	Compact Design under 3'x3'x3'	Complete Course < 10 min	Payload > 30% of weight	Time of flight > 10 min	Total Cost under $3,000	Meets FAA requirements (weight < 55 lbs)
High mobility	4	5	5	5	1	2	1	
Small	1	4	5	3		5	5	5
Complete Boeing Recon Mission	5	5	3	2	4	2		
Payload Capacity	5	5	1	2	5	1	2	
Battery Capacity for small mission	4	3	2	4	4	5	1	1
Cost Efficiency	3	1	2	3		2	5	4
Thrust Efficiency	4	5	3	5	4	5	2	
Technical Requirement Units			Feet	minutes	% weight	minutes	USD	pounds
Technical Requirement Targets		3:1	< 3x3x3	< 10	> 30	> 10	>3000	< 55
Absolute Technical Importance		28	24	24	18	22	16	15
Relative Technical Importance		1	3	3	5	4	6	7

Questions?