Helium Micro Air Vehicle (MAV)

Concept Generation and Selection

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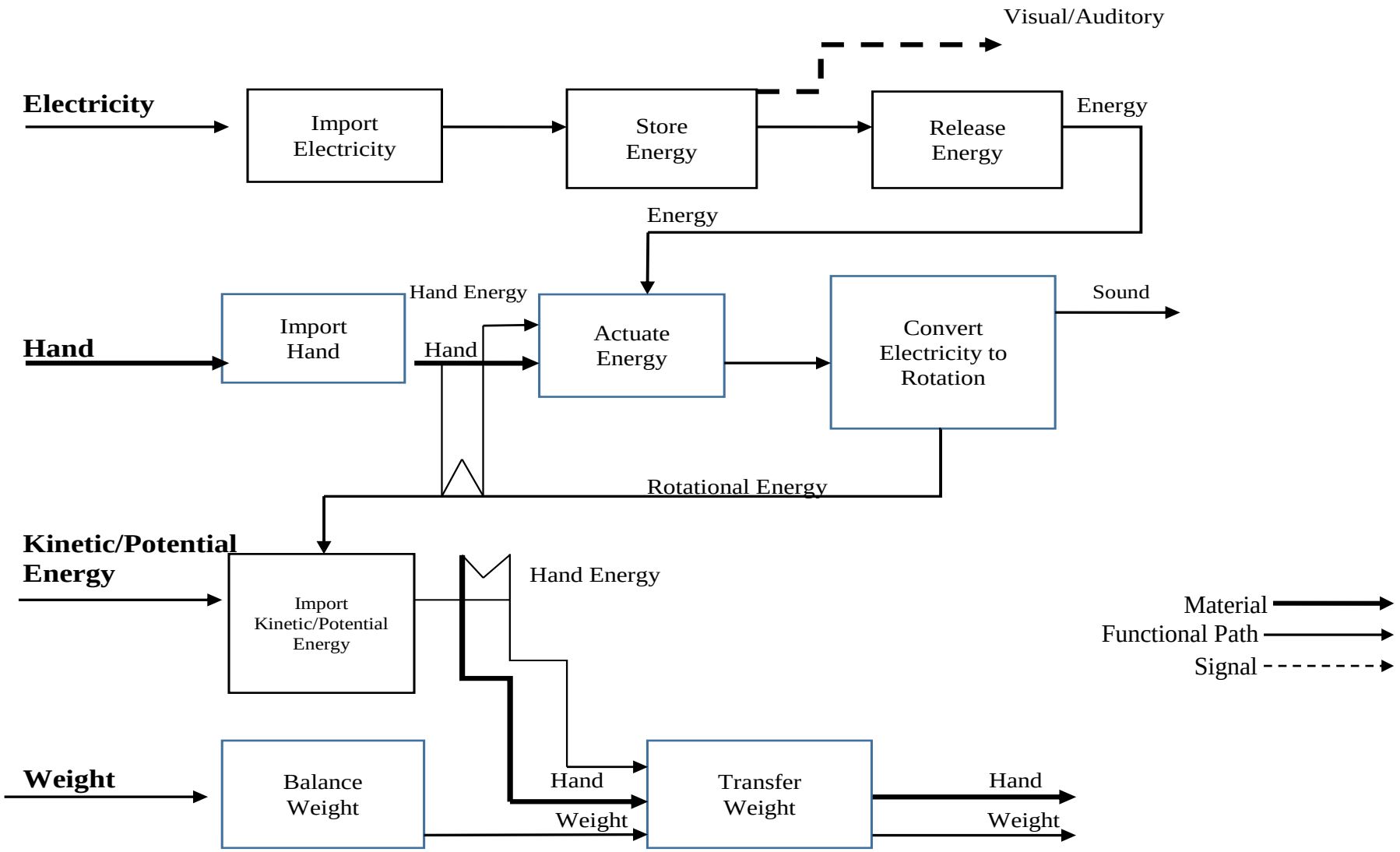
Overview

- Introduction
- Functional Diagram
- Criteria
- Relative Weights of Criteria
- Concept Generation
- Decision Matrix
- Updated Project Plan
- Conclusions

Introduction

- Dr. Srinivas Kosaraju requested a Helium MAV device to fly over fires and contaminated areas
- Our objectives include are to optimize weight payload limit, minimize the response time, double the distance of quadcopters and is durable
- Constraints include that the budget is $2000, remote control guidance system, reach a minimum height of 31 m and the max size must be 1.8 X 0.91 X 0.91 m^3
- The Quality Functional Deployment recognized different designing necessities such as engineering requirements and customer requirements.

