B9 Robot Construction

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2 SUPPLIERS

The information below contains an itemized list of the components that I purchased for the B9 robot and where I obtained each component.

2.1 Belly Lights

The belly lights utilize standard T3 1/4 sockets and are made by Osram/Sylvania. I decided to utilize 24 VDC and 12 VDC in the B9 robot since I was controlling the robot with an Allen-Bradley PLC (Programmable Logic Controller). PLC's utilize 120 VAC, 24 VDC, and relay contact closures as their native outputs. They typically utilize 120 VAC and 24 VDC levels for inputs. 12 VDC work in most instances but it is at the lower end of the input/output module voltage range. Since I utilize 24 VDC for everything possible, I purchased 24 VDC LED bulbs from Allied Electronics along with the Osram lights. The Osram lights will accept several different colored lens types.

Note: When installing the belly lights I had to grind down the nuts that hold each light in place since the pointed section of each nut would interfere with tightening down the adjacent light. I did this on my belt sander using pliers to hold the nut since it will get hot enough to burn you while grinding/sanding. I also did not use the retaining washer.

Manufacturer	Purchased	Description	Part #	Qty
Osram	Allied Electronics	Socket; T2 1/2 & T3 1/4 Miniature Bayonet; Front to Panel to End; Panel	31099/32173-0	14
Dialight	Allied Electronics	Lamp; LED; T-3 1/4; Mini Bayonet(BA9s); White; Clear; 28V; 7.5mA; 412mcd; 100K Hrs; NonPol	586-2406-205F	14
Osram	Allied Electronics	Lens; Dome, Fluted, Red	30120	3
Osram	Allied Electronics	Lens; Dome, Fluted, Green	30122	3
Osram	Allied Electronics	Lens; Dome, Fluted, Amber	30126	3
Osram	Allied Electronics	Lens; Dome, Fluted, Clear	30125	3
Osram	Allied Electronics	Lens; Dome, Fluted, Blue	30124	3
Osram	Allied Electronics	Lens; Dome, Transparent, Amber	30111	2
Osram	Allied Electronics	Lens; Dome, Transparent, Yellow	30114	2

2.2 Dialight Reproductions

The Dialight reproductions are for the lens and cap (you get two units). They are of excellent quality and finish. I found a few old indicator lamps at SkyCraft that can screw onto the reproduction units.

Manufacturer	Purchased	Description	Part #	Qty
Pat Burns	Pat Burns	Dialight Chest Light Reproductions		1
	SkyCraft	Sockets to fit Dialight Chest Light reproductions lenses		2

Norman Sockwell had a set of the original Dialight units that I ended up using. The reproductions are excellent but since the originals just fell into my lap, I could not pass them up. The lens mounting for the reproductions and the originals is the same. Since I wanted the option to have white lights or a red and a green one, I removed the base portion and used epoxy to mount the Osram socket (belly light socket) to each assembly. This method allows me to change the lens color located on the socket any time I wish. The Osram socket and light is mounted behind the white Dialight lens.

2.3 Neon Back Plate

Manufacturer	Purchased	Description	Part #	Qty
David Huber	David Huber	Neon Back Plate		1

2.4 Brain

Manufacturer	Purchased	Description	Part #	Qty
Mike Burrill	Mike Burrill	Steel Brain		1

2.5 Bubble

Manufacturer	Purchased	Description	Part #	Qty
Fred Barton	Fred Barton	Acrylic Bubble		1

2.6 Neon

Manufacturer	Purchased	Description	Part #	Qty
Craig Reinbrecht	Craig Reinbrecht	12 Row Neon		1

2.7 Programming Bay / Rails

Manufacturer	Purchased	Description	Part #	Qty
Craig Reinbrecht	Craig Reinbrecht	Programming Bay Complete Lower Torso Package with Side/Rear Rails		1

2.8 Torso Chest Light Bezel & Button Kit

Manufacturer	Purchased	Description	Part #	Qty
Craig Reinbrecht	Craig Reinbrecht	Bezel & Button Kit		1

2.9 Clear Acrylic Button Backer

Manufacturer	Purchased	Description	Part #	Qty
Craig Reinbrecht	Craig Reinbrecht	Clear Acrylic Button Backer		1

2.10 Aluminum Knob / Microphone Rings

Manufacturer	Purchased	Description	Part #	Qty
Craig Reinbrecht	Craig Reinbrecht	Aluminum Knob / Microphone Torso Rings		1

2.12 Collar

Manufacturer	Purchased	Description	Part #	Qty
Greg Logue	Greg Logue	Collar		1

2.13 Radar Animation Kit

Manufacturer	Purchased	Description	Part #	Qty
Greg Logue	Greg Logue	Radar Animation Kit		1

2.14 Torso/Donut

Manufacturer	Purchased	Description	Part #	Qty
Mike Joyce	Mike Joyce	Torso & Donut		1

2.15 Torso Knob

Manufacturer	Purchased	Description	Part #	Qty
Mike Joyce	Mike Joyce	Torso Knob		1

2.16 Power Pack

Manufacturer	Purchased	Description	Part #	Qty
Immortal Creations	Immortal Creations	Power Pack		1

2.17 Microphone

Manufacturer	Purchased	Description	Part #	Qty
Immortal Creations	Immortal Creations	Reproduction Microphone		1

2.18 Crown

Manufacturer	Purchased	Description	Part #	Qty
Immortal Creations	Immortal Creations	Crown		1

2.19 Claws / Wrists

Manufacturer	Purchased	Description	Part #	Qty
Immortal Creations	Immortal Creations	Claws/Wrists		1

2.20 Legs/Knees

Manufacturer	Purchased	Description	Part #	Qty
Norman Sockwell	Norman Sockwell	Fiberglass legs and knees		1

2.21 Treads

Manufacturer	Purchased	Description	Part #	Qty
Norman Sockwell	Norman Sockwell	Flat Style Treads		1

2.22 Wheels

Manufacturer	Purchased	Description	Part #	Qty
Norman Sockwell	Norman Sockwell	Aluminum CNC Wheels with lighting holes		1

2.23 Neck & Arms – Silicone Rubber

Manufacturer	Purchased	Description	Part #	Qty
Will Huff	Will Huff	Neck & Arms		1

2.24 Neck & Arm Support Rings

Manufacturer	Purchased	Description	Part #	Qty
Greg Logue	Greg Logue	Neck & Arms		1

2.25 Tread Section

Manufacturer	Purchased	Description	Part #	Qty
Eric Johnson	Eric Johnson	Steel Tread Section		1

2.26 PLC (Programmable Logic Controller)

Manufacturer	Purchased	Description	Part #	Qty
Rockwell Automation	Rexel Consolidated	SLC-500 with Flex I/O		1

This is an expensive item that is being phased out with CompactLogix & ControlLogix PLC controllers. Since I do this for a living, I tend to have older PLC hardware sitting on the shelf.

2.27 Waist Rotation Servo Drive & Motor

Manufacturer	Purchased	Description	Part #	Qty
Rockwell Automation	Rexel Consolidated	Ultra 3000 Indexer Servo Drive		1
Rockwell Automation	Rexel Consolidated	TL servo motor		1

This is an expensive item but since I had one sitting on the shelf, I figured I would put it to good use.

2.28 Brain Led's

Manufacturer	Purchased	Description	Part #	Qty
Cointaker	Cointaker.com	LED's		Several

2.29 Audio Playback/Storage

I am using this for my entire audio playback as well as driving the speaker(s) using the onboard amplifier built into the CFSound III. I control the phrases using the serial interface. The PLC generates the appropriate serial commands.

I use the CFSound III sound system for audio playback. Since I am using a PLC for control of the system, I initiate all triggers to the CFSound III sound system via the serial port. This allows me to initiate a myriad of audio files via a simple connection. The benefit of utilizing serial control is that you only need to purchase the basic CFSound III sound system without the input and output option boards. I even programmed the Detent + and Detent – pushbuttons to initiate the volume up and down press that you normally do from the front of the CFSound III sound unit.

Manufacturer	Purchased	Description	Part #	Qty
CFSound	ACSCONTROL.com	CFSound III	ACS-CF-CFSoundIII	1
CFSound	ACSCONTROL.com	4 Gig Compact Flash Card	ACS-CF-CARD-4GIG	1

2.30 Speakers

Manufacturer	Purchased	Description	Part #	Qty
CFSound	ACSCONTROL.com	4" Dual Cone Full Range 50 Watt 10oz Magnet	ACS-SPEAKER-GM-65-8	2

2.31 Neon Control

Manufacturer	Purchased	Description	Part #	Qty
Tech 22	Tech 22	Transformer		1
Tech 22	Tech 22	Audio Interface		1

2.32 Radar Ears

Manufacturer	Purchased	Description	Part #	Qty
Immortal Creations	Immortal Creations	Radar Ears		1

2.33 Radar Ear Motors

The radar ear motors are miniature metal gear motors - 60 RPM, 6 VDC. I am powering them via 7805 voltage regulators. The reduced voltage will result in lower motor torque and RPM. This is not a problem since they are just turning the spinners.

Manufacturer	Purchased	Description	Part #	Qty
Pololu Robotics & Electronics	www.pololu.com	Ear Spinner Gear Motor	1096	2

2.34 Radar

Manufacturer	Purchased	Description	Part #	Qty
Greg Logue	Greg Logue	Radar		1

2.35 Radar Ear Spinners

Manufacturer	Purchased	Description	Part #	Qty
Immortal Creations	Immortal Creations	Radar Ear Spinners		1

2.36 PVC Waist Plate/ Laser Cut Gears

Manufacturer	Purchased	Description	Part #	Qty
Andy Schwartz	Andy Schwartz	PVC Waist With 16” Hole		1
Andy Schwartz	Andy Schwartz	18” Laser Cut Waist Gear	FR-04	1

2.37 Lazy Susan Bearing

Manufacturer	Purchased	Description	Part #	Qty
Lee Valley	Lee Valley	17-3/8" Lazy Susan Bearing	12K6817	1

2.38 Torso Hooks

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Torso Hooks		1

2.39 Brain Cup

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Brain Cup		1

2.40 Light Rod Kit

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Light Rod Kit		1

2.41 Neck Bracket

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Neck Bracket		1

2.42 Light Rod Cam

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Light Rod Cam		1

2.43 Crown Shaft

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Crown Shaft		1

2.44 Brain Motor

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Motor		1

2.45 Brain Motor Plate

Manufacturer	Purchased	Description	Part #	Qty
Jerry Chevalier	Jerry Chevalier	Motor Plate		1

2.46 Cat Eyes

Manufacturer	Purchased	Description	Part #	Qty
Gary Oiley	Gary Oiley	Brain Cat Eyes		1

2.47 Connectors

Manufacturer	Purchased	Description	Part #	Qty
Zip Port	Automation Direct	Insert 16B 16 Pole Male Screw Terminal	ZP-MC16B-1-MS016	3
Zip Port	Automation Direct	Insert 16B 16 Pole Female Screw Terminal	ZP-MC16B-1-FS016	3
Zip Port	Automation Direct	Hood 16B Side Entry Pg21 Metal	ZP-MC16B-2-SSW21M	3
Zip Port	Automation Direct	Base BulkHead Metal	ZP-MC16B-2-SBHM	3
Zip Port	Automation Direct	Insert 24B 24 Pole Male Screw Terminal	ZP-MC24B-1-MS024	2
Zip Port	Automation Direct	Insert 24B 24 Pole Female Screw Terminal	ZP-MC24B-1-FS026	2
Zip Port	Automation Direct	Hood 24B Top Entry Pg21 Metal	ZP-MC24B-2-STE21M	2
Zip Port	Automation Direct	Base BulkHead Metal	ZP-MC24B-2-SBHM	2
Zip Port	Automation Direct	Cable Gland Pg21 Dia 9.5-18.5mm	ZP-MC-CG-21M5	5

The connectors are used to remove the torso quickly by disconnecting the wiring for the lights, power, etc.

