Shieldy Bot - From Concept to Design

Roak Ely, Mark Cieslikowski, Mekai Ely
Lincoln BCBs Team 07-0047
Coach: Linda Reynolds teckteacher@yahoo.com

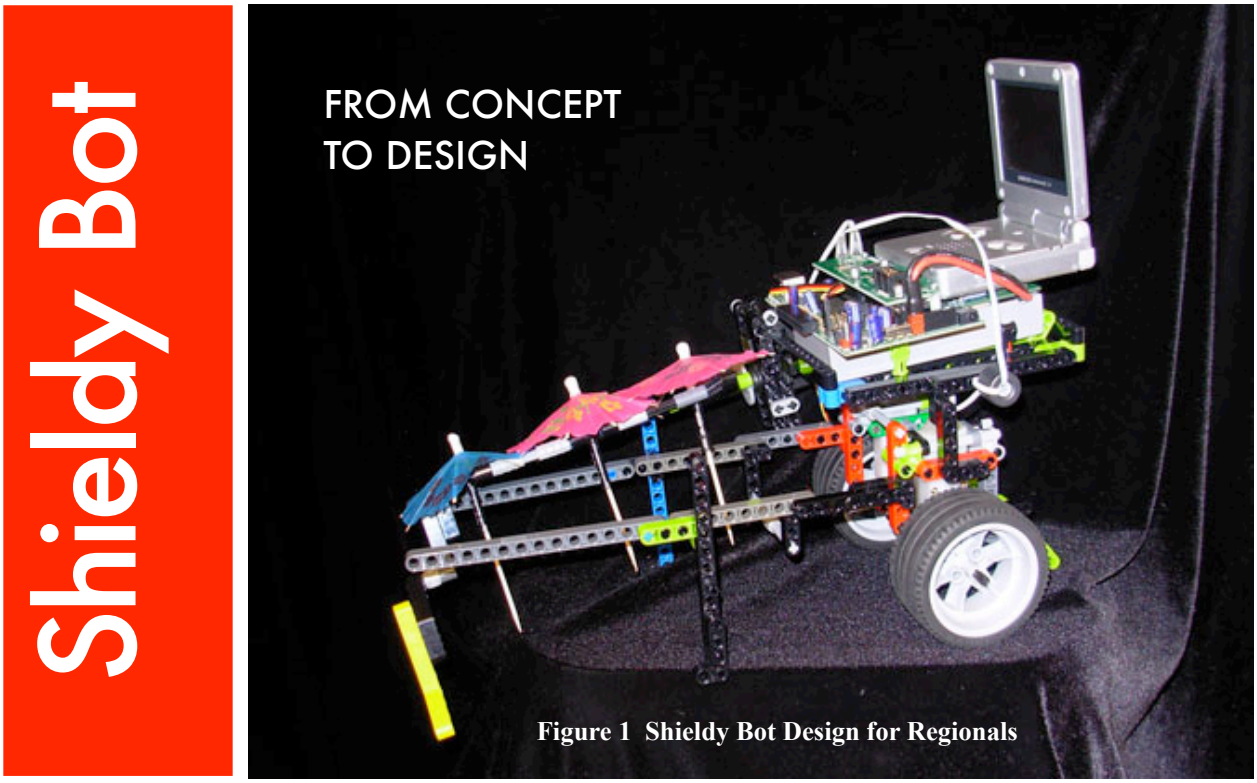


Figure 1 Shieldy Bot Design for Regionals

1. The Mission

Shieldy Bot's mission is to gather the 3 huts and place the lava shields inside them. After gathering the huts Shieldy Bot then returns to the starting box. The reward for this is 24 points!