Functional Diagram



Criteria

1. Frame
   a) Weight
   b) Volume
   c) Cost

2. Battery
   a) Life
   b) Amps
   c) Voltage
   d) Weight
   e) Cost

3. GPS / Sensors
   a) Controllable
   b) Pre- programmed
   c) Range
   d) Wi-Fi
   e) Cost

4. Motor
   a) Weight
   b) Thrust
   c) Cost
   d) Battery compatibility

5. Balloon Envelope
   a) Payload
   b) Balloon material
   c) Cost
   d) Volume
   e) shape

6. Camera
   a) Size
   b) Cost
   c) Weight
   d) Resolution
   e) Waterproof

Relative Weights of Criteria

Batteries					
Criteria	Life	Amps	Voltage	Weight	Cost
Life	1	3	3	1/5	3
Amps	1/3	1	1	5	7
Voltage	1/3	1	1	5	7
Weight	5	1/5	1/5	1	3
Cost	1/3	1/7	1/7	1/3	1
Sum	7.00	5.34	5.34	11.53	21.00

Batteries						
Criteria	Life	Amps	Voltage	Weight	Cost	Relative Weight
Life	0.143	0.561	0.561	0.017	0.143	0.285
Amps	0.048	0.187	0.187	0.434	0.333	0.238
Voltage	0.048	0.187	0.187	0.434	0.333	0.238
Weight	0.714	0.037	0.037	0.087	0.143	0.204
Cost	0.048	0.027	0.027	0.029	0.048	0.036

Judgement of Preference	Numerical Rating
Extremely Preferred	9
Strongly Preferred	7
Moderately Preferred	5
Preferred	3
Equally Preferred	1

Relative Weights of Criteria

Frame		
Criteria	Relative Weight	Percentage
Weight	0.533	53.3%
Volume	0.338	33.8%
Cost	0.129	12.9%

GPS/Sensors		
Criteria	Relative Weight	Percentage
Controllable	0.269	26.9%
Pre-Programmable	0.204	20.4%
Range	0.124	12.4%
Wi-fi	0.178	17.8%
Cost	0.225	22.5%

Motor		
Criteria	Relative Weight	Percentage
Weight	0.342	34.2%
Thrust	0.290	29.0%
Cost	0.213	21.3%
Battery Capability	0.155	15.5%

Batteries		
Criteria	Relative Weight	Percentage
Life	0.244	24.4%
Amps	0.191	19.1%
Voltage	0.284	28.4%
Weight	0.147	14.7%
Cost	0.134	13.4%

Balloon Envelope		
Criteria	Relative Weight	Percentage
Payload	0.262	26.2%
Volume	0.184	18.4%
Cost	0.193	19.3%
Material	0.229	22.9%
Shape	0.133	13.3%

Camera		
Criteria	Relative Weight	Percentage
Size	0.250	25.0%
Cost	0.110	11.0%
Weight	0.208	20.8%
Resolution	0.277	27.7%
Waterproof	0.155	15.5%

Concept Generation: Power Source

Li-Polymer New Tunigy

Source:hobbyking.com

Tenergy Li-ion

Source:amazon.com

Turnigy Nano-Tech Li-Polymer

Source:hobbyking.com

Decision Matrix: Power Source

Battery Criteria	Relative Weights	Turnigy Nano-Tech	Li-Po New Tunigy	Tenergy 11204	Turnigy Nano-Tech Score	Li-Po New Tunigy Score	Tenergy 11204 Score	Turnigy Nano-Tech	Li-Po New Tunigy	Tenergy 11204
Cost	0.134 (13.3%)	$16.43	$31.29	$16.50	8.36	6.871	8.35	1.120	.920	1.118
Voltage (V)	0.284 (28.3%)	7.4	7.4	7.2	7.6	7.6	7.4	2.158	2.158	2.101
Amps (mAh)	0.191 (19.1%)	2	5.0	3.0	4	10	6	.764	1.91	1.146
Weight (g)	0.147 (14.6%)	98	279	314.67	9.925	7.39	7.03	1.458	1.086	1.033
Life at max capacity (mins)	0.244 (24.4%)	60	60	60	=	=	=	2.44	2.44	2.44
Score	**Weighted Scores**				29.885	31.861	28.78	**7.941**	**8.515**	**7.839**