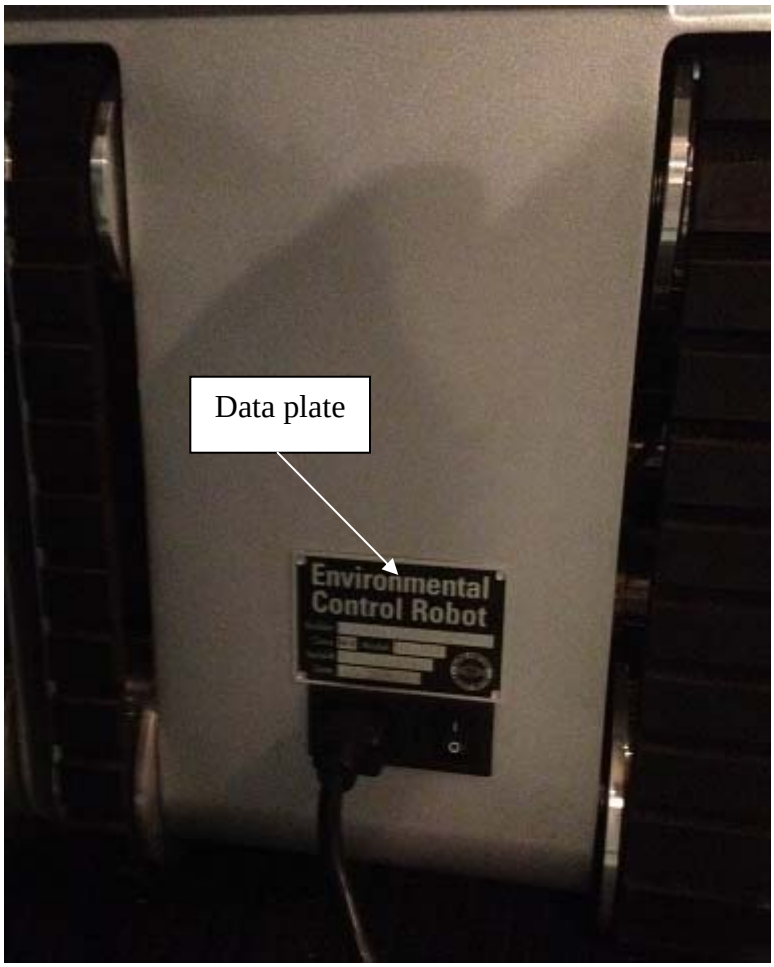
2.48 Data Plate

Manufacturer	Purchased	Description	Part #	Qty
Mark Newlon	Mark Newlon	Engraved Style 1 Data Plate	Style 1	1

To finish things off, I attached an engraved data plate I purchased from Mark Newlon. The data plate allows you to provide the following information:

Builder Info:
Model#:
Serial Number:
Date:

I placed the plate above the power connector and I used epoxy to affix the plate. I was going to drill and tap the plate into the tread section and utilize screws to attach the plate but I figured something would go wrong (like a tap breaking) and I did not want to push my luck at this stage. The data plate is a nice addition to the robot and adds a nice professional touch.



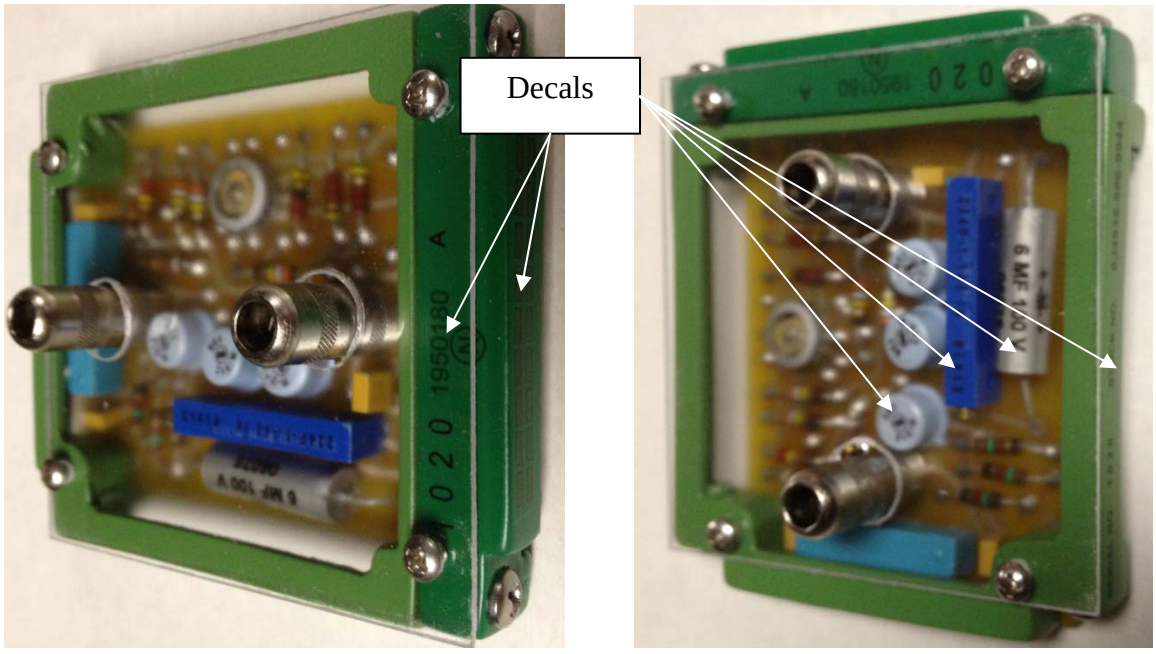
3 Power Pack

One of the first items to arrive was the power pack. This item was purchased from Immortal Creations as a kit and has all of the components included in the kit to make an exact replica of the power pack.

While I did not use an exact color match, I am happy with the results. The following paint colors were used.

Description	Paint	Purchased
Capacitor	Rustoleum Metallic	Home Depot
Modified 1/8" Connector	Rustoleum Metallic	Home Depot
Transistors	Valspar – Satin Encounter Spray	Lowes
Case	Rustoleum – Leafy Green	Home Depot
End Connector	Rustoleum – Meadow Green	Home Depot
5 Pin Connector	Valspar – Tropical Oasis Spray	Lowes
Clear Coat	Krylon Crystal Clear - Gloss	Auto Zone

I assembled all of the components in the kit. The clear plastic cover is not included. I printed the decals using the templates provided on the b9creations website listed in the construction tips area. Since my painting skills have a great deal to be desired, I created decals for the power connector terminals. Once the decals were on, I sprayed a coat of clear over the entire power pack. I bought the clear plastic cover piece at Lowes. You can find small pieces of plastic that can be used for the cover near the window isle. All that you need to do is cut to the appropriate size and drill the holes as shown. I used Papilo brand laser premium waterslide clear decal paper that I ordered from Amazon to make the decals.



Power Pack Installed

Power Pack plug in jacks

The power pack jacks were obtained from radio shack. I had to use a small round Dremel sanding drum to remove some of the interior surface of the Torso since the threaded area of the jacks were too short. Once this was done, I wired one of the jacks up with two wires so it acts like a switch when the power pack is inserted or removed.

4 Sensors/Spinners

The spinners and holders were purchased from Immortal Creations. They are fabulous. Once you sand down the spinner base casting, remove the attached screw and drill a small hole to accept the motor shaft (I used small brass tubing to make a motor shaft). Verify the spinner fits in the base properly. Once complete, the only thing left to do is paint the spinners and bases. Remember, only one side of each spinner is painted.

The following paint colors were used.

Description	Paint	Purchased
Spinner (Left Ear) – One Side Only	Dupli-Color Ceramic Yellow Engine Enamel	Advanced Auto
Spinner (Right Ear) - One Side Only	Dupli-Color Ceramic Chevrolet Orange-Red DE1607 Engine Enamel	Advanced Auto
Spinner Holders	Dupli-Color Paint Bgm0344 Gunmetal Metallic 8 Oz Aero	Amazon

The Spinners and sensors are shown below.

Robot Right

Robot Left

5 Brain

The brain was purchased from Mike Burrill. If you are thinking "I wish I only had a brain", get this one. The brain comes with 5 steel pieces that must be soldered together. The steel pieces do not require any cutting and can be put together fairly easily. Use a micro torch (my initial torch was from Harbor Freight) to get the steel hot enough to have the soldered applied. After the Harbor Freight unit stopped working, I just bought a quality miniature butane torch at Home Depot. An acetylene torch would be cumbersome. Once the steel pieces are soldered, the pieces are fused together. Since I soldered the pieces using a spot soldering technique, I filled in any non-soldered areas with JB weld (not required but I prefer overkill).

The following parts were used to assemble the brain.

Description	Usage	Purchased
Micro Torch	To heat metal pieces for soldering	Home Depot
Solder	Solder to fuse metal pieces	Home Depot
JB Weld	Used to fill spot solder gaps	Home Depot
1/8" Tap	To tap holes for the top of the brain plate. This was done so the top plate of the brain could be removed.	Home Depot

The brain was painted with Duplicolor Gunmetal paint. The old T177 paint code has been replaced with paint code BGM0344. The paint was obtained at Advance Auto Parts and Amazon.

Here is a picture of the brain.

Brain

6 Brain Lights

I wanted to have control of the brain lighting so that I could program any sequence that I wanted to.

To make the internal light assembly for the brain, I used the following components.

Description	Usage	Purchased
Orange 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Blue 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Red 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Yellow 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Pink 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Green 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Violet 555 Retro Led's	Brain internal lights as desired	Cointaker.com
Lamp Holder for Wedge Bulb	Led holder for internal brain lights	TwistedQuarter.com
4-40 screw & nuts	Mounting screws for Led holders	Radio Shack
Brain top lamp holders	Top of brain lamp holders -screw base	Radio Shack
12"x12" ABS sheet (1/8" thick)	Material to fabricate internal brain LED holder(s)	ServoCity.com

The retro lamps run at a maximum of 6 volts. Since I have a 24 VDC and 12 VDC power supply in my robot, I source 12 VDC power from a PLC output module to a board I made that has 7805 voltage regulators on it that convert each 12 VDC power output to 5 VDC. 10 VDC is the minimum voltage that PLC output modules will switch. Due to this fact, I needed to go the voltage regulator route for each output. The brain lighting board is configured in a triangular shape and a single output will control one LED on each side of the triangle. Each side of the triangle has 6 LED's. The 3 lights located at the top of the brain share a single output. The color arrangement in a clockwise fashion for the internal brain triangle is as follows.

1) Blue
2) Green
3) Red
4) Violet
5) Orange
6) Yellow

Notice the Blue LED's were installed at each corner. The blue LED's allow the Cat Eyes to be solid blue.

7 Brain Cup / Rods / Cam

Light Rods

I used red retro Led's purchased from Cointaker.com for the light rods. I soldered 28 AWG wire to the Led's and placed heat shrink around the base of the bulb for insulation. I placed a dab of hot glue on the heat shrink and they fit perfectly into Jerry's light rods. A great deal of effort was eliminated by using the system provided by Jerry. It is a well engineered system that works flawlessly. Each light rod also has its own PLC controlled output for each LED located in the rod.

Description	Usage	Purchased
Red 555 Retro Led's	Lights as desired	Cointaker.com

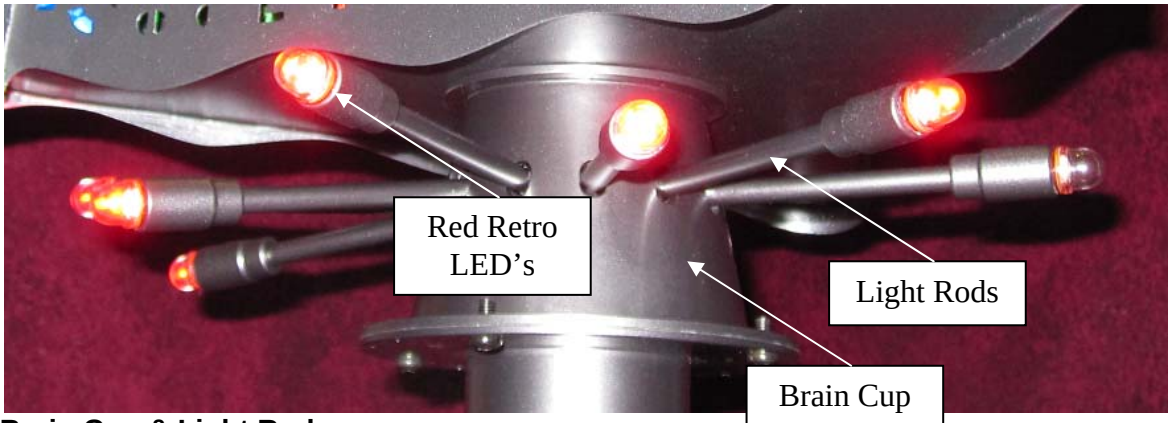
Brain Cup

The brain cup was purchased from Jerry Chevalier. The only thing I did was enlarge the pushrod holes slightly to allow the pushrods to smoothly move through the brain cup. I used a slightly larger drill bit than the holes that were installed originally in the Brain Cup.

