Concept Generation

1.5.1 Concept Generation Tools

In order to generate 100 concepts for the design the ME and ECE teams met and initiated a brainstorming session. This session was a free, safe space for everyone to collaborate and think of ideas while one member acted as a recorder of all the ideas. After the session 48 concepts were generated. The ME team met again separately to create a morphological chart to generate more concepts and come up with two more free thinking ideas. The problem was split into subproblems, initial solution, and then combined to generate 80 different solutions, with the top 50 being added to the concept chart. The subproblems consisted of wheel type, drive train, and sorting mechanism. Another method used to generate ideas was random possible solutions. This promoted creativity but started to cause the same concepts to be formed.

1.5.2 Extracting High and Medium Fidelity Ideas (Concept Selection)

Out of 100 concepts, 5 medium fidelity and 3 high fidelity ideas would be selected from the list after analyzing the list. The concepts were chosen by what best fit the customer needs and what the sponsor wanted.

1.5.3 High Fidelity Concepts

The high fidelity ideas and justifications for each selection: (Green Boxes)

Concept 1: 18 Compactor

This concept involves two arms that come together to clamp onto the astral materials and pick them up. At the end of the arms are rectangular plates with rubber pads, and these are what the astral materials are held between. The robot will operate by first sensing a material while

travelling on the game field. Once a material is detected the arms will swing down to trap the material between the plates. The arms will then rise and carry the material to a bin to deposit it. Material detection would be done using a weight sensor to indicate which material has been acquired based on weight. The robot will know what bin to go to based on the associated weight with that material.

Concept 2: 52 Multi Conveyor

This concept utilizes a multi-lane conveyor belt which transports materials up and into a storage container on the robot, which can then be dumped into the cosmic shipping container. Multiple lanes on the conveyor allow for mass collection of materials. This concept also creates the opportunity to simplify navigation by creating a predetermined route which the robot can follow to cover a specified portion of the arena. This concept excludes a sorting mechanism, saving time and reducing complexity, while giving up minimal point gains.

Concept 3: 85 Lazy Hercules

This concept utilizes a robot with a standard drive train with omnidirectional wheels and no sorting mechanism. Due to calculations of point optimization it was found that while more points are possible if the astral materials are sorted, it will take time and resources away from the team during building and testing stages so it was decided that sorting is not as important as maneuverability and speed of collection. This robot will have a simple collector mechanism that will pick up astral materials and put it in a collection bin.

1.5.4 Medium Fidelity Concepts

The medium fidelity ideas and justifications for each selection: (Yellow Boxes)

Concept 4: 48 The Band Box Bot

This concept utilizes a roller with rubber bands along the horizontal portion (looks like a whisk, but without a handle, and with a cylindrical shape). Materials are collected within the roller as the robot moves over them. The roller is periodically emptied into a container on the robot, which can then be dumped into the cosmic shipping containers. This design can quickly collect materials as it collects them by simply driving over them. This design ignores sorting to save time and reduce complexity. The rubber band roller is also a very simple design which can be easily and cheaply tested.

Concept 5: 8 Magnetic Bulldozer

This concept involves a sort of bulldozer that scoops up astral materials in a bucket with a magnet that can turned on or off inside. Depending on the coding, the robot then toggles the magnets to then sort the materials into the bucket on the field.

Concept 6: 36 Robotic Claw

This concept features a robotic arm with a claw at the end on top of a robot with a standard drive train and omni wheels. The robot will also have the shipping container for the astral materials stored in the center so that as the robot moves around the field and collects the materials, they can be stored in the shipping container. The robotic arm would have three joints that allow for rapid pick up and dropping of the astral material into the shipping container.

Concept 7: 28 Frank

This concept involves an agricultural combine. The header (cylinder on the front) will collect the materials by scooping them up. The robot will then travel to a bin, and a conveyor belt will drop the materials into the bin.

Concept 8: 31 Clamp and Lift

Clamp and lift the collection bucket onto the robot, and then sort the astral materials into the competition bucket to save space on assembling our own astral material suspension system.

