VILE THINGS

http://www.vilethings.com/bellicose.htm

BELLICOSE

I was mesmerized by a particular haunt prop at the Transworld Chicago show in 2003.

The Scarefactory's Floating Reaper prop was incredible. The motion was fast and wild.

The range of motion was impressive as well. The character would lift and fall several feet while swinging side-to-side.

Scarefactory's Crypt Wraith prop mimics these movements, but hinges on a ground level mechanism as opposed to the

Floating Reaper's elevated mechanism. Since my Halloween display is essentially a graveyard scene, I can't incorporate elevated machines without building something to disguise or completely cover the structure.

This is my attempt to reproduce the movements of one fantastic haunt prop while keeping the machine as low as possible.

The goal is to build a base/frame that will firmly hold a short vertical post or mast. The outer shell of the mast will rotate roughly sixty degrees, powered by a pneumatic cylinder. The mast will also support a single lifting arm and a second air cylinder.

This machine will move through a fairly large space. Considering it will be less than twelve inches tall in it's retracted state, it has to be built "tough." We'll be lifting and swinging a seven-foot-long lever with the added weight of a prop character. The motion needs some speed as well - not startle speed, but an angry kind of speed.

Moving parts, making it strong and dependable.

The rotating spindle will be the key to this machine's successful operation.

I chose to fabricate the spindle using a couple of specific main components described in more detail below. This is certainly not the only way to produce a functional joint with these capabilities, but it is my opinion that this is the most durable and dependable method. Since this joint is critical to the performance of this machine, a high quality fabrication is a good investment.

Tapered Roller Bearings

Bearings are used to reduce friction in rotating joints. Reducing friction not only allows the joint to move with less effort, it also reduces wear on the individual parts of the joint.

Incorporating bearings in the Bellicose machine joints will provide two important benefits. The leverage disadvantage on the air cylinder will be slightly lessened once joint friction is reduced. Also, the chance of the joint becoming sloppy over time is practically eliminated with basic bearing maintenance. (cleaning, visual inspection, lubrication, etc.)

Want to learn more about different types of common bearings and how they work? Start here; http://science.howstuffworks.com/bearing3.htm

Once you know the load characteristics of your project, you can easily determine the proper bearing for the job. In our case, we will be working with an axial load and a thrust load in the same joint. Think of a wheel ... The wheel spins on its axis. This is the axial load on the joint ... the vertical "pressure" of the wheel on the axle.

A ball bearing used here would handle the vertical pressure and allow the wheel to rotate freely of the axle. If you change the direction of the axle while the wheel is rotating you introduce a side-to-side force. This "thrust" load would push the wheel in a direction across the axle. A thrust bearing used here would allow the wheel to turn on the axle while providing resistance to the side load.

Ball bearings could handle our axial load easily, but are not designed to handle the considerable thrust load. Thrust bearings have little axial load handling capabilities, if any. A tapered roller bearing is designed to handle both loads simultaneously and efficiently.

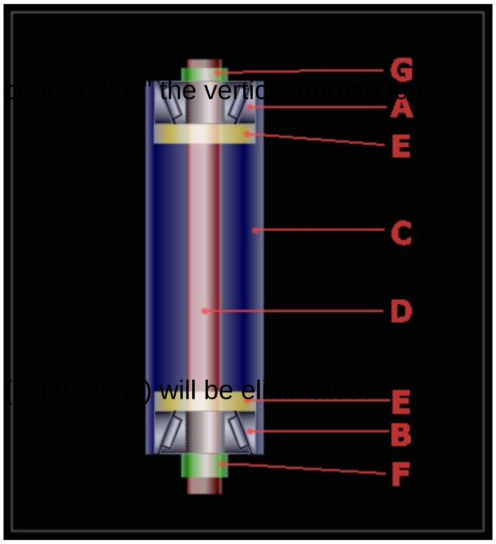
Finding tapered roller bearings is no major task. Finding a usable size bearing may require a little more effort. I found a perfect bearing set on Ebay, and later saw the same kit for sale at Northern Tool. Since then, both links have vanished! What I found was a wheel bearing kit for trailer axles. They should be available at most auto parts stores.