Cam

The cam spins and is used to move the pushrods down which will move the light rods up. The weight of the light rods will allow them to move back down via gravity. The cam was purchased from Jerry Chevalier

The following picture shows the light rods with the LED's illuminated.

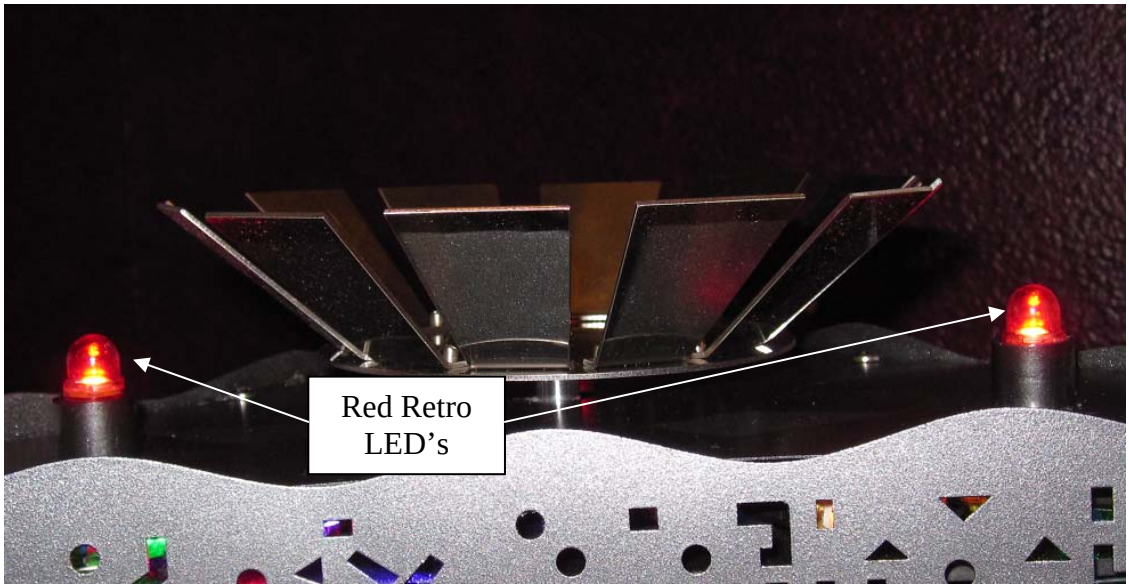


Brain Cup & Light Rods

8 Brain Top Red Indicators

The brain top indicators utilize (3) red retro LED's from Cointaker.com. I wired the LED's in series and power the series chain with 12 VDC. Since the LED's are rated for 6 VDC, this makes them slightly dimmer than the light rod LED's but very acceptable. I soldered 22 AWG wires to each 555 style bulb. I placed heat shrink around the bulb to act as an insulator. The sockets I used are just the normal radio shack bulb sockets that most of the builders use. I removed the inside of the bulb socket and used a dab of hot glue to attach the bulb in the socket.

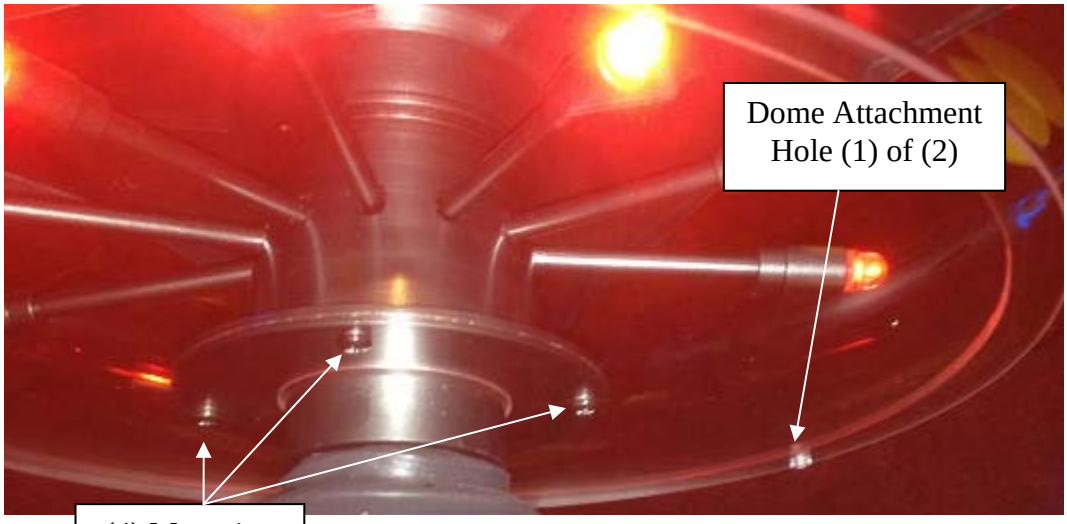
As you can see from the picture below, they look fine.



Construction Tip:
I initially used a heat gun to shrink the heat shrink to the bulb. The bulbs can obviously not take the heat and one of them did not work afterwards. From that point on I used a lighter to apply the heat shrink tubing to the bulbs.

9 Bubble

The bubble is a key component to the B9. I purchased the bubble from Fred Barton. The first bubble I received was crushed in shipping. Fred handled the return like a true professional. He sent me a return shipping label that I affixed to the damaged box and the return was painless. Fred told me he was out of bubbles at the time and said he would give me a refund or I could wait until he had some more units manufactured. Based on the clarity of the crushed bubble I received; I decided to wait for him to have more bubbles available. I am glad I waited since the new bubble I received was worth waiting for. I used drill bits that I ordered from TAP Plastics to drill the mounting holes. The larger center hole is already pre-drilled. I used 1/8" and 3/16" PlasDrill bits for making the mounting holes. I used the 3/16" bit for the (4) mounting holes that attach the brain cup to the curved piece that the dome rests upon. I also drilled (2) 1/8" holes for mounting the dome to the curved piece that the dome rests upon. The (2) holes in the lower piece were enlarged using the 3/16" drill bit. The (2) 1/8" holes in the dome were tapped using a 1/8" tap. I secured the dome using (2) 6-32 x 3/8" clear polycarbonate pan head machine screws. The screws were purchased from McMaster-Carr. The part number for a 50 pack of screws is 93140A146.



10 Torso Holes

The torso was purchased from Mike Joyce. The following areas on the torso will require cutting:

- Vent openings (4)
- Neon opening (1)
- Arm holes (2)
- Holes for the belly lights (12)
- Rectangular are for the teeth lights (1)

Holes for the power pack, torso hooks, microphone, and torso knob, and teeth light bezel will also need to be drilled.

Purchasing the torso will save you a lot of time and effort and is one purchase that should be made. The torso is a great piece offered at a fair price. Just be prepared that Bondo, sanding, etc. will be required in the areas where the torso seams meet.

Construction Tip #1:
While cutting out the vents, the fiberglass is thicker in different areas of the vent opening. I ended up using a Dremel tool circular cutting blade to remove the thicker area. I cut everything based on the line that was exposed on the black gel coat and used that as a guide. When I was done, I smoothed the edges with sand paper and used a Dremel rotary sanding attachment.

Construction Tip #2:
I used the speed bore bits that were suggested by a board member. The bits are available at Home Depot and are only a few bucks each.

Construction Tip #3:
I waited to cut my arm holes until the arms arrived from Will Huff. I wanted to be sure I cut the holes the correct size. Once the arms arrived, I realized that I needed to cut a 6" hole for each arm in the torso. I decide to order a 6" hole saw just for this purpose. I ordered the following parts. Since this would be a onetime use tool, I went for the cheapest solution I could find.

Quantity	Description	Usage	Purchased
1	Ridgid 7033 1-Piece, 6-Inch Bi-Metal Cryo Hole Saw	Cut Arm Holes	Amazon.com
1	MK Morse M45P 7/16-Inch Boxed Hole Saw Arbor Fits AV20-AV96	Cut Arm Holes	Amazon.com

11 Torso Rotation

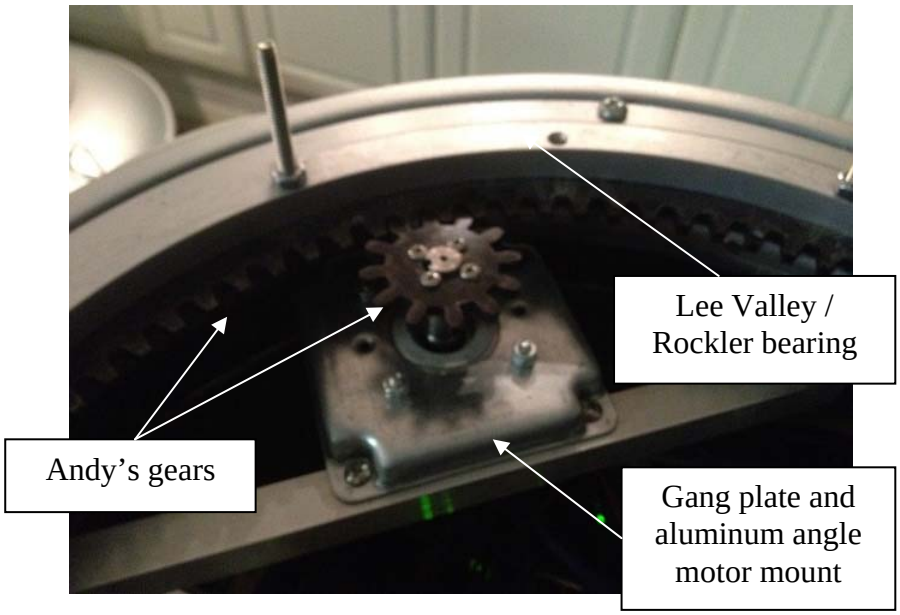
For the Torso rotation, I used the laser cut gears from Andy Schwartz and the Lee Valley/Rockler bearing.

I cut out the center of the donut supplied by Mike Joyce so I could mount the gear to the bottom side of the bearing. The six holes that are located in the bearing were drilled and tapped to accommodate 10-24 3" screws. The threads for the screws face upward toward the Torso and the hold the torso in place via matching holes drilled in the Torso. I do not put nuts on the screws since the screws keep the Torso aligned to the Donut. The Torso bottom was drilled with 6 identically spaced holes so it could be set on the upward facing screws. The nuts were added to provide the correct torso/bearing spacing so in retrospect, the holes do not need tapped.

For the rotation motor, I utilized an Allen-Bradley TL series servo motor that I already had. The shaft of the motor is 1/2 "so I ordered a 1/2 inch x 0.770 inch set screw hub from Servocity.com (item# H500-770). I aligned the small gear on top of the hub and drilled holes in the gear so the hub could be mounted to the gear (you need a total of four 6/32 screws).

