# Concept Generation

In order to develop the best product and meet our objective, the team underwent a concept generation session. In this session, multiple concept generation techniques were used. Our goal is to lightweight the Believer 1960mm, a commercially available mapping UAV, and through brainstorming and other methods, we developed concepts to successfully do so.

To develop many of the concepts, the team took a biomimicry approach to brainstorming. This is when you think of your project in a way that relates to nature. What in nature represents aspects or a solution to your problem? For us, we looked at birds. Some birds can fly long periods of time since they have large wingspans that generate lift as they glide in the air. However, in general, birds have very light weight bones. If we can develop a structure similar to the bone structure of birds, that would help us reach our objective greatly. Concepts generated using this method are evident in Appendix C where our entire list of concepts is listed.

Another approach we took to develop concepts was the anti-problem approach. This style of brainstorming is when the team thinks of the opposite of the problem. For us, that would be looking at making the UAV heavier. What can we do to make the UAV heavier? Well, a big heavy aspect of the UAV is the battery and electrical system. So, from there, we reverse the question and focus back to our goal of light weighting. We can develop a lighter UAV by reducing the weight of the battery and electrical system.

A third approach Team 518 took to generate concepts was to take an approach similar to a morphological chart. We took our systems and analyzed the current components that exist in the UAV. We have an electrical system, made of batteries, controllers, and receivers. We have a

flight system, made of motors to drive the plane through the air and control the ailerons. We have a support system that holds the plane together. And we have a payload system made of a camera to capture the necessary data. Analyzing these subsystems individually, we can look at how to light weight each one and then combine these to get an overall reduction in weight. One example of light weighting the flight system is by improving the propellor design. Also, analyzing the support structure, using a more efficient rib structure may allow us to reduce the weight of the supports while maintaining the needed strength.

After brainstorming, we had 100 concepts listed (Appendix C). As a team, we were able to narrow these down to a total of eight concepts. Five of these concepts are medium fidelity concepts and three of them are high fidelity concepts. The medium fidelity concepts are listed in the table below:

Table 5: *Medium Fidelity Concepts*

| **Medium Fidelity Concepts** | | |
|---|---|---|
| Regenerative Power Source | Generative Design | Honeycomb Structures |
| Electric Components used as support | Complete Wing Design | |

Regenerative power supply was an idea we came up with to help reduce the weight of the standard power source. By having components to recharge the UAV while it was being operated, this would reduce the size of the primary battery. This idea was inspired by hybrid cars. Generative design was an idea we had to reduce the weight of parts of the UAV using computer software. Generative design optimizes a design by a computer program taking in parameters from the engineer and developing a design that probably would have never been designed by a

person. Designs constructed using this method are often hard to manufacture. The honeycomb idea was inspired by looking at the structure of a beehive. This provides space between the material, decreasing the weight compared to a solid piece, and making the UAV lighter. However, this process cannot be applied to many small components on the UAV as it would be too difficult to manufacture. Using the electric components as part of the support structure in the UAV reduces the need for extra material to be used as support. This reduces the total material on the UAV and decreases the weight in that aspect. The last medium fidelity concept generated was designing a complete wing structure. This idea was inspired by the Northrop Grumman B-2 Spirit. The fuselage and wing are one structure, not like a typical aircraft where they separate and must be assembled. Incorporating the fuselage and wings together can decrease the overall size of the fuselage and reduce the overall weight.

The three high fidelity concepts that were generated by our team are listed in the table below:

Table 6: *High Fidelity Concepts*

| **High Fidelity Concepts** | | |
|---|---|---|
| LW-PLA Constructed Parts | Lighter Electrical Components | Improve Propeller Design |

The first high fidelity concept that was generated was the idea to construct parts of the UAV using LW-PLA (Light Weight Polylactic Acid). This is a lightweight 3D printing material that will result in parts that weigh less than the original ones. Another high-fidelity concept that was generated was the idea to implement lighter electrical components. The electrical components in UAVs and other vehicles are some of the heaviest parts. Reducing the weight of

the battery, and other parts, can greatly increase the flight time and reduce the overall weight of the UAV. The third high fidelity concept that was generated was to improve the design of the propeller. Increasing the performance of the propellers by their design can lead to the reduction of weight in other areas. This is because less work will be needed to get the same performance results.