1.5.5 Morphological Chart

Subproblem Solution Concepts		
Wheel Type	**Drive Train**	**Sorting Mechanism**
Tank Treads	Standard Drive	Weight Sensor
Standard Rubber Wheels	H Drive	Magnetic Sensor
Omnidirectional Wheels	X Drive	Conveyor Belt
Mecanum Wheels	Kiwi Drive	No Sorting Mechanism
All Terrain		

There are 80 possible solutions using the morphological chart. Only 50 will be used for the 80 concepts table but all will be considered, so the top 50 concepts will be included in the table.

1.5.6 Concepts

Green – High Fidelity

Yellow – Medium Fidelity

Concept Number	Concept Title	Concept Description
1	Robert	Robot that throws a bag with a lasso around its opening that closes and is drawn into the robot with all the astral materials.
2	Oklahoma Spooner	A robot that uses two spoons that stick out straight forward in front of the robot and are in a diagonal orientation. The spoons come together to scoop the materials up.
3	Mothership	A robot that sends forth smaller robotic minions to collect and retrieve individual astral materials, bringing to an elevator which accepts the retrieved materials for distribution.
4	Magneto	A robot that plants itself in the game field and activates a powerful magnet that sucks

		up all the geodinium to the magnet in the center of the robot; after completion, electricity will run to turn off the magnet for the rest of the match.
5	Sticky Pad	A robot that uses a pad with adhesive material. The pad presses down on the ground to collect materials. The pad is then lifted above a container, and a pattern of prongs stick through the pad to drop materials from the pad.
6	Pitchfork	Robot pushes a pitchfork shaped tractor bucket along the ground. The materials are collected along the spaces in the fork and then lifted and dropped into a collection container.

7	The Bouncer	A robot that sits low and collects as many astral materials as possible and then raises its body to hover over the collection bin and deposits the gathered astral materials in it.
8	Magnetic Bulldozer	A robot that can act as a bulldozer with a magnetic bucket (where the magnet can be turned off) to sort astral materials from magnetic and nonmagnetic.
9	Original Bulldozer	A robot that can act as a bulldozer and collect large amounts of unsorted astral materials and deposit them into collection bins.
10	Roomba	A robot that resembles a Roomba that sits low and sweeps the astral materials into the center of the robot for collection.

11	Angry Roomba	A robot that has a vacuum with a brush head on it with magnets to pull the magnetic astral materials to it.
12	Rubber Band Mover	A robot that uses rubber bands on sprockets that rolls the astral materials up into the robot and then into a collection bin.
13	Archimedes Combine	A combine that has an Archimedes screw to pull astral material into the center of the robot.
14	Hay Baler	A robot that collects astral materials and then drops them into the correct bin by sorting it like a hay baler does after it finishes wrapping a bale.
15	The Flipper	A robot that has curved "arms" that fold out at the start and can sweep most of the field and gather a large percentage of the astral

		materials in one sweep and then flip them into a collection bin.
16	Double Conveyor Belt	Two different conveyor belt lines for the different types of astral materials. One has magnets strong enough to pull the magnetic astral material to it.
17	Weighted Compactor	A compactor that is horizontal instead of vertical and weights the astral material to distinguish whether the magnetic or nonmagnetic is present then sorts into the correct collection bin.
18	Compactor	Two large plates compact the astral materials between them and hold in place, then raise up to deposit them into the collection bins.

19	UFO	A robot that looks like a crop sprayer that is way above the field and collection buckets and gathers astral materials and deposits them by sitting above the buckets and deposits them into the collection bins.
20	Elevator	An elevator that has two doors, one in the front to gather astral materials and then on in the back to release the material in the collection bin by a push arm.
21	Tongs	Have tongs that hold an individual astral material on grips it into a collection bin.
22	Front End Garbage Truck	Having a way to store the astral materials in a secondary bin then dump them into the competitions collection bins like how a front end garbage truck does.