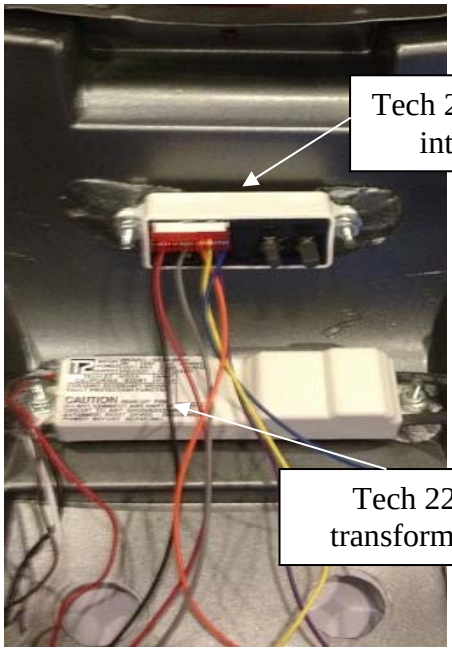
I used a four gang receptacle mounting plate with the center already drilled in it so I had a motor mount. I got the plate at Home Depot. I drilled four holes into the plate aligned with the holes on the shaft end of the motor. I affixed the motor to the new plate and installed the on the motor shaft. I aligned the motor to the gear mechanism and mounted the motor plate. I made a cross beam out of aluminum angle stock to aid in the support of the motor plate.

With the torso attached, the servo drive required additional tuning since the additional mass of the torso tended to create a situation where the servo would overshoot the target position and hunting would occur due to instability. I tuned the servo with everything attached to get the correct operation.

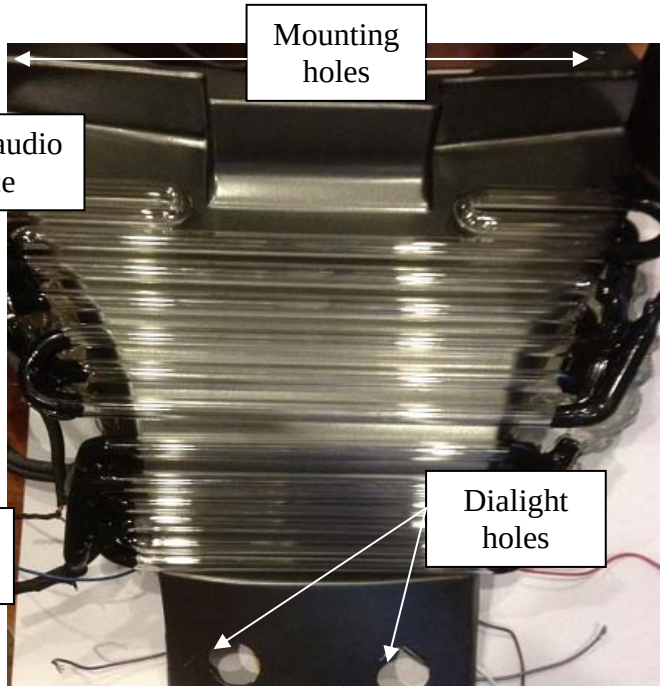


12 Torso Neon

I used the neon back plate that was supplied by David Huber. I trimmed the plate and attached mounting screws to the back of the plate to house the Tech22 neon transformer and audio interface. I also drilled two holes that allow the Dialights to pass through and act as a lower support for the neon assembly. I drilled two holes at the top of the plate to allow my Torso installed mounting screws to pass through.



Rear of Back Plate

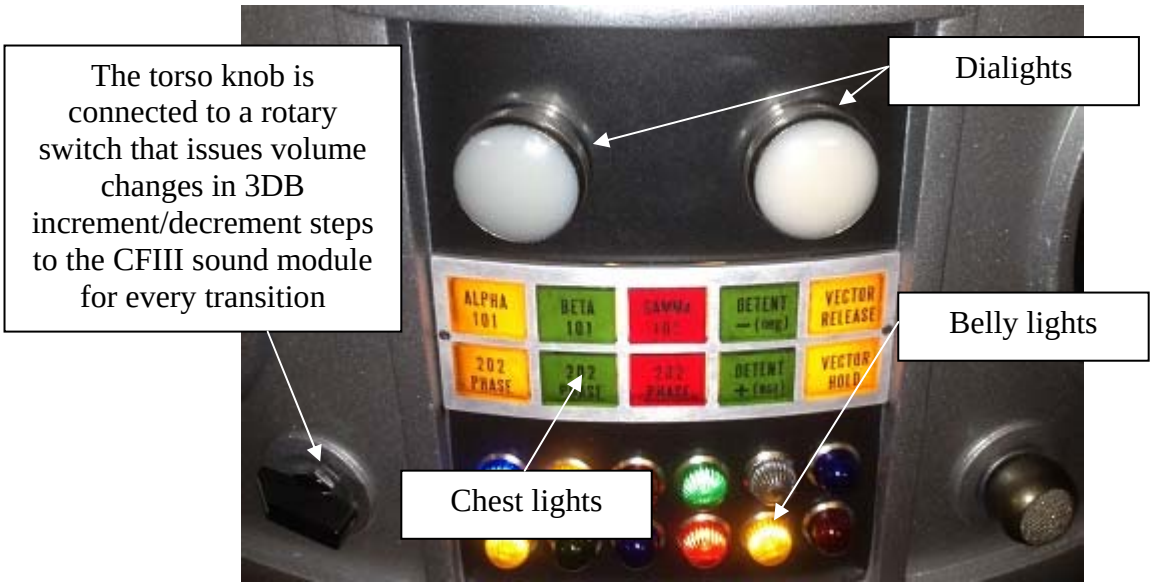


Front of Back Plate

The neon was obtained from Craig Reinbrecht. I noticed some slight beading in one of the neon sections. I installed the TIP transistor recommended to eliminate the beading. The transistor solved the issue most of the time. I notice slight beading every so often. Not a big deal since it is infrequent.

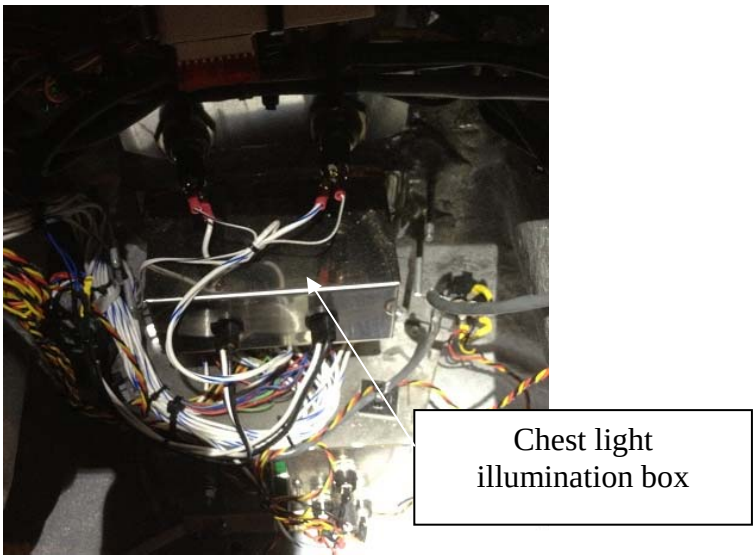
13 Torso Chest Lights/Bezel

The chest light and bezel kit is simple to put together and Craig provides instructions for what to do. I originally used pushbuttons for each chest light. This quickly became a cluttered mess and I decided to abandon the idea and install small hidden pushbuttons into the top section of the programming bay to initiate sequences.



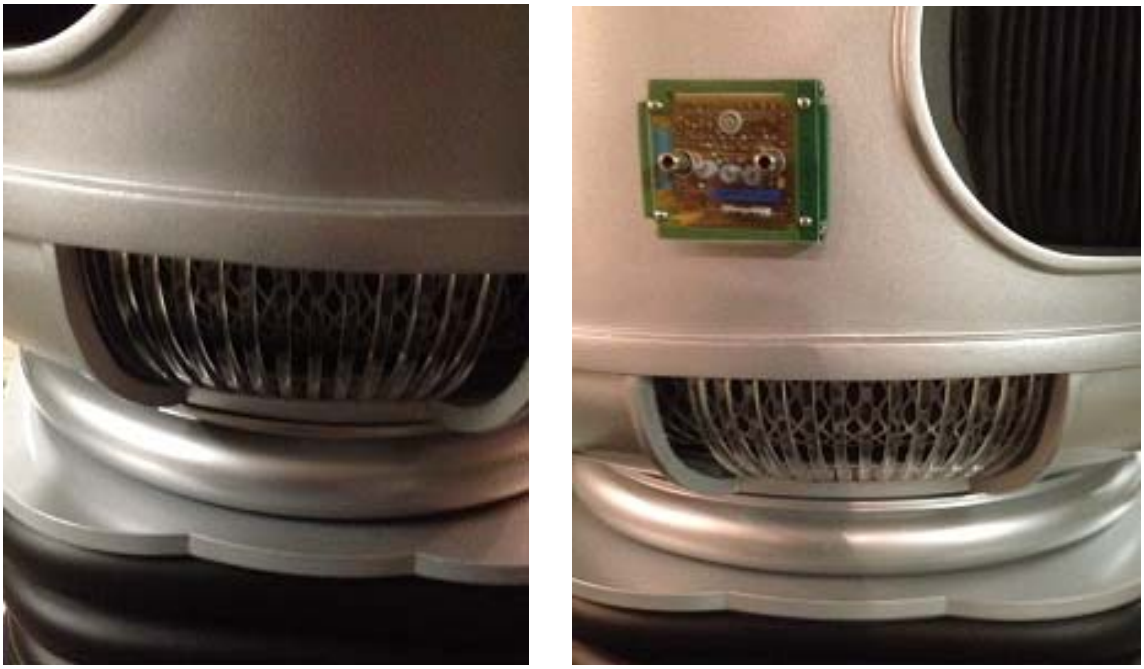
14 Torso Chest Light – Light Box

The torso chest lights utilize the light box that is sold by Bill Kendzierski & Rod Rickenbach. I changed the included bulbs to an LED 555 type. The box is an easy way to illuminate the chest lights provided by Craig Reinbrecht.



15 Torso Vents

I ordered the torso vents, mounting slides, and screening from Craig Reinbrecht. It is a perfect system. I used epoxy to attach the slide tracks to the torso. I formed a bend for the vent mesh and laid it into place on top of the slides. I then marked along the curve of the slide channel and cut the vent mesh to shape. Once the vent looked correct, I used spray glue on the back of the vent and attached some inexpensive black air conditioning foam I picked up at home depot. The foam for all of the vents was less than $1.25. I wrapped the upper and lower sections of the mesh with Velcro. I also attached Velcro to the upper and lower slide rails. I simply pushed the vent mesh onto the Velcro. The Velcro allows the vent screens to be removed easily if required.



Vents

16 Torso Hooks

The torso hooks from Jerry Chevalier were painted the same color as the torso. I did not do a thing to the torso hooks except a little tack cloth and paint.

Note: Each torso hook requires (2) 8/32" screws for mounting.

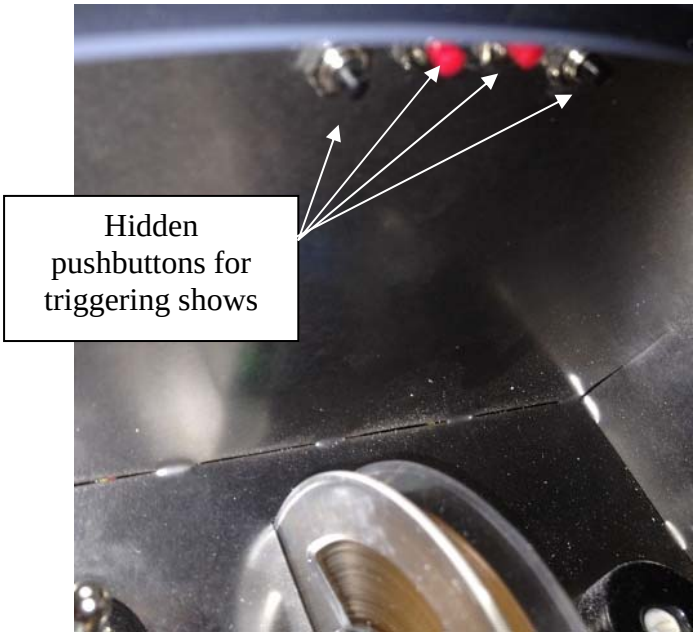
Torso Hook

17 Torso Programming Bay

I ordered the programming bay from Craig Reinbrecht. It is simple to assemble and includes everything that the original programming bay contained. The only thing I did was change the bulb to an LED version and install (4) hidden pushbuttons on the top section of the programming bay that are used to initiate sequences. The picture below illustrates the programming bay.