You need to consider three measurements. The inner diameter , which would represent your axle size. The outer diameter, which would be the hub's bearing measurement. And least importantly depth, or total bearing assembly thickness.

If you look for wheel bearing kits, be sure to look for those that work with straight spindle axles. Some axles are tapered and/or measure differently for each face of the hub/wheel.

I mentioned "perfect" wheel bearing kits ... perfect in that they measure .75" i.d. and 1.75" o.d. With these common measurements I can use standard pipe size(s) to build my rotating machine joint!

Here's a cutaway, side view drawing of the pivot mechanism I need ...



(A) and (B) are tapered roller bearing sets. The lower bearing (B) is installed so that the angular face of the cone "holds" the vertical (thrust) load.

The cone direction of the upper bearing (A) opposes that of the lower bearing. A washer (G) and nut will be used above the upper bearing.

By adjusting the torque of this nut, we dictate the tension on the bearing cones/outer races. When properly adjusted, the joint will pivot easily and any side motion (axial "play") will be eliminated.

(D) is the center post. This will be permanently fixed to the base of the machine.

(F) is the lower bearing stop. It is fixed to the center post (D) The outer diameter of the bearing stop is important because it must support the bearing's inner race, but cannot come in contact with the outer race. The inner race will remain in a fixed position on the center post, but the outer race will rotate with the case.

The outer race retainers (E) are permanently fixed within the outer case (C). These keep the bearing's outer race in proper position, and determine the placement of the outer case above the base of the machine.

Since my bearing sets measure .75" i.d., I know I need .75" o.d. pipe for the center post (D). My bearing's outer diameter is 1.75", so I need 1.75 i.d. pipe for the outer case (C). The outer case must be 1.75" i.d. in order to snugly hold the bearing's outer race. The o.d. of this pipe isn't necessarily crucial here either. A usable (weldable) wall thickness is important.

The lower bearing stop (F) has to be .75" i.d., and should be 1" o.d. to avoid contact with the bearing's outer race. This determines the required wall thickness of the pipe for part (F).   1" minus .75" equals .25" Divide .25" in half (half of the total gap per each side of the pipe) and we need a .125" wall thickness.

Easy, right? We need pipe that measures 1" outside, and 3/4" inside ... having a wall thickness of 1/8" for part (F).

The outer race retainers (E) must be 1.75" o.d.

The inner diameter in this case isn't overly critical ... as long as we can slide the finished outer case over the finished center post.

This photo shows the rotating portion of this spindle. In the lower left corner you can see the bearing's outer race is installed in the outer case. You can also see round plug welds roughly one inch from each end of the outer case. Holes were drilled through the case, and when the outer race retainer stops were in the proper position, they were welded in place through these holes.

DOM Tubing

If you've used galvanized or "black" pipe in your projects, you may have noticed some structural inconsistencies.

There is always a weld bead on the inside of the pipe. This is no big deal when you're plumbing water, but when you're making bushings or

other mechanical parts, the weld bead could pose a problem. Grinding the weld smooth is easy enough at the end of the pipe,

but what if you need a longer length of smooth walled pipe?

Another issue that may be problematic is accuracy in wall thickness, or inner and outer diameter measurements.

Galvanized and black pipe are not always the same measurement everywhere.

If you have access to a metal lathe, making pins, bushings, etc. is an easy process.

If you want stock tubing that can be purchased in various dimensions that are accurate and consistent,

look for DOM (Drawn Over Mandrel) tubing.

This page; http://www.steeltubeinstitute.org/domprocesses.htm

explains the process(es) used to create DOM tubing as well as the benefits of the finished product.

If you're interested in obtaining DOM tubing and your local metal supplier doesn't carry it, look for websites like this; http://www.industrialmetalsales.com/

I found tubing with usable dimensions for the tapered roller bearings sets I bought.

.75" o.d. X .5" i.d. for the center post.

.75" i.d. X 1.00" o.d. for the lower bearing stop.

1.5" i.d. X 1.75" o.d. for the outer race retainers.

