Concept Generation

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Project: FPL Remote Switching Device

Date: 3 November 2023

Concept Generation overview and tools

Concept generation is perhaps the first major milestone of the design process as the decisions made here ultimately impact the entire direction of the project. Generating such a massive list of concepts is no easy task but is necessary to give innovative concepts a much greater chance of formation. We utilized a plethora of methods and tools to aid and inspire our concept generation. These methods include Brainstorming, Reverse brainstorming, SCAMPER, crap shoot, and synectics.

Brainstorming is a technique that inspires creative thinking amongst a group of people. The intent is to devise new ideas and solve problems creatively by encouraging new paths of thinking and collectively generate solutions. This is accomplished by creating an environment that promotes free thinking and voiced thoughts/concepts without judgment; which fosters an open and innovative space for concept generation. Reverse brainstorming, SCAMPER, and crap shoot are all derived concepts of brainstorming.

In a typical brainstorming session, we considered solutions to the problem at hand; meaning we spent time generating solutions with the end goal in mind. Reverse brainstorming, however, considers the root of the problem. Rather than reacting to the problem and finding a solution, we consider how to remedy the root of the problem such that a solution is no longer required; Thus we define an entirely new solution.

The SCAMPER method is a mnemonic that represents another process we utilized. It is also a derivation of brainstorming and stands for Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse. By taking previously synthesized concepts and applying SCAMPER, we were able to generate concepts that were either a better version of a previous idea or a completely new idea. This is because the premise of SCAMPER is to treat whole concepts as sectioned parts; once we have several concepts broken into even more partial concepts, we can combine the partial concepts from several different ideas to generate an entirely new concept.

The method of crap shoot is possibly the most traditional brainstorming method we used. Synonymous with derivations such as the random ideation method, the crap shoot method is simply conceptualizing the first thoughts that come to mind when

considering the project as a whole. While this method may seem trivial, it produces and promotes out-of-the-box thinking; which is the epiphany of brainstorming.

The last notable method we utilized is synectics, which incorporates problem analogies to create and validate solutions in a seemingly unrelated environment. By doing this, we stimulate creative out of the box thinking that energizes the team and creates a fun carefree environment while still generating results.

Generated Concepts

1. Robot that will climb the extendo pole and close the fuse switch. The motor will be battery powered and the device will directly attach to the already existing extendo pole
2. Drone that will hover and have a robotic arm to close fuse switch
3. Magnetic ports that can attract the ends of the fuse switch into the right spot to close
4. Redesign fuses to close automatically with a motor or actuator using electricity from the actual pole*
5. Redesign fuses to close automatically using a motor or actuator using an external battery provided by the linemen
6. Robot that drives power lines using hooked wheels inspecting and closing switches with robotic arm
7. Tripod system that can leverage the pole like a telescope mount
8. clamping robot with four wheels that climbs power pole and closes switch
9. Change the orientation of the fuse switch catch to face down to make closing easier
10. Wire the fuse switch down to the bottom of the pole to make closing occur at shoulder level
11. A three legged device with a motor powered wheel that can extend the pole and support it. It will have a way to manipulate the legs of tripod to adjust for terrain
12. A two legged device with motor powered wheels that can extend the pole and support it*