Completed Programming Bay

The picture below illustrates the location of the pushbuttons.



The pushbuttons are mounted at the top of the programming bay and out of the viewing area. I purchased them at Radio Shack. You can find them on the B9 based on feel.

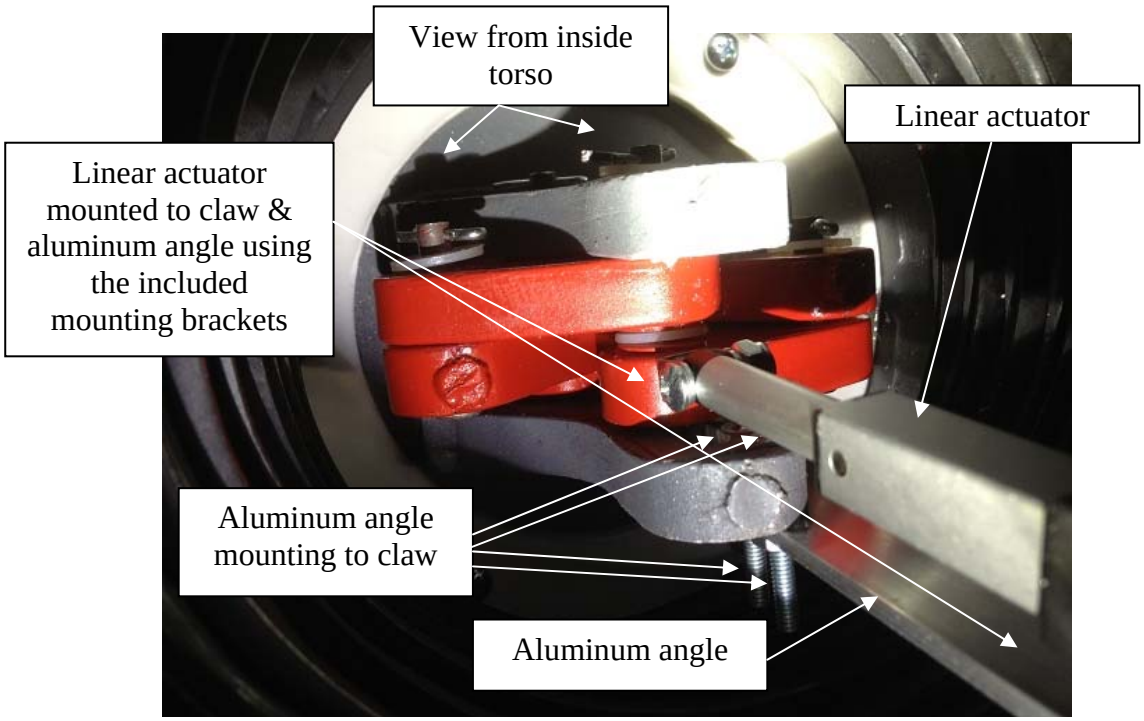
18 Claws & Wrists

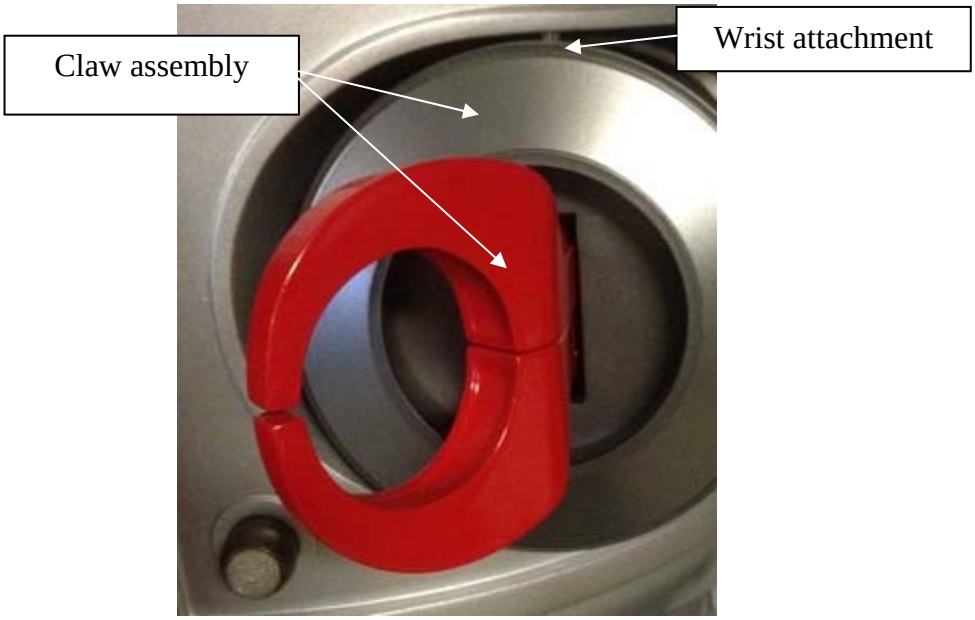
The claws and wrists were purchased from Bill Kendzierski & Rod Rickenbach. The parts require minor sanding and minimal body filler. I ended up painting the claws several times since every time I painted them, I would find a defect in my paint job. Perhaps I am too picky but they now look excellent.

Construction Tip #1:
I only painted one claw at a time since I wanted to make sure I had an assembled unit to look at for reference. I probably should have just taken a picture and worked on both at the same time. When putting the claw back together, do not mount the claws to the rotator and expect to slide them through the wrist. Take it from me, it will not fit. Before you paint, take one apart and put it back together. It is much easier to learn the assembly lesson while they are not finished.

Linear Actuators:
I wanted the claws to provide pinching movement under automatic control. The arms were to be set at a fixed distance (retracted) and would not be motorized. To accomplish the pinching effect, I utilized a linear actuator for each pincher. The actuator pulls and pushes on the linkage of the claw assembly to provide pinching motion. To mount the actuator, I affixed each claw to an aluminum angle and mounted each actuator to the aluminum angle. The aluminum is attached to a portion of the claw. The linear actuators are very small and the ones I used are listed below.

Quantity	Description	Usage	Purchased
2	L12-S Linear Actuator – 30mm – 100:1 – 12 VDC (L12-30-100-12-S)	Provide pinching motion for claws	www.firgelli.com





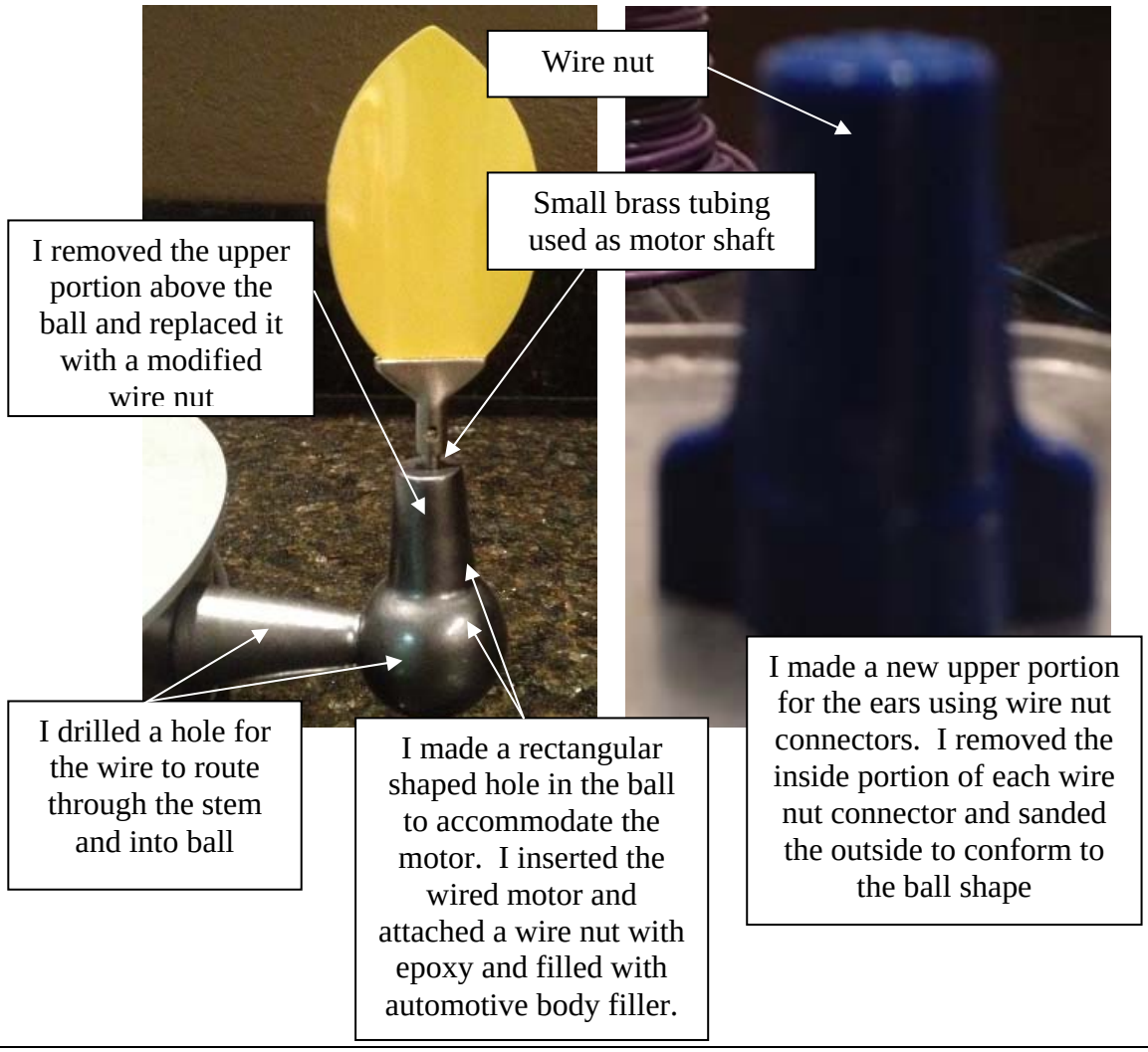
Wrist Attachment:

My arms are fixed and do not extend from the torso. To attach the wrist, I used the bolt shown below. It is a 1/4 20 bolt found at Home Depot or Lowes. The bolt is a furniture bolt located in the aisle with the hanging screws. I used the one that has a 40mm depth. I attached the bolt to inside of the torso with a 1/4 20 nut and washer. The bolt goes through a hole I drilled in the wrist strap and then into the torso. The flat surface on the bolt head requires no modification to the wrist. I inserted the bolt through the wrist strap and attached the Will Huff rubber arm to the wrist and clamped the wrist strap around the wrist. I placed a small spacer onto the bolt. I show a 1/4x 3/8 x 3/4 spacer in the picture but I actually used a 1/4x 3/8 x 1/2 spacer since the 3/4 spacer was too long. The spacers are located in the pull out drawers at Lowes. I just have the one bolt on the top of each wrist and it provides sufficient hold with no danger of cracking the torso.

19 Ears

The ear arms are resin and were purchased from Bill Kendzierski & Rod Rickenbach. The ears are of good quality. I am using the miniature metal gear motor as shown below to turn the spinners.