23	Streetsweeper	A streetsweeper design for the robot's collection of the astral materials.
24	Hungry Hungry Hippos	A mechanism that operates how the hungry hungry hippos game is to collect the astral materials.
25	Bristle Combine	A combine that has bristles attached incrementally to better grip the astral materials while collecting them.
26	Catapult	A catapult arm that shoots the astral material into the collection bins that are placed in their final location in the beginning of the match.
27	Vacuum	A vacuum that sucks up all astral materials into a collection bin.
28	Frank	Have a combine that collects astral materials and deposits them into a collection bin.

29	Double Combine	Have a double combine that has a magnetic cylinder and a nonmagnetic cylinder for sorting of astral materials.
30	Clamp and Drag	Clamp and drag the collection bin to the back of the robot and drive around collecting astral materials.
31	Clamp and Lift	Clamp the collection bin and lift it on the back of the robot and drive around collecting astral materials.
32	Storage	Put the collection bin in the interior of the robot and gather astral materials as the robot moves.
33	Cage	An internal cage with an internal roof that stores the astral materials.
34	Slide	A slide that has a conveyor belt on it that fills the full interior of the robot to gather

		materials and deposit them in a collection bin.
35	Gatherer	Two robotic arms that gather astral materials between them and then drop them in a collection bin.
36	Robotic Claw	A robotic arm with a pinching claw on it to gather one astral material at a time.
37	The Cleaner	An arm that sweeps up astral material into a collection bin that the opening is perpendicular to the floor.
38	The Plunger	A suction cup that collects the astral materials and drops them into a collection bin.
39	Ed Lasso	A lasso that wrangles astral materials and brings it back to the robot.
40	Sticky Hand	A slapper like sticky hand that slaps the astral material and collects it in a bin that it hits on the way back.

41	Magnetic Claw	A robot with a crane arm that has a swinging magnet on a string attached to it to pick up only the magnetic astral materials.
42	Watermill	A robot that has a collector similar to a watermill to gather all the astral materials and deposit them in a bin that is in the interior of the robot.
43	Sticky Roller	An adhesive roller that collects astral materials by them sticking to it and have them fall off into a collection bin.
44	The Claw	A robot that mimics a crane with a claw to collect astral materials and dump them in the collection bins.
45	EZ-Nabber	An EZ-Nabber on the robot used to mass collect astral material and lift it into the collection bins.

46	The Abductor	A robot that has a magnetic tractor beam that uses electrical current to power on and off to manual sort the astral material.
47	Tennis Ball bot	A robot that has something similar to a tennis ball collector tube to collect astral materials.
48	The Band Box Bot	A robot that has a container that can dump out and rollers with rubber bands on them to collect the astral materials and deposit them in the container as the robot drives over them.
49	Cup Trap	A robot that collects astral materials with plastic cups that come together to trap the astral materials between them.

50	Tread Master	A robot that has tank treads, a standard drive, and a weight sensor for sorting.
51	Tanko	A robot that has tank treads, a standard drive, and a magnetic sensor for sorting.
52	Multi Conveyor	A robot which uses a multi-laned conveyor belt to transport materials up and into a collection bin which will then be dumped into the cosmic shipping container.
53	Turbo Tread	A robot that has tank treads, a standard drive, and no sorting.
54	Steel Track	A robot that has tank treads, an H drive, and a weight sensor for sorting.
55	Track Titan	A robot that has tank treads, an H drive, and a magnetic sensor for sorting.

56	Rollin' Thunder	A robot that has tank treads, an H drive, and a conveyor belt for sorting.
57	Tread Hawk	A robot that has tank treads, an H drive, and no sorting.
58	Steel Stride	A robot that has tank treads, an X drive, and a weight sensor for sorting.
59	Rumble Rover	A robot that has tank treads, an X drive, and a magnetic sensor for sorting.
60	Terra Tank	A robot that has tank treads, an X drive, and a conveyor belt for sorting.
61	Heavy Hauler	A robot that has tank treads, an X drive, and no sorting.
62	Tread Warlord	A robot that has tank treads, a Kiwi drive, and a weight sensor for sorting.
63	Grip Force	A robot that has tank treads, a Kiwi drive, and a magnetic sensor for sorting.