13. Vehicle bumper mounted robot arm that extends to close switch*
14. A vertical extendo stick with an arm at the end that attaches directly to the utility pole that can be lined up with the fuse switch and allow the user to only adjust the rotation of the device and the arm at the end.
15. A three legged device that can be placed directly under the switch with a remote controlled arm that can extend upwards and manuever the arm
16. A device that attaches around the utility pole and climbs to a reasonable height and extends an arm to close the switch
17. Voltage resistance inflatable material that can be filled up with compressed air to extend and close the switch
18. Portable Scissor lift to raise the user to the height of the fuse switch
19. Install a series of steps on the pole for the user to climb and close the switch
20. An extendo stick that has a bridge-like attachment so it can be rested against the pole while in use, similar to a pool cue bridge*
21. A collapsible stick that is powered by a piston and can be extended under the fuse to push it into place, works similarly to the arm of an excavator
22. A tripod system with a spring loaded wheel that can be extended using tent-like pin and slot system in the legs
23. The mount that holds the fuse switch has a pulley built in and the stick has a rope end that can loop it and be pulled on to close the switch.
24. A jet pack that the user can wear and propel themselves up to fuse switch to close it
25. Implement a rope and pulley at the top of each pole to help extend the current extendo stick to its full length closer to the fuse
26. Redesign the fuse switch to be at the top of the pole and have a more pronounced hook that a drone can easily hook and pull
27. The fuse switch is redesigned to be a smart device that break the circuit in the event of shorting, but can also be connected by bluetooth to a device that the linesman carry to troubleshoot
28. Drone that will hover with a fixed hookstick to close the switch.
29. Robot that climbs the pole with a robotic arm to close the switch.

30. Robot that climbs the pole with a fixed arm to close the switch.
31. Electromagnet fixed to the switch that can be activated.
32. Drone with an electromagnet strong enough to be activated and close the switch.
33. Robot that climbs the pole with an electromagnet that is strong enough to activate at the top and close the switch.
34. Redesign switch so that there is a motor that can be activated to close it at the bottom of the switch.
35. Redesign the hookstick to have a tripod at the button and a second stick attached to a hinge at the top so one direction of movement is fixed.*
36. Use the previous design, but have a belt running up the stick, and have the belt be withdrawn with a motor to close the switch.
37. Redesign the switch to have a motor connected to it and connect the motor to SCADA with a status. Allow SCADA to have control of the motor to close the switch.
38. Redesign the switch to be connected to a hand-crank at the bottom of the pole which can be used to close the switch.
39. Redesign the hookstick so that it is the same as solution 35, but use a hand-crank instead of an electric motor.
40. Have aliens use a very small hookstick while standing on a flying saucer to close the switch.
41. Coat a hawk's beak in an insulator and train it to close the switch.
42. Hire a convict with an insulated glove to close the switch by climbing a ladder.
43. Train monkeys with insulated gloves to climb the pole and close the switch.
44. Give the workers steroids so they are stronger and less affected by the stresses of using the current hookstick design.
45. Redesign the fuse so that the loop is bigger and thus, easier to hook
46. Redesign the fuses so that they are curved. When they blow, instead of swinging down, they will swing inward slightly. The top point of contact will be on the top curved side and the hook directly on the end to provide a more natural closing motion as well as a smaller range of motion

47. Train an army of squirrels to close the switch. 401k and personal protective equipment must be provided.
48. Design a robotic extendo pole with a tripod. When the tripod opens, it will anchor itself into the ground by pneumatic hooks. The pole can then be extended and controlled by remote joystick.
49. Design an apparatus that will use magnets that act as a gravitational maglock. When the fuse needs to be broken to prevent line overload, the magnets will disengage. We can then re-power the magnets to attract the fuse back into position. The fuse must be on guides.
50. Design an apparatus that utilizes a cable to pull the fuse back into position. The fuse will be on guides to accomplish this. The cable will be fixed to the pole as would a flag mast rope.
51. Design an apparatus of revolving fuses (think revolver cylinder). When one blows, it will slide down in its chamber. Once it is deemed safe to reconnect, the springs inside the cylinder will re-engage the fuse. If the fuse is bad, the cylinder will rotate to a new fuse
52. A stick that is supported with a wider base, extends straight in the air and uses a piston powered arm to extend and close the switch
53. Two extendable legs with rack and pinion gears to extend that support the weight of a stick while the end can be maneuvered
54. Two extendable legs that can extend with hydraulics while the butt of the stick is planted in the ground to move the end of the stick around
55. Two extendable legs that can extend using a pin and groove system similar to a tent setup
56. A stick that collapses like a tent pole and can be supported by extendable bipod legs
57. Tripod like system with linear actuator legs that holds onto the stick and allows the point of leverage to move
58. A redesign of the fuse switch that allows it to magnetically attach to the pole so the point of contact is easier to reach
59. A voice activated fuse switch that closes when the user yells “CLOSE CIRCUIT”