# Appendices

## Appendix A: Concept Generation

1. Entirely constructed of carbon fiber
2. carbon fiber parts used to replace existing
3. Entirely constructed of aluminum
4. Replace parts with aluminum
5. Create different shape fuselage
6. Hollowed out body of UAV
7. Hollowed wings
8. Paper thin wings, w/ rib structure
9. generative design
10. Kevlar constructed components
11. balsa wood frame
12. replace electric components with lighter versions
13. extra-large wingspan(large birds)
14. smoother outer surface (less drag)
15. Honeycomb structures
16. replace components with composite materials
17. Replace Styrofoam with lighter weight foam

18. Use electric wires as structural support
19. optimizing bonding materials
20. optimize subsystem placement in UAV
21. reduce thickness of current body
22. Optimize tail design
23. Fiber glass frame
24. Use efficient motor
25. Improve Propeller design
26. Use bamboo materials
27. Use Lithium battery
28. Improve electrical wire gage
29. Use tensegrity structure
30. Decrease amount of total parts
31. decrease payload weight
32. decrease payload volume
33. decrease total volume of UAV
34. RAM air structural design
35. Air filled plane (balloon type structure)
36. Use a smaller battery
37. Helium filled plane
38. Replace mounts with lighter versions
39. Vertical lift motors to reduce lift needed
40. Remove unnecessary components

41. Remove Fuselage
42. Use spider silk threading as plane structure
43. Complete wing design
44. Biplane wing to increase lift
45. Triplane wing to increase lift
46. High density materials
47. Increase aspect ratio
48. Low density materials
49. Hollowed rear of plane (AC130 hatch)
50. Exposed frame of plane
51. Changing Motor position
52. Increase cruise altitude
53. Replace parts with titanium
54. fiber metal laminates
55. Use solar panel for energy source
56. Use solar panels for support structure
57. Regenerative power source
58. Hollow frame (birdlike)
59. Use propeller as wind turbine when gliding
60. Combine quadcopter & fixed wing styles
61. Metal lattice materials (represent bones)
62. Replace components with ones made of magnesium
63. Replace parts made with LW-PLA

64. Replace parts with ones made of polypropylene

65. I-beam support down fuselage

66. Develop a ribcage structured fuselage

67. Create wings out of bird feathers

68. Transfer electricity by making UAV out of conducting material

69. mount hardware directly to structural supports

70. Make support structure out of paper

71. 3D-print UAV components

72. Reduce mass of non-essential components

73. Use smaller engine

74. Make flight controls fly-by-wire

75. Select lighter receiver

76. Make support structure out of bird feathers

77. Use Pi joints instead of fasteners

78. Make plane of toothpicks

79. Use cardboard for the support structure

80. Use components as body of UAV

81. Attach balloons

82. remove outer shells of components

83. remove any doors, attachments, and hardware not needed

84. Design nose of UAV to be smaller/pointier

85. Shorten fuselage

86. Add wind fans to the sides of the fuselage to generate power

87. Shorten Wingspan

88. Bore out solid components

89. methane balloon in fuselage

90. Ammonia filled fuselage (like a balloon)

91. glue parts together

92. Position of wing

93. Make the plane internal structure out of macro lattice

94. Make the external structure out of graphene aerogel

95. Make  the plane resemble an elliptical shape (tear drop)

96. Use a  lithium-air battery

97. Narrow the fuselage like a knife blade

98. Single motor at rear of UAV to offset camera

99. Use capacitors to store charge.

100. Use triangular support structure design.