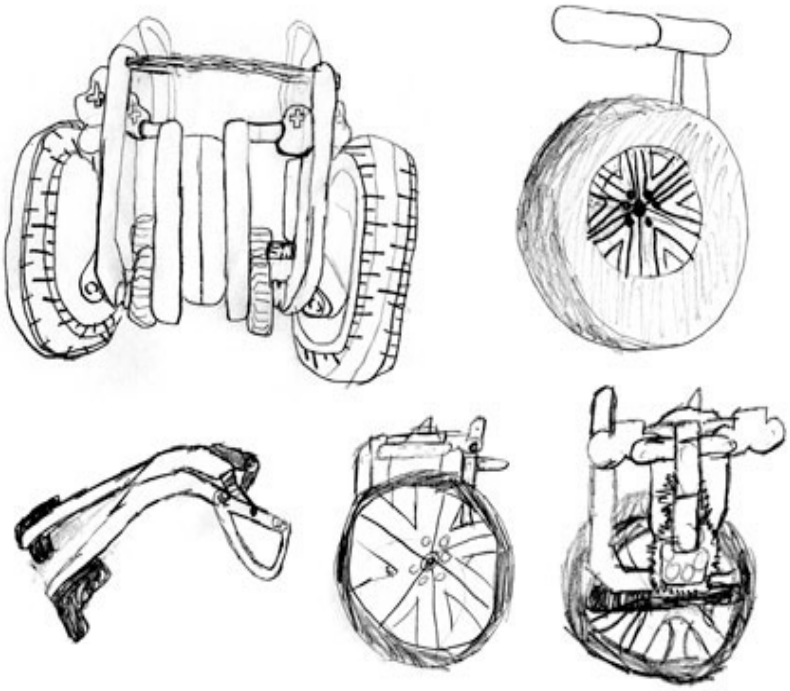
2. The Concept

Shieldy starts out carrying the shields in its arm. See Figure 1. After gathering the 3 huts inside the front cradle, a servo arm moves the shields into scoring position. At the same time the front arm of the cradle closes. Shieldy then just backs up and pulls the huts along and backs into the starting box.

3. Wheels and Gear Train

We made the wheels so that they can come apart. If one breaks we can swap it out easily. We wanted to give the robot some strength so we designed a gear train. We used the 12 tooth bevel gear meshed with the 20 tooth bevel gear. This gives us a gear ratio of 12 to 20 or 3 to 5. The smaller gear turns 5 times to the bigger gear turning 3 times. The wheel assemblies attach together at the bottom of the robot. See Figure 2 for design concepts.

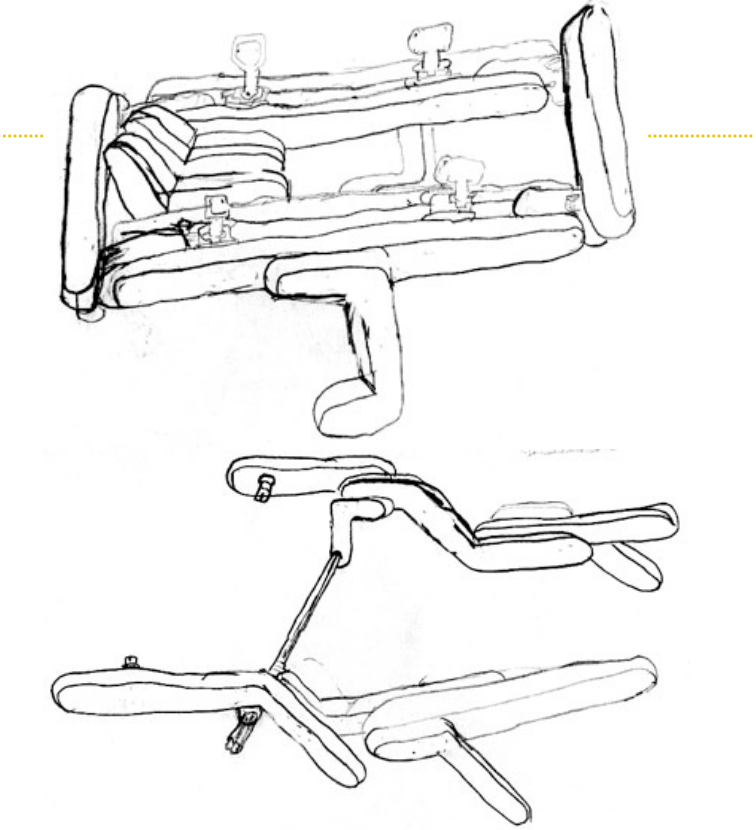
Figure 2 Concept Drawings



The gears are attached to the white motors and enclosed in a housing. The motors are positioned with the wire ends up. We 1st tried to lay the motors down horizontally, but the wheel clearance was not enough.
Since the wheel assemblies can come apart we had to add a connecting piece from one side to the other so that the wheels wouldn't come apart when we didn't want them to. We also had to attach a 3 x 7 angle beam to keep the robot from falling backwards and make it more stable. See Figure 3 for prototypes.