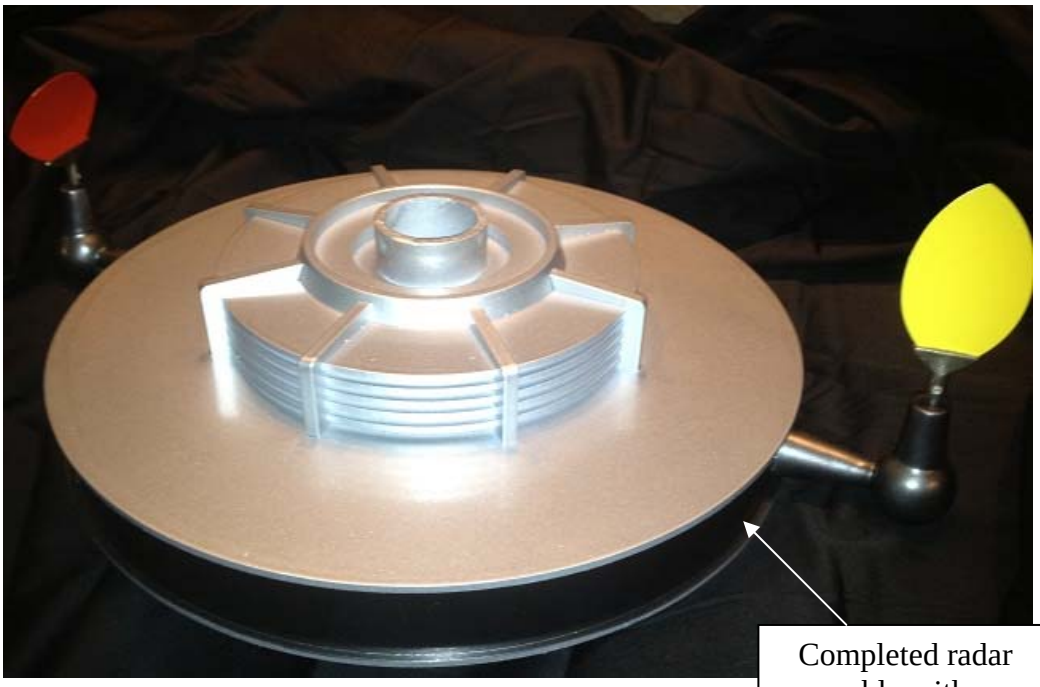
The motor does not fit into the ball portion of the ear without major surgery. Here is what I did to get the motorized ears operational.



20 Radar

The radar was purchased from Greg Logue. Greg included good instructions so the assembly was not a problem. Prior to starting the assembly, I ordered the items listed in the table below from Tap Plastics. Do not even bother starting assembly until you have the water thin solvent. Greg included a syringe but I broke mine after several uses because the rubber seal came off. I am glad I ordered a spare. As you will see, gluing acrylic is easy and very cool using the solvent and syringe. It flows like water.

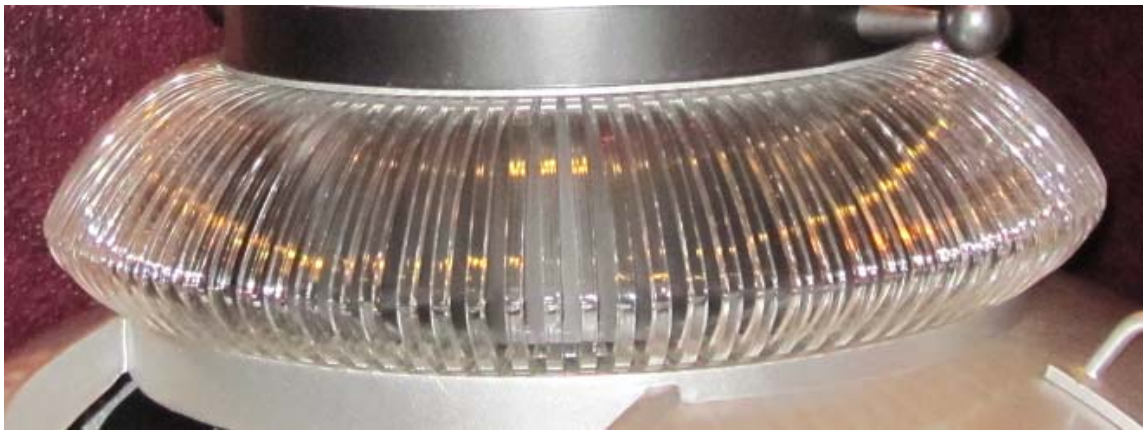
Quantity	Description	Usage	Purchased
1	IPS Weld-On 3 Cement - 1 pint.	Radar Glue	Tapplastics.com
1	16 Gauge Hypo Applicator	Glue Applicator	Tapplastics.com

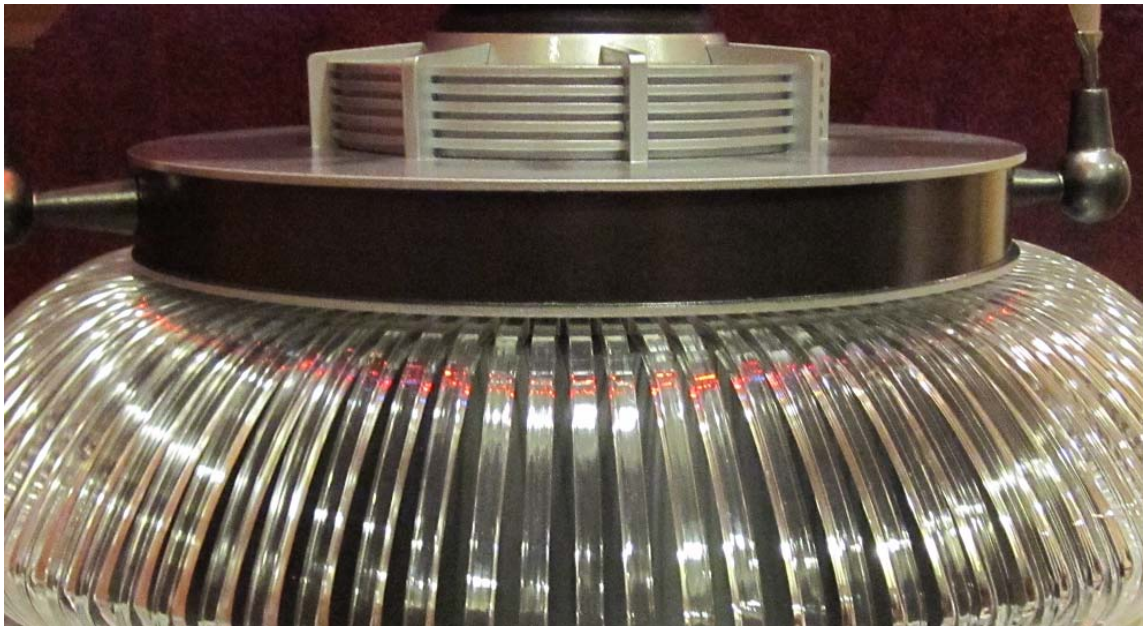


Completed radar assembly with ears attached

21 Collar

The collar was also purchased from Greg Logue. Not much to say except it is a work of art. Greg has been a top notch vendor and everything that I have purchased from him has been great. Here are a few pictures of his most excellent collar installed on the B9.



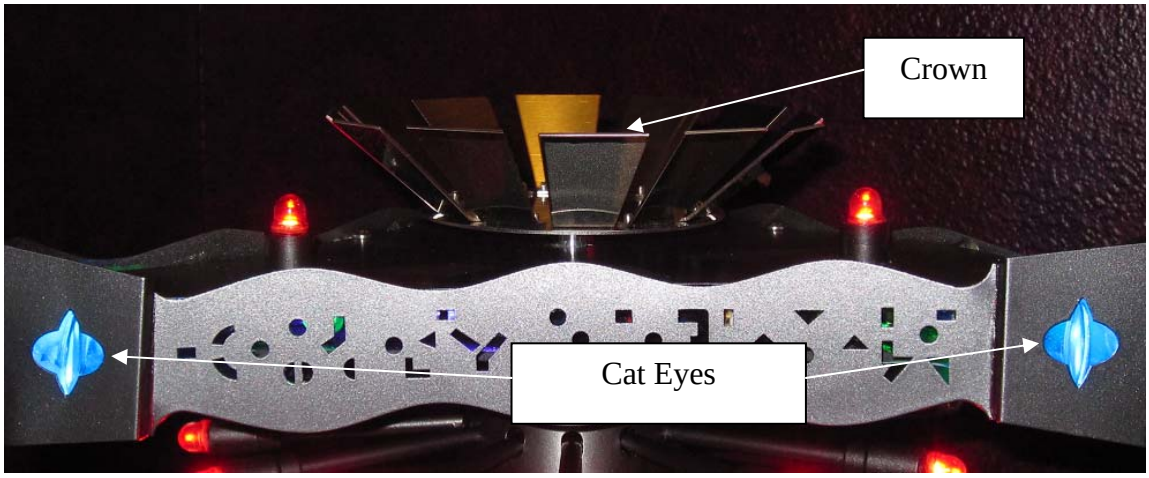


22 Radar Animation

I purchased the radar animation kit from Greg Logue. It operates as advertised. I am not sure if I will animate the radar during my shows but I can if I want to.

23 Cat Eyes

The Cat Eyes were purchased from Gary Oiley. The Cat Eyes are the molded pieces shown below. The Cat Eye lens fit in the Mike Burrill brain easily. I just used a belt sander to reduce the rectangular signature of the mounting area and glued them into the brain. The price is inexpensive. The time required to manufacture your own Cat Eyes would exceed the cost of buying them from Gary. I am using the clear Cat Eyes from Gary. With a colored light located behind the lens. They will appear any color that you choose for the light. Gary also sells colored Cat Eyes.



24 Crown

The Crown was purchased from Bill Kendzierski & Rod Rickenbach. The crown mounts to the crown motor shaft provided by Jerry Chevalier via a screw on the crown shaft that Jerry provides with the crown shaft/. The crown was another quality piece provided by Bill Kendzierski & Rod Rickenbach.

25 Paint

I painted the robot using the following colors:

Quantity	Description	Usage	Purchased
6	Dupli-Color BSP202 Brilliant Silver Metallic Paint Shop Finish System - 32 oz.	Torso, Tread Section, Radar	Amazon.com
4	Dupli-Color BSP300 Clear Coat Paint Shop Finish System - 32 oz.	Torso, Tread Section, Radar	Amazon.com
2	Dupli-Color BSP100 Gray Paint Shop Finish System Primer - 32 oz.	Tread Section, Radar	Amazon.com
Several	Dupli-Color Spray Can Grey Filler Primer - 11 oz.	Torso, Tread Section, Radar, Fiberglass Legs, Fiberglass Knees. I used this primer to check my sanding work. It dries fast and I have tried several different primers. This one was the best.	Advanced Auto
4	Krylon Flat Black Spray Can	Fiberglass Legs, Fiberglass Knees	Advanced Auto
4	Dupli-Color Paint Bgm0344 Gunmetal Metallic 8 Oz Aero	Wrists, Neon back plate, radar center band, radar ears. I got tired of going to a bunch of stores trying to get the quantity I wanted. Amazon was an easy solution.	Amazon.com

I was going to use the colors suggested on the b9creations website but the colors listed required a mixing process, etc. The Body Shop Dupli-Color paint is just pour and spray. Since I am not a painter, this seemed like the easiest solution. The color looks good and it really is a no fuss solution that is easy to apply. I would probably forego using their primer next time and just use the filler primer only. After spraying the color, I sprayed the clear. Be sure to lower the air pressure when spraying the clear. With it too high, you will get a rough finish. Since I did this, I just lightly knocked down the finish with 600 grit paper and sprayed several heavy coats of clear at a reduced pressure. The end result is an automotive finish. The arm cavities are not as smooth as the rest of the B9 but it is pretty good for an amateur.

I painted the robot using the following equipment:

Quantity	Description	Usage	Purchased
1	Campbell Hausfeld 8 Gallon Air Compressor	Torso, Tread Section, Radar *Note: The compressor cycled often since the tank is undersized for spraying*	Home Depot
3	Central Pneumatic Spray Gun Filter	Attach to spray gun to remove contaminants before they reach the spray gun	Harbor Freight
2	Central Pneumatic 20 ounce disposable paint spray gun cups	Comes with 5 in each package	Harbor Freight
1	Central Pneumatic Professional Automotive HVLP Spray Gun Kit	Spray guns – comes with 2 guns(large and small). I only used the larger one	Harbor Freight
Several	Tack Cloths	Wipe down of parts prior to spraying	Home Depot
1	Acetone	To clean spray gun when I finished spraying each day	Home Depot

I do not plan on embarking in a career that involves painting so I just went the inexpensive route and bought the Harbor Freight stuff. After my bad experience with a butane torch breaking after one use, I was not sure if I should go the cheap route. I wanted the spray gun to last for the entire robot painting process. It worked just fine so I guess even a blind squirrel gets a nut sometimes. If I was to spray often, I would probably get a bigger air tank and better sprayer.