Cost	Score	Meaning
$0.00	10	Desirable
$100.00	1	Undesirable

Voltage	Score	Meaning
15v	10	Desirable
5v	1	Undesirable

Weight	Score	Meaning
25g	10	Desirable
1000g	1	Undesirable

Amps	Score	Meaning
5	10	Desirable
.25	1	Undesirable

Concept Generation: GPS

Hardwired GPS Tracking Device

Source:loc8tor.com

GPS Logger

Source:rcgroups.com

Personal GPS Tracker

Source:dhgate.com

Real Time GPS Tracker

Source:spyguysecurity.com

Decision Matrix: GPS

Criteria	Weight	GPS Logger	Personal GPS Tracker	Real Time GPS Tracker	Hardwired GPS Tracking Device	Hardwired Gps Tracking Device	GPS Logger	Personal GPS Tracker	Real Time GPS Tracker
Weight	0.269	3.54	5.6	8.8	5.72	1.538	0.952	1.506	2.367
Power source	0.178	10	10	10	5	0.89	1.78	1.78	1.78
Real time feed	0.204	5	10	10	10	2.04	1.02	2.04	2.04
Cost	0.225	8.8	4.16	3.36	6.56	1.476	1.98	0.936	0.756
Total	1	27.34	29.76	32.16	27.28	**5.944**	**5.732**	**6.262**	**6.943**

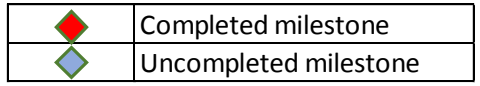
Weight(g)	Score	Meaning
150-200	3	undesirable
100-150	5	average
50-100	7	above average
0-50	9	Excellent

Cost($)	Score	Meaning
150-200	3	undesirable
100-150	5	average
50-100	7	above average
0-50	9	Excellent

Power Source	Score	Meaning
External Battery	5	not qualified
Built in battery	10	Qualified

Real Time Feed	Score	Meaning
Real Time	10	Qualified
Not Real time	5	not qualified

Updated Project Plan



Tasks	Weeks														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Communicate With Client															
Defining Project ,Need, Goal, Objectives and Constraints															
Preparing Quality Function Deployment															
State of The art Research															
Creating Functional Diagram															
Creating Conceptual Drawing															
Conceptulaizing Alternative Approach															
Applying Decision Matrices															
Concept Generation and Selection															
Engineering Analysis															
Material Selection															
Building Concept Prototype															
Testing Prototype															
Preparing Budget Analysis													Break		
Finalizing The Project Proposal															
Problem Definition and Project Plan Presentation															
Problem Definition and Project Plan Report															
Concept Generation and Selection Presentation															
Concept Generation and Selection Report															
Proof Of Concept Demonstrations															
Proof of Concept Report															
Project Proposal Presentation															
Project Proposal Report															

Conclusion

- The functional diagram showed how each sub-function of the Helium MAV operates
- Criteria have been assigned based on the sub-systems to ensure the qualification of the concept
- Designs were chosen after comparing them using decision matrices and assigned criteria
- Tunigy Lithium Polymer 5000 mAh was chosen as best battery pack for our weighted criteria
- GPS Real Time was the best type according to the decision matrix but since it was close with the personal tracker we will consider both options

References

1. Julie Hirtz, Robert Stone, Daniel McAdams, Simon Szykman, and Kristin Wood. "A Functional Basis for Engineering Design: Reconciling and Evolving Previous Efforts." *Research in Engineering Design,* vol. 13, pg 65-82, March 2002.

2. Dieter, George E & Schmidt, Linda C, Engineering Design, 4th ed., New York City, New York: McGraw-Hill, 2009, ISBN 978-0-07-283703-2.