Figure 3 Prototypes: Wheel Assembly and Gear Train

Figure 4 Design Concept: Chassis and Cradle



4. Chassis and Cradle

The chassis is the part that holds the xbc and attaches to the wheel system. Other systems, like the arm and cradle attach to the chassis. In building the holder for the xbc we learned that you have to plan and organize the pieces to make them the right size. One size doesn't fit all. We started with the pieces that attach the holder to the robot. Then we build the sides and then filled in the middle with the angled pieces. The xbc fit in there but it slid sideways so we put pieces on the sides to hold the xbc. See Figure 4 for design concepts.

Figure 5 Prototypes: Chassis and Cradle

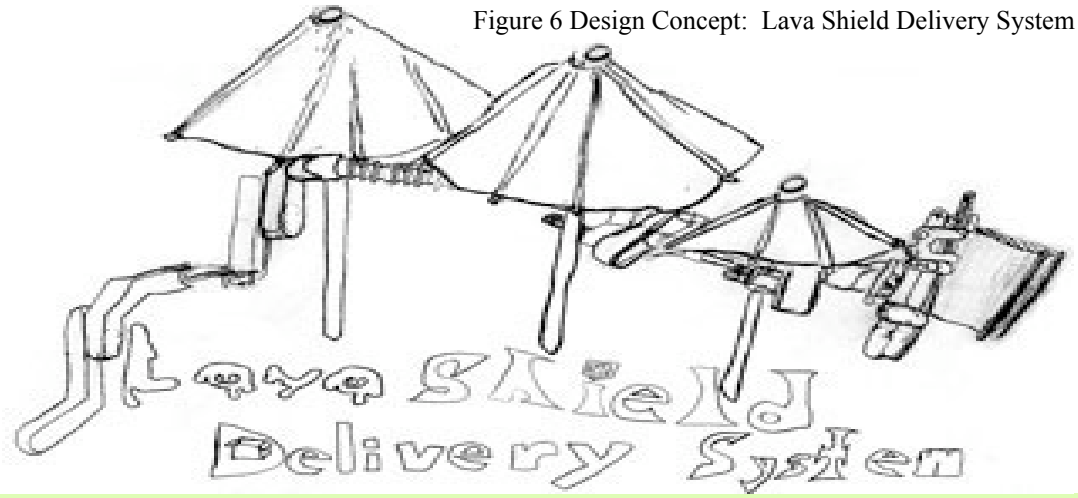
The xbc fit but just moved the pieces on the sides. So we had to come up with a design that would move the sides one half of a single beam. We used the 3 x 3 flat angle piece with a 3 liftarm. This worked well. The xbc fits perfectly.

The size wouldn't let us put something at each end to hold the xbc in, so we decided to tilt the chassis up on one end. The xbc fits in and slides to the back.
See Figure 5 for prototypes.