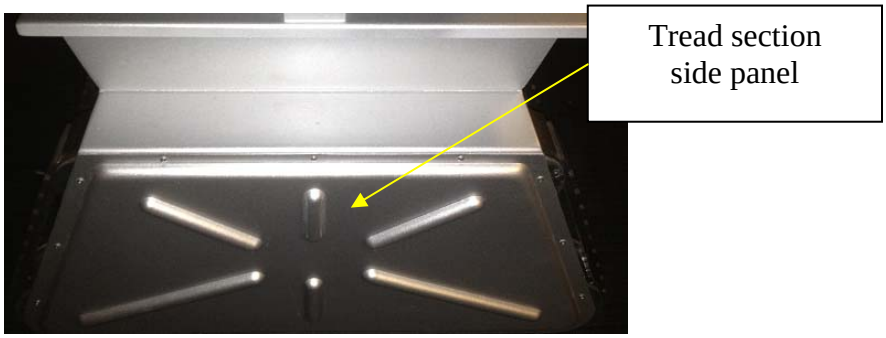
After painting, I caused a few scrapes and scratches during the assembly process. I was distraught and contemplated taking things apart and repainting. After a minor panic attack, I decided to try air brushing the blemishes. I picked up an inexpensive Harbor Freight air brush kit and repaired the blemishes. The Dupli-Color paint I used for the robot also worked perfectly in the air brush. I sprayed the damaged areas with the air brush (paint and then clear), you cannot see where the damaged areas were. I never used an air brush before but it is an excellent tool and erased my careless assembly efforts. Do not panic if you damage your paint job, it can be easily corrected.

26 Tread Sections

The tread sections were purchased from Eric Johnson. These are well made steel units. They are the perfect foundation for your B9. The tread sections come with plastic side panels. The side panels must be cut and the holes must be drilled to match the 4-40 pre-threaded mounting holes on the lower tread sections. After messing up one of the side panels, I contacted Eric and he was able to get me a new set of side panels right away.

This time, I was going to be careful and take my time. Here is how I cut and drilled the side panels.

- I placed the right tread section on its side so the 4-40 holes faced upwards.
- I taped 6 sheets of clear binder covers over the tread section so it was like one piece of clear, kind of sturdy plastic.
- I marked all of the 4-40 holes with a permanent marker along with the corner wheel hole mounts so I could be sure to center the template correctly on the plastic side panel.
- I removed the template and transferred the pattern of the 4-40 holes to the plastic side panel. I centered the panel using the wheel mounting marks I made on the template.
- I cut off the plastic bends located on the top and bottom of the plastic side panel so it was now a flat rectangle.
- I drilled the 4-40 holes and mounted the plastic side panel to the tread section.
- I used a new disposable razor blade knife and trimmed the plastic around the sides and bottom of the tread section.
- I sanded the plastic to the metal of the tread section so it was identical to the sides and bottom.
- On the top of the side panel where the tread section curves inward, I made a mark on the plastic below the curve.
- I placed the plastic panel on a board and clamped it down with a large straight edge along the top to use as a cutting guide.
- I scored the top section several times until the knife cut through the plastic.
- I added some axle bolts to the corners of the tread section to verify there would be no clearance issues.
- I mounted the side panel to verify fit.
- I removed the side panel, filled imperfections with glazing compound, sanded, and painted.



27 Soil Sampler

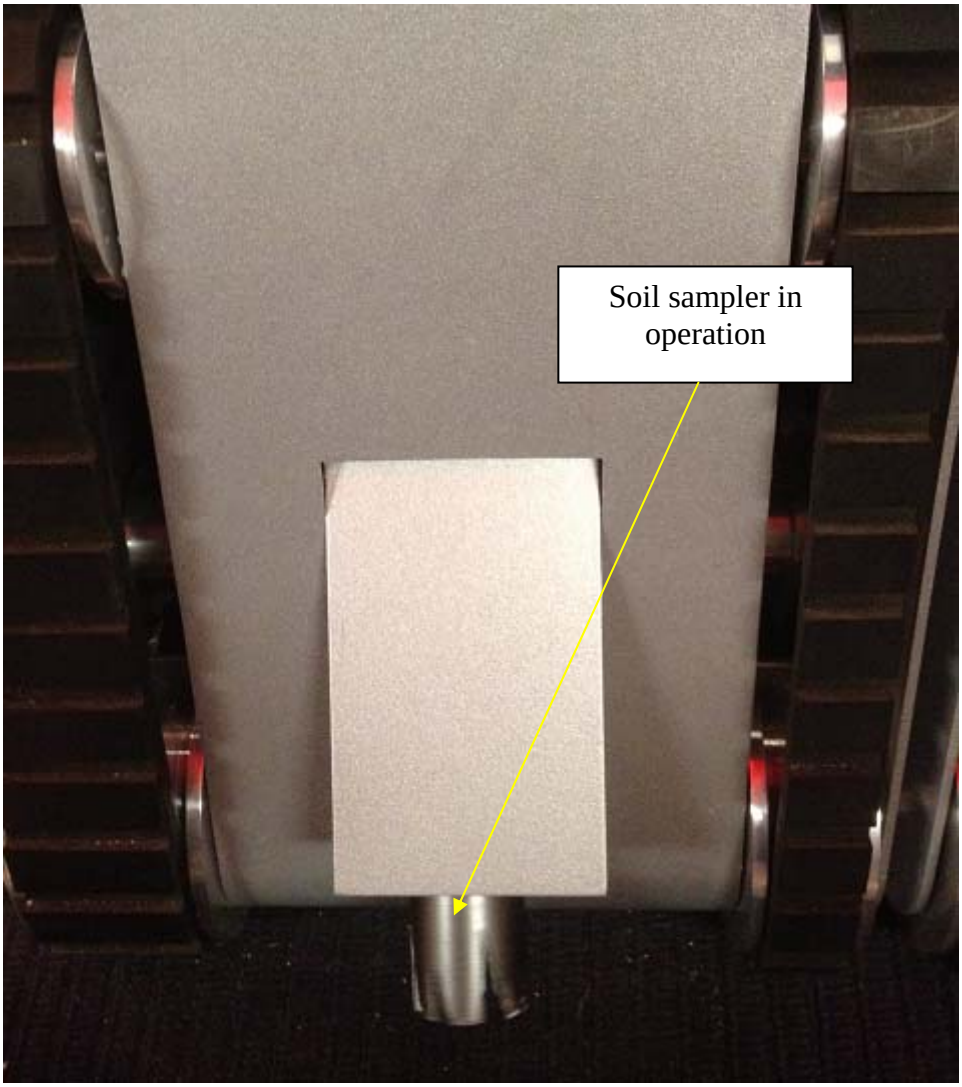
If Mike Joyce still sold the soil sampler, I would have just bought one from him. I knew I wanted a soil sampler so I made one. I am an electrical engineer and not a mechanical engineer. With that said, I used a linear actuator to drive the soil sampler tube / soil sampler tube gear motor. The gear motor is used to spin the tube. I used the following parts to make the soil sampler.

Quantity	Description	Usage	Purchased
1	Ball Bearing Drawer Slide	Slide to attach the sampler tube and motor. The slide is driven by a linear actuator.	Lowes
1	40 RPM Gear Motor Item# RZ12-300-40RPM	Motor to turn the soil sampler tube	ServoCity.com
1	Hose clamps to attach soil sampler motor to drawer slide.	Motor mounts	Lowes
2	6mm Bore Set Screw Hub Item# 3472H	Hub to attach soil sampler tube to gear motor	Lowes
1	HDM250 H/D Linear Actuator Mount	Servo actuator mount	ServoCity.com
1	HDA8-2 H/D Linear Actuator (12 VDC)	8” Servo actuator but a shorter one would have been easier to mount and a better option.	ServoCity.com
1	1-1/4 “ PVC Pipe	Soil Sampler Tube	Home Depot
1	1-1/4 “ PVC Pipe End Cap	Soil Sampler Tube	Home Depot

I examined the Mike Joyce soil sampler tube notches and recreated the notches on a PVC pipe. I painted the PVC pipe the gun metal color. The most difficult part was getting the motor hub centered on a PVC end cap. If it is off center, the sampler tube will wobble quite a bit. To compensate for the obvious wobble I was going to have, I used a 40 RPM gear motor to attach to the tube. It spins slow and reduces the wobble appearance. After all, it is just an effect and it is not going to do any digging.

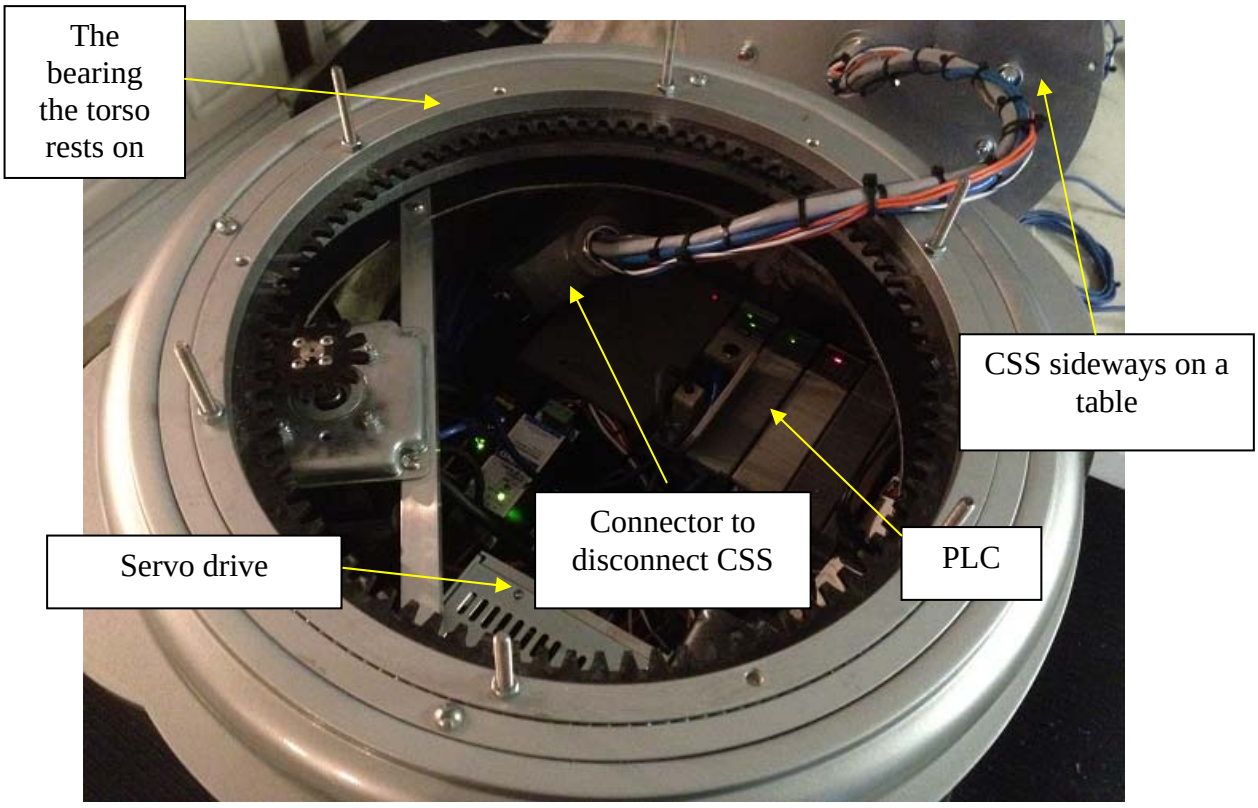
The soil sampler tube was painted with Duplicolor Gunmetal paint. The old T177 paint code has been replaced with paint code BGM0344. The paint was obtained at Advance Auto Parts.