60. A set of robotic stilts that the user can lift themselves to within reach of the fuse switch
61. A slimmer and more lightweight stick that collapses like a tent pole with a V shaped catch on the end to close the switch with.
62. Give the workers lifetime gym memberships so they can get stronger and traditional fuse switching won't be so much of a strain on their bodies.
63. Remake extendo stick so that it is carbon fiber, it will have more rigidity and be more lightweight and have nearly double the strength to weight ratio
64. Utilize the Auburn concept with one spherical joint, stakes in the foot pedals, and a hand held remote control to adjust the legs.
65. A linear screw acutator design that will extend the pole use a motor at the base of the pole.
66. A single pole and cylinder attachment to the extendo pole that will allow the user to manuever the pole with more ease because the distance to the fulcrum is greater.
67. A system that leans against the utility pole with a cylindrical joint through a pole that can be manuever through user power..
68. A system that leans against the utility pole with a cylindrical joint through a pole that is motor assisted and can manuever though user power.

Fidelity Concept Selection Method and Tools

From the above list of concepts generated, the following 8 were pre-selected as showing the most promise. This was accomplished by a series of eliminations in tiered selection format. To elaborate, this means we took our 68 concepts and created 34 groups of two. Whichever concept from each group was selected advanced to the next tier and so on until the following 8 fidelity concepts were chosen.

Medium Fidelity Concepts: (5 selections)

1. Design a robotic extendo pole with a tripod. When the tripod opens, it will anchor itself into the ground by pneumatic hooks. The pole can then be extended and controlled by remote joystick.
2. Design an apparatus that will use magnets that act as a gravitational maglock. When the fuse needs to be broken to prevent line overload, the magnets will disengage. We can then re-power the magnets to attract the fuse back into position. The fuse must be on guides.
3. The fuse switch is redesigned to be a smart device that break the circuit in the event of shorting, but can also be connected by bluetooth to a device that the linesman carry to troubleshoot
4. Redesign the hookstick to have a tripod at the button and a second stick attached to a hinge at the top so one direction of movement is fixed
5. Design an apparatus that utilizes a cable to pull the fuse back into position. The fuse will be on guides to accomplish this. The cable will be fixed to the pole as would a flag mast rope.

High Fidelity Concepts: (3 selections)

1. Design an apparatus of revolving fuses (think revolver cylinder). When one blows, it will slide down in its chamber. Once it is deemed safe to reconnect, the springs inside the cylinder will re-engage the fuse. If the fuse is bad, the cylinder will rotate to a new fuse
2. Utilize the Auburn concept with one spherical joint, stakes in the foot pedals, and a hand held remote control to adjust the legs.
3. A three legged device with a motor powered wheel that can extend the pole and support it. It will have a way to manipulate the legs of tripod to adjust for terrain

Codes and Standards

The utility industry is heavily regulated by codes and standards and as a result, there are many guidelines that the group must stay within when designing a new device to close the fuse switches.

There are regulations on the distances that each phase of cable must be from each other and this will rule out some of the possible designs where the switch is being moved closer to the top of the pole. This also prevents some solutions where drones or devices closing the switch from above would not be able to access the fuse switch because of interference with other lines.

OSHA also regulates the distance that a linesman can safely work on a power line with the shortest being 1 meter for lines between 0 and 75 kVA and increasing as the line becomes more powerful. This regulation is only for trained linesmen, and there are separate guidelines for civilians.

For overhead lines between 0 and 50 kVA, there must be at least 10 feet of distance between the line and the area that can be accessed by civilians, and the distance increases as the line becomes more powerful. This rules out designs where the fuses are moved to lower access points.

OSHA also regulates the stick to be tested at 75kV per foot of length for at least 1 minute to ensure safety of the users. This must be taken into account when selecting the material of the device.