64	Asphalt Avenger	A robot that has tank treads, a Kiwi drive, and a conveyor belt for sorting.
65	Tread Warlord	A robot that has tank treads, a Kiwi drive, and no sorting.
66	Gear Guardian	A robot that has standard rubber wheels, a standard drive, and a weight sensor for sorting.
67	Bob	A robot that has standard rubber wheels, a standard drive, and a magnetic sensor for sorting.
68	Stuart	A robot that has standard rubber wheels, a standard drive, and a conveyor belt for sorting.
69	Kevin	A robot that has standard rubber wheels, a standard drive, and no sorting.
70	Axiom	A robot that has standard rubber wheels, an H drive,

		and a weight sensor for sorting.
71	te	A robot that has standard rubber wheels, an H drive, and a magnetic sensor for sorting.
72	Walmart Checkout	A robot that has standard rubber wheels, an H drive, and a conveyor belt for sorting.
73	Golf Ball Collector	A robot like a golf ball collector at a driving range. No sorting mechanism
74	X-magneto-bot	A robot that has standard rubber wheels, an X drive, and a weight sensor for sorting.
75	X-Bot	A robot that has standard rubber wheels, an X drive, and a magnetic sensor for sorting.
76	X-conveyor-bot	A robot that has standard rubber wheels, an X drive,

		and a conveyor belt for sorting.
77		A robot that has standard rubber wheels, an X drive, and no sorting.
78	Kiwi	A robot that has standard rubber wheels, a Kiwi drive, and a weight sensor for sorting.
79	Magneto-kiwi	A robot that has standard rubber wheels, a Kiwi drive, and a magnetic sensor for sorting.
80	Conveyor-kiwi	A robot that has standard rubber wheels, a Kiwi drive, and a conveyor belt for sorting.
81	Lazy Kiwi	A robot that has standard rubber wheels, a Kiwi drive, and no sorting.
82	Hercules	A robot that has omnidirectional wheels, a

		standard drive, and a weight sensor for sorting.
83	Magneto-Hercules	A robot that has omnidirectional wheels, a standard drive, and a magnetic sensor for sorting.
84	Conveyor-Hercules	A robot that has omnidirectional wheels, a standard drive, and a conveyor belt for sorting.
85	Lazy Hercules	A robot that has omnidirectional wheels, a standard drive, and no sorting.
86	H-bot	A robot that has omnidirectional wheels, an H drive, and a weight sensor for sorting.
87	H-Magneto	A robot that has omnidirectional wheels, an H drive, and a magnetic sensor for sorting.

88	H-conveyor	A robot that has omnidirectional wheels, an H drive, and a conveyor belt for sorting.
89	Lazy H	A robot that has omnidirectional wheels, an H drive, and no sorting.
90	Hercules-X-bot	A robot that has omnidirectional wheels, an X drive, and a weight sensor for sorting.
91	Magneto-X-bot	A robot that has omnidirectional wheels, an X drive, and a magnetic sensor for sorting.
92	X-conveyor	A robot that has omnidirectional wheels, an X drive, and a conveyor belt for sorting.
93	Lazy-X	A robot that has omnidirectional wheels, an X drive, and no sorting.

94	Mighty Kiwi	A robot that has omnidirectional wheels, a Kiwi drive, and a weight sensor for sorting.
95	Magnetic Omni-wi	A robot that has omnidirectional wheels, a Kiwi drive, and a magnetic sensor for sorting.
96	Conveyor Omni-wi	A robot that has omnidirectional wheels, a Kiwi drive, and a conveyor belt for sorting.
97	Lazy Omni-wi	A robot that has omnidirectional wheels, a Kiwi drive, and no sorting.
98	Lazy Mech	A robot that has mecanum wheels, a standard drive, and no sorting.
99	Minecrafter	A robot that has all Terrain wheels, a standard drive, and no sorting.

| 100 | Lazy H Minecrafter | A robot that has all terrain wheels, an H drive, and no sorting. |