5. Lava Shield Delivery System

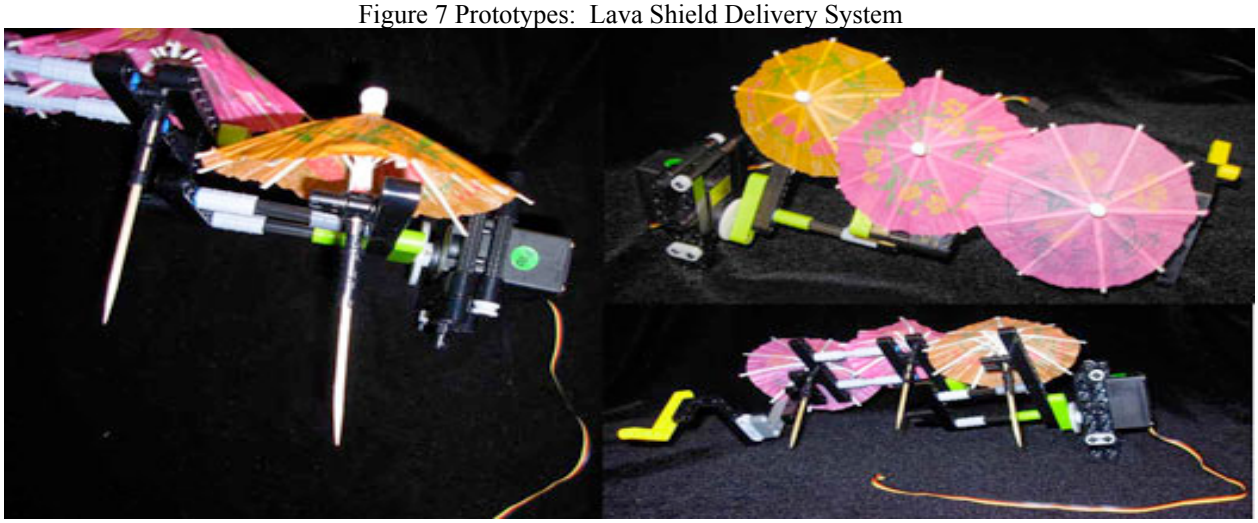
Robot 1 starts off carrying the 3 lava shields on an arm in the front. The arm is designed to put the lava shields into the huts. The arm is operated by a servo motor attached to the right side of the robot. The arm starts in the up position high enough for the end of the shields stick to be above the top of the huts. At the end of the arm there is a structure designed to make the huts stay with the robot. The entire arm rotates with just one movement of the servo placing the shields in the huts and closing off the end catching the huts inside the cradle. See Figure 6 for design concept.