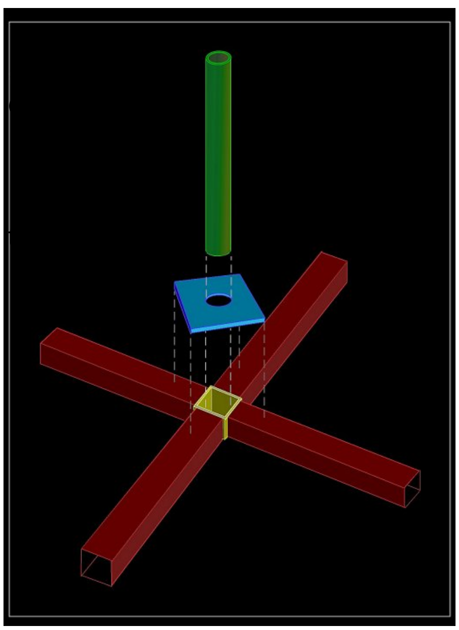
1.75" i.d. X 2.00" o.d. for the shell.

Given these dimensions, you'll notice all of the pipe is 1/8" wall thickness ... thick enough for this project. This material measured well within "tolerance." You may need to sand the outer diameter of one part or hone the inner diameter of another. If you have access to metal working machines, this tubing is perfect for this task.

Ground level, building the base

The base consists of three main parts. The spindle base, the rear brace, and the forward brace.

It is designed to accommodate future access to the bearings for maintenance purposes. The forward braces are bolt-on pieces intended to simplify transport and storage issues.



This drawing shows the individual components of the spindle base. The yellow colored square tubing in the center of the

is made of a 1-inch length of 1.25" square tubing. The 1 inch square tubing legs (red) are welded to the faces of the yellow

This 1.25 width is needed to accommodate the head of a 1/2" through-bolt for the spindle assembly.

The square plate (blue) is 1/4" plate stock with a 3/4" hole drilled through the center. This will accept the center post (green).

The center post is welded to the plate from underneath. The weld is ground smooth, and the post/plate assembly is tack welded to the legs

making sure the 1/2" through-bolt is aligned properly. After making sure everything fits properly and checks "square",

the new spindle base assembly is welded 100 percent.

Rear Brace Assembly

Rear braces are added to keep the spindle assembly securely in position.

A 2 X 3 inch piece of 1/4" plate is drilled to accept the through-bolt from the spindle assembly.

2 pieces of 1.25" square tubing, 2 inches long, are modified to work as saddles.

2 pieces of 3/4" square tubing are cut 12 inches long, with parallel 45 degree miter cuts on each end.

The sections of 3/4" tubing are welded to the 1.25" saddle pieces.

The 1/4" plate is bolted to the top of the spindle and the welded brace parts are positioned and marked.

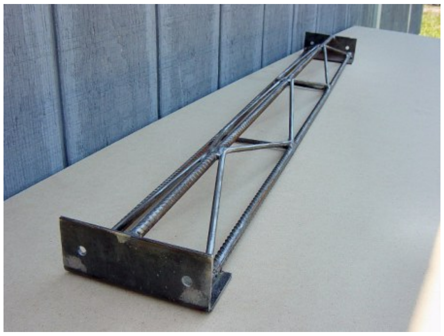
Remove the pieces, tack the rear brace parts to the plate and test the fit. The entire rear brace assembly should slide straight down into position with ease. If the fit is good, weld everything 100 percent. Install the brace assembly, bolt the top down, and clamp the saddles to the base legs temporarily. Drill holes and install bolts through the saddles and base legs to finish the rear brace assembly.

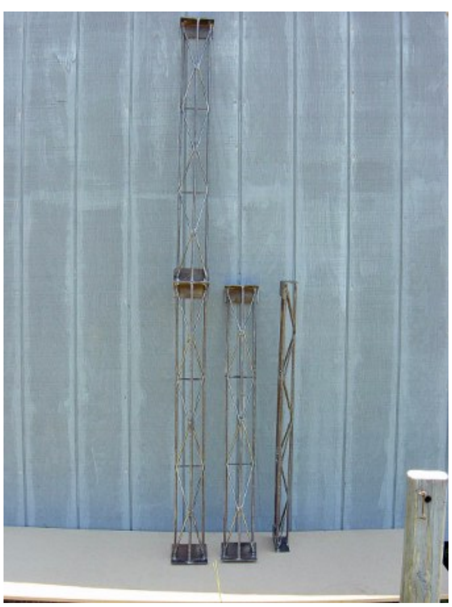
Directly opposite the rear brace assembly, the remaining two legs of the spindle base are joined with a cross brace.