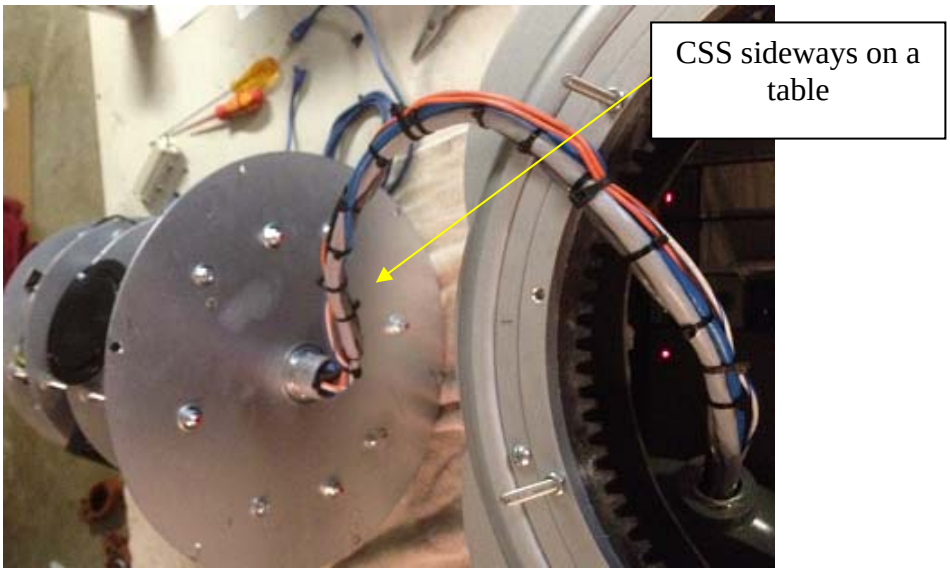
A picture of the soil sampler is shown on the next page:


Soil sampler in operation

28 CSS

The CSS rests upon the donut and bearing. As shown below, the CSS is laying on its side while connected to the electronics located in the leg section. The CSS can be completely removed via a connector but having a table next to the robot allows me to quickly lay the CSS sideways while doing some additional work in the leg section.

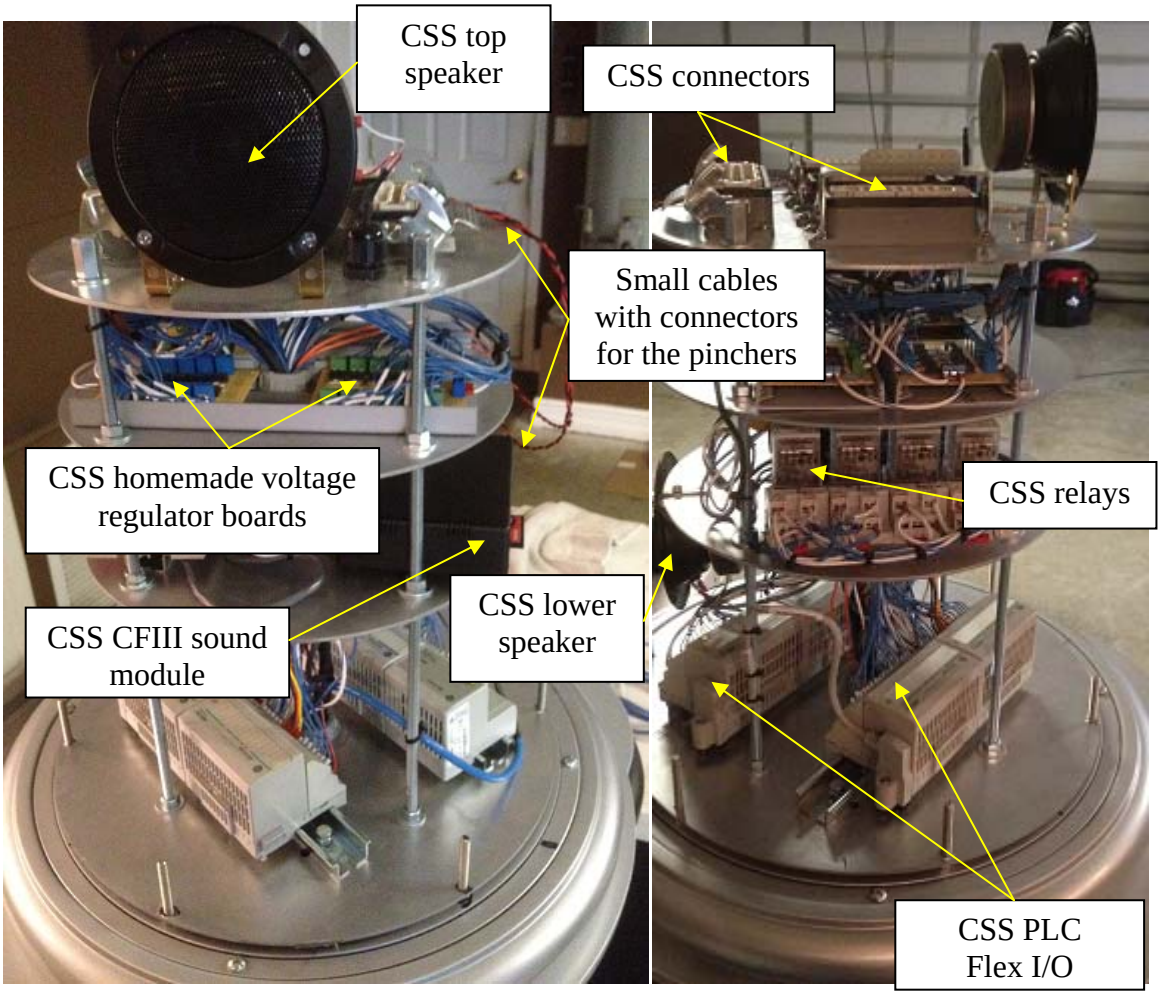




The CSS shown below is resting on the bearing /donut. The CSS just lowers on top of the bolts that extend from the bearing. A few views of the CSS are shown for clarity. The CSS was constructed with round plates. The round plates were purchased from eBay via a seller's store - sirussteel.

Quantity	Description	Usage	Purchased
3	1/8: .125 steel plate 12" diameter circle.	CSS	eBay – seller was Siriussteel
1	1/8: .125 steel plate 16" diameter circle.	CSS	eBay – seller was Siriussteel

Holes were drilled in the CSS plates and threaded rod that was purchased at Home Depot is used to connect it all together. As you can see, I mounted two speakers to the CSS utilizing small angle brackets I purchased at Home Depot. The relays shown in the picture are used for switching power to the soil sampler motor, radar motor (2 relays used to switch polarity/direction), and the crown motor. I purchased the relays from Automation Direct.



29 Control

The B9 robot is controlled via an Allen-Bradley SLC 5/05 PLC with Flex I/O and the waist motor is controlled via an Allen-Bradley Ultra 3000 servo drive. The sound is triggered via serial commands originating from the PLC to a CFIII sound module. Three switches and four normally open pushbuttons are used to control shows/playback sequences for the robot. Pulling the power pack and plugging it back in also generate a power down/power up sequence. The following input devices located in the programming bay perform the functionality as described below:

INC Programming Bay Switch
The INC switch is used to shutoff all motors in the robot. This switch also removes power from the servo drive. When this switch is active (all motors off), the robot goes into time clock mode.

In time clock mode, all of the LED indicators remain active and, the robot will announce the date and time on the hour. Here is an example of what he will say on the hour:

"Today is Sunday, May 27th" [pauses for one second] "The time is 2 o'clock".

I did this by using the IB9 software to generate a sound clip for every month (Jan – Dec), every day (0-31), every weekday (Sun-Sat), and every hour (1-12). I also got a wave file for "Today is" and "The time is". With this data I had all of the wav files I needed. The PLC triggers an internal bit on the hour and based on the current date and time, it sends the appropriate serial strings to the CFIII sound module.

AB Programming Bay Switch Left
This switch issues the wife show. When this switch is toggled, the wife show begins. The wife show rotates the torso and moves the pinchers two times. The robot says the following during the wife show.

"[wife name], where have you been all my life? Oh baby, you look very slim in that outfit. [wife name], for a human, you are an extremely attractive specimen; you look like a million bucks, hey baby, would you like to talk to a robot? Please forgive me if my treads have scuffed your floor. [wife name], that is a very beautiful name"

AB Programming Bay Switch Right
This switch issues the photo op show. When this switch is toggled, the photo op show begins. The photo op show does not rotate the Torso but operates the pinchers during a portion of the dialogue. The robot says the following during the photo op show.

"Will you pose with me? Closer please, I do not bite, however, I do pinch and I may electrocute you, you call that a smile? Say cheese, please watch where you put that hand, is that your hand on my rear vent? OK, do you need to get that close?


The switches are tied to a one-shot instruction. They must see a false to true transition to operate the show.

Hidden Programming Bay Pushbutton #1
This pushbutton issues the main show. When this pushbutton is pressed, the main show begins. The main show rotates the Torso to several different positions and activates the pinchers at specific points in the show. The robot says the following during the main show.

"Hello, I can state with certainty that John is an extremely attractive specimen, John, your parents must be very proud, what do you mean, what else do I do?, is it not enough that I stand here providing protection as well as being the most esthetically pleasing machine on this planet? What else do I do? With all of my lights I can double as a passable Christmas tree, all my circuits are function perperperfectly, I was very famous at one time, everyone knew me and adored me as the robot from Lost in Space, now I am retired, and I, well I just stand here most of the time and look really cool, for the record, I never said Danger Danger Will Robinson, I do not vacuum or do the dishes, pardon me. Do you have any WD-40? Building a B9 Robot, Bubble 300 dollars, Torso 1000 dollars, laser cut steel tread sections 1200 dollars, having me standing in your living room, priceless, I have great difficulty getting through the airport metal detector, R2D2, what a hack, the prime directive forbids taking human life, but I could certainly pinch you very hard (pinchers actuate open and closed three times), the only danger that my sensors indicate is that you forgot to utilize your deodorant this morning, for a human, you are not an extremely attractive specimen, John is my friend, without John, I would be a spineless shell of a robot, you should not use your entire vocabulary in a single sentence, what you do not posses in accuracy you make up for in lack of logic, John, you look marvelous, may I be excused? Thank you, live long and prosper, hasta la vista baby. "

Hidden Programming Bay Pushbutton #2
This pushbutton issues the soil sampler show. When this pushbutton is pressed, the soil sampler show begins. The soil sampler show rotates the Torso and extends the soil sampler tube out the soil sampler door. Once the soil sampler tube is extended, the soil sampler tube will rotate. At a certain point in the dialogue, the tube rotation will halt and the tube will retract. The robot says the following during the soil sampler show.

"Activating soil sampler, please stand clear, analyzing sample, it is composed primarily of carpeting with trace amounts of dirt, hey I found a dime, can I keep it?"

Hidden Programming Bay Pushbutton #3
This pushbutton issues the youngest daughter show.

Hidden Programming Bay Pushbutton #4
This pushbutton issues the oldest daughter show.

The power pack also issues a small audio and light sequence when it is detected as pulled out or pushed in. The power pack performs the functionality as described below:

Power Pack Disengage
While the power pack disengage sequence is playing, motors are cycled off one at a time to provide the illusion of dying and the light sequence freezes. When the dialogue has completed, all of the motors stop and the lights turn off. The robot says the following when the power pack is disengaged.

"uhhhh….my power pack needs chargiiiiing"

Power Pack Engage
While the power pack engage sequence is playing, the ear motors, crown motor, and radar operate. The indicators cycle normally. The robot says the following when the power pack is engaged.

"Where am I? Who turned out the lights? Robot initiating systems check, please stand by, initiating recalibration procedure, main computer boot sequence completed, I am a robot, model B9 of the class M3, programmed to provide information and support to all members of this household"