Figure 6 Design Concept: Lava Shield Delivery System



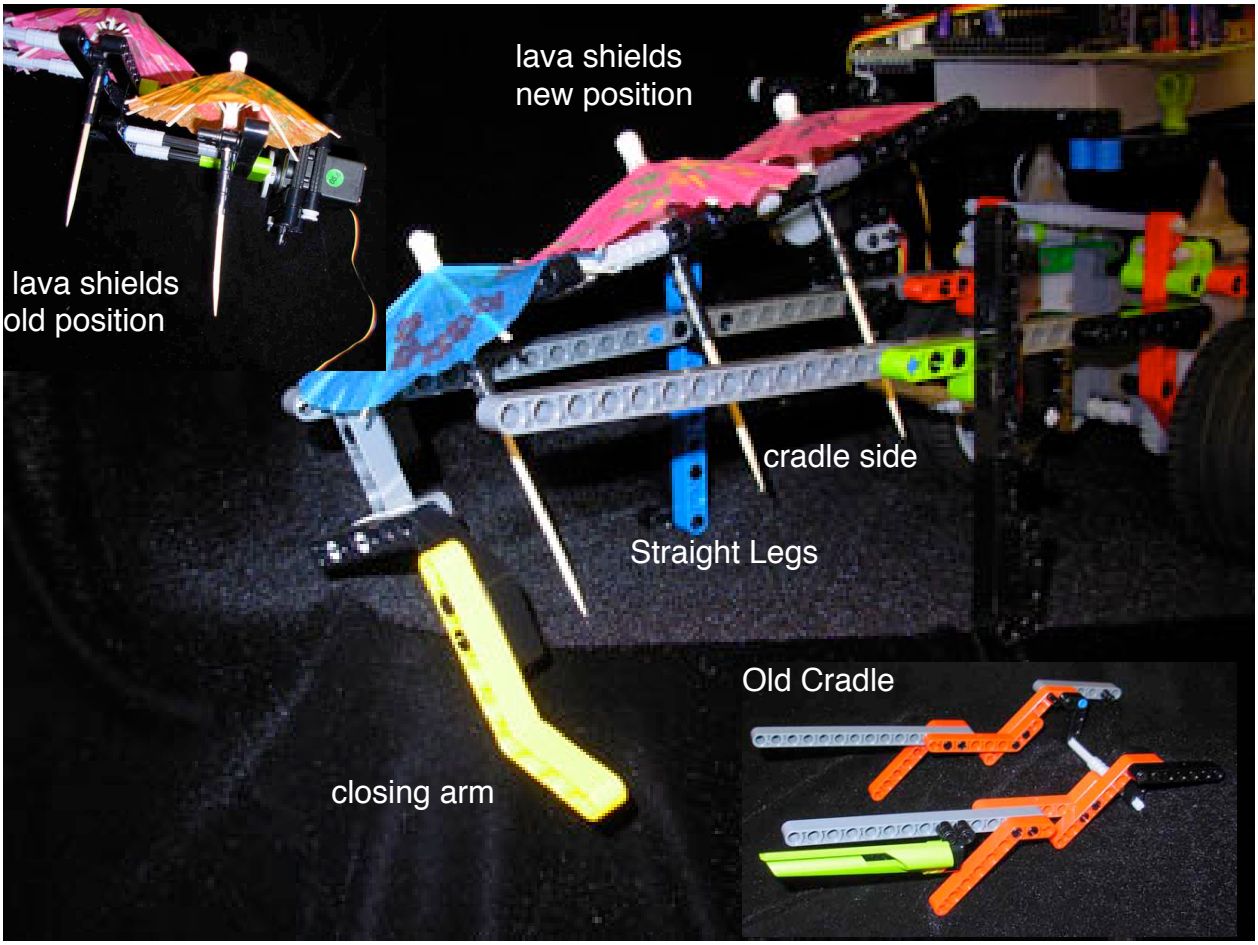
This allows the robot to move backwards and move the huts. This strategy was designed so the robot didn't have to turn around to return to the starting box. The shields come down at an angle so we had to adjust the position of each shield to get it in the corresponding hut. We did a lot of tests by moving the arm by hand to see just how it lowered the shields. The two shields farthest from the robot had to be raised because the arm leans down as it goes out from the robot. When the arm was raised the shield kept moving around and sometimes fell off. We knew we needed to attach the shields tothe arm but couldn't find a lego piece that held them on tight. Finally after trying a lot of pieces we found that the long black pin fit tightly over the umbrella stick. See Figure 7 for prototypes.

Figure 7 Prototypes: Lava Shield Delivery System



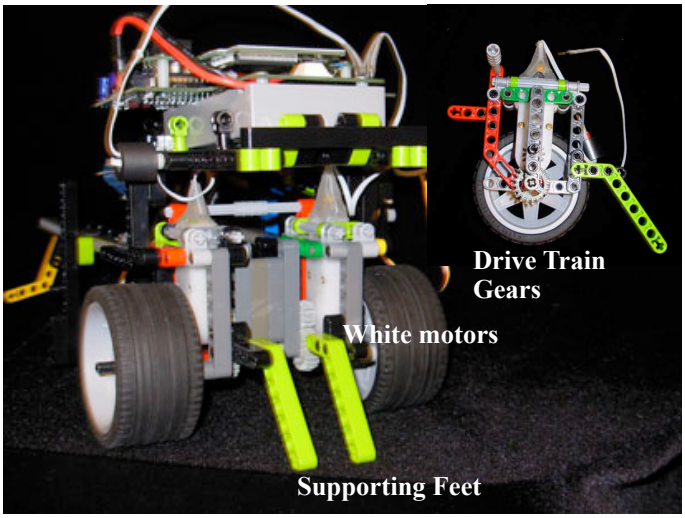
6. Design Changes

Figure 8 Design Changes: Lava Shield Delivery System



Here you can see the arm that carries the lava shields and also the cradle that collects the huts. We made three very important changes to the arm and the cradle. You can see in this picture that the shields (umbrellas) are sitting so that the sticks are about the same length. In our first prototype the first shield nearest to the robot was sitting lower. This came about because all the shields were lower in the beginning and because the arm leaned down towards the front the two shields on the end would miss the huts. So we raised them up, but for some reason not the 1st one near the robot. It took several simulations and trial runs before we realized that all of the shield needed to be equal in height. Then the sticks enter the huts. At the end of the arm you can see the closing piece that locks the huts inside the cradle. We had to change this piece and move it up and out in order to keep the huts from slipping out and to make sure that the arm went down and didn't hit the huts. We found that we needed to change the cradle for the huts on robot 1 because the legs were not very stable. The original legs were slanted and short and would cause the robot to breach went it would take off. The way they sat on the floor made the robot jerk and make a loud squeaking noise. So in the new design we decided to make the cradle longer and put the legs in the middle. The legs are straight with L brackets as feet. This works much better. See Figure 8 for design changes.

Figure 9 Drive Train / Supporting Feet



ShieldyBot has a geared drive train. You can see it here in Figure 9. The wheels are attached to axles in the medium bevel gears. We used the white motors. This drive train has worked very well. We have had no problems with it. The only change that we have made was back in the very beginning. We started with the large bevel gear meshed to the medium bevel gear. Then we changed it to the small bevel gear meshed with the medium gear. The reason for this was the position of the gears in relationship to the wheels. The only other change to any of the drive train is the supporting feet. The yellow bent lego beams you see at the bottom on the robot under the white motors. We had to try several different pieces to get the ones that would give support but wouldn't drag on the table. The changes in the robot in the past few days have been very good. For instance, we made changes on the wires. We changed one wire and put it in with the other wire on the same side. We also fixed the wheels because they were coming out and we needed to fortify them. We added longer axles.

Figure 10 Chassis

ShieldyBot has a great chassis. You can see the four axle connectors that hold the xbc in place in Figure 10. (two green, one black, and one grey). We changed these several times before finding these pieces that work very well. They are bigger at the top than where they connect to the beam holding the xbc in place better. The ferrous beads have a pin in them that is connected to a hole in one of the side beams. This keeps them out of the way.

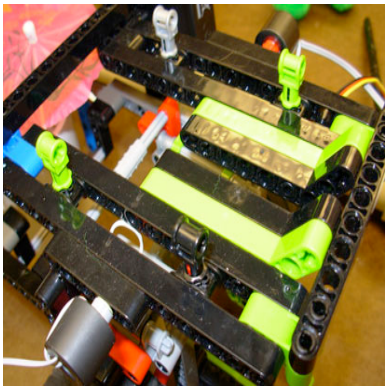
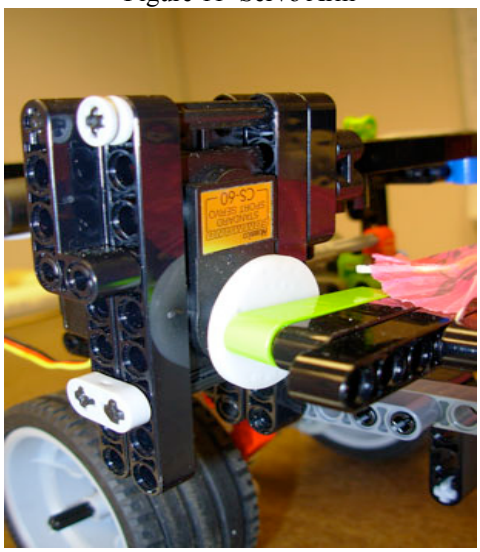


Figure 11 Servo Arm



The shield arm is attached to a servo. It is screwed right on to the round servo horn. Then a LEGO beam is attached to that one and finally the arm is attached to the 2nd beam. These are the two black beams in Figure 11. You can also see how the servo is held in place with axles catching the servo and then beams connecting the axles so they cannot move. L brackets hold the two side together and the whole thing is pinned onto the chassis side beams. This is the 3rd design for this servo. It is stronger and more reliable than the other 2 designs. The servo could move slightly on the other two and this caused problems when the arm moved up and down.