Positively linking these two legs is part of the stability plan for the forward braces. The photo above also shows the addition of two angle iron brackets. These brackets share matching hole patterns with the forward brace segments.

More on that below ...

Forward Braces





It is essential that the forward braces are strong. When finished, they will be almost seven feet in length. They will attach to the spindle base an additional twelve inches from the machine's center of gravity. This total distance must be strong enough to support the weight of the prop body in motion. Although not a requirement, I also decided to apply a low profile theme to this whole machine. Finally, a wider "footprint" will provide better support on less stable surface(s), such as my lawn ... Using a truss type system, I am able to accomplish all of these tasks while keeping the segments smaller in size and lighter in weight.

To keep the pieces small for storage reasons, I decided to break the individual braces in half, each section being 38 inches in length.

I started with ten-foot lengths of 3/8" rebar (reinforcing bar for concrete work.) Each bar was cut into three pieces of equal length.

Four sticks of rebar were needed to make twelve pieces ... enough for four leg segments.

2" X 2" angle stock was cut into five-inch lengths. Ten of these pieces are needed. Carefully mark and drill holes in all of these pieces before any assembly. Slightly oversized holes will be helpful later on as pieces get mixed up and turned around.

With this setup, any segment can be used in any position, so it's important that the holes are all the same on every piece of angle.

The lengths of rebar are tacked in place between two angle pieces. Check for straight and square, and weld them in place.

The real strength of this design is in the diagonal bracing. I used 1/4" cold rolled round bar for this job.

Bend the 1/4" round bar into shape and tack it to one side. Check for straightness and repeat the process on the adjacent side.

Weld all of the joints 100 percent on the top side, flip the segment over and finish the welds underneath.

While upside-down, I added two cross braces between the lengths of rebar, equal distance from each end.

This design was a little more work than using big flat or tube stock, but it was worth it.

This is very strong, and reasonably lightweight compared to large tube stock.

With the basic form and function of the machine complete, it's time to move into more detailed aspects of the movements.

The spindle assembly will allow the prop to swing left and right. Attached to the outer casing of the spindle assembly is a single pivot joint. This joint will allow the prop to travel up and down. The decision to use bearings here was based on the same principle as within the spindle. Reduce friction, and ensure longer life to the joint components.

These are sealed ball bearings. They are designed to handle radial loads. These particular bearings have an 1/8" flange on one face which are to be seated against the receiving end of the assembly. Without this flange, it would be necessary to add a backing shoulder, collar, sleeve, etc.between the bearings. The inner diameter of the these bearings is 1/2", and the outer diameter is 1.180".

Considering the desired strength of this joint, the 1/2" i.d. is perfectly suited to a 1/2 pin. Anything smaller might not be strong enough if the prop weight and leverage become larger than anticipated. The bearing's outer diameter is slightly larger than the inside measurement of 14 gauge 1 1/4" square tube. This worked out perfectly. The bearings were pressed in and remain snugly in place.

Two short lengths of 1-inch angle material work very well in providing a strong, square point of attachment between the verical, round spindle and the horizontal, square lift pivot joint. This approach allows for roughly nine linear inches of weld ... far stronger than the individual components.

Lift Arm Base Section

This is the base section of the lift arm. This mounts to the pivot joint attached to the spindle.

An air cylinder mounted between the spindle and this lift arm will cause the arm to move up and down.

The prop body will be mounted to the opposite end of the lift arm when completed.

1 inch square tube spacers are cut to length. This measurement should match the total width of the pivot joint's bearings, which protrude slightly beyond the housing. These spacers are clamped to a pair of 1" X 1/4" flat bars. These flat bars have 3/8" holes centered at one end. The pivot pin is installed through these holes and the pivot joint bearings. When the pin is square (90 degrees) to the flat bars and the whole assembly is flat, tack the square tube spacers to the 1/4" flat bars. Additional 1 inch square tube bars, roughly 14 inches long, are stitched to the outside faces of the flat bars. (In the next phase of this lift arm construction, these 1 inch tubes will accept the