## Concept Generation

Concept generation is a very crucial part in any big project as it introduces many perspectives that helps show the best route to be taken. To brainstorm solutions to our problems we used concept generation to come up with multiple possible combinations. With these combinations some offered benefits while others introduced some flaws along the way. Through analyzing the pros and cons of each possible direction we could take, we gathered up the top ideas that we believe will work the best.

Our group used various methods of concept generation. Biomimicry was used to generate a handful of concepts. This method allowed us to analytically apply our problem to nature and brainstorm nature’s own solutions. This method was deemed insufficient in generating the number of concepts required. Next, Anti-problem was used to generate concepts. In this method, the problem was reversed, and possible solutions and problems were created. For example, instead of trying to solve the problem “How will the batteries be cooled” the problem was stated as “How to keep the car from catching fire”. This method allowed us to see simple solutions we were previously missing. After using these methods of concept generation, the ideas were added to a morphological chart. The combination of three methods led to the creation of our completed morphological chart.

Table 3: *Concept Generation*

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| --- | --- | --- | --- | --- |
| Function | Option 1 | Option 2 | Option 3 | Option 4 |
| Box Shape | Cube | Rectangle | Cross | T-Shape |
| Box Cooling | Liquid cooling | Air cooling (ventilation) | Fans |  |
| Box Waterproofing | Rubber seals | Water diversion | Silicon Sealant | Vacuum Sealed |
| Box Mounting | Integrated into chassis | Bolted into chassis |  |  |
| Energy Storage Device | Individual ion-cells | Purchase off shelf | Capacitor |  |
| Energy Storage Device Wiring | Series | Parallel | Both series and parallel |  |
| BMS Measurements | Current | Voltage | Temperature | All measurements |
| Current Type | AC | DC |  |  |
| Charging Device | Wall power | Solar | Regeneration |  |

The top three concepts were chosen to be the overall, top three designs. Most of the functions for the concepts are the same. These functions could easily be picked as the best options without having to use a Pugh matrix or house of quality thanks to their simplicity and effectiveness. The two functions that alternate between the top three concepts are box mounting and box cooling. Further concepts selection methods will be required to decide which variation of these functions will work best.

Concepts 4 through 8 were selected because they nearly met all our top desired criteria, except for one or two components. These components are viewed as acceptable trade-offs that do not necessarily detract from the overall quality and function of the finished product but are just not viewed as the most effective methods to use in a real-world model. These trade-offs may allow for a final system that is easier to implement into a concrete model.

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### Concept 1.

Box Shape: Rectangle, Box Cooling: Liquid Cooling, Box Waterproofing: Rubber Seals, Box Mounting: Integrated into Chassis, Energy Storage Device: Purchase off Shelf, Energy Storage Device Wiring: Wiring Included with Purchase, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 2.

Box Shape: Rectangle, Box Cooling: Air Cooling, Box Waterproofing: Rubber Seals, Box Mounting: Integrated into Chassis, Energy Storage Device: Purchase off Shelf, Energy Storage Device Wiring: Wiring Included with Purchase, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 3.

Box Shape: Rectangle, Box Cooling: Liquid Cooling, Box Waterproofing: Rubber Seals, Box Mounting: Bolted into Chassis, Energy Storage Device: Purchase off Shelf, Energy Storage Device Wiring: Wiring Included with Purchase, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 4.

Box Shape: T-Shape, Box Cooling: Liquid Cooling, Box Waterproofing: Rubber Seals, Box Mounting: Integrated into Chassis, Energy Storage Device: Purchase off Shelf, Energy Storage Device Wiring: Wiring Included with Purchase, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 5.

Box Shape: Cube, Box Cooling: Liquid Cooling, Box Waterproofing: Silicon Sealant, Box Mounting: Integrated into Chassis, Energy Storage Device: Purchase off Shelf, Energy Storage Device Wiring: Wiring Included with Purchase, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 6.

Box Shape: Rectangle, Box Cooling: Liquid Cooling, Box Waterproofing: Silicon Sealant Silicon Sealant, Box Mounting: Integrated into Chassis, Energy Storage Device: Purchase Off Shelf, Energy Storage Device Wiring: Wiring Included with Purchase, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 7.

Box Shape: Rectangle, Box Cooling: Liquid Cooling, Box Waterproofing: Rubber Seals, Box Mounting: Integrated into Chassis, Energy Storage Device: Build Using Ion-Cells, Energy Storage Device Wiring: Parallel, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power

### Concept 8.

Box Shape: Rectangle, Box Cooling: Liquid Cooling, Box Waterproofing: Rubber Seals, Box Mounting: Integrated into Chassis, Energy Storage Device: Build Using Capacitors, Energy Storage Device Wiring: Parallel, BMS Measurements: Temperature, Voltage, and Current, Current Type: DC, Charging Device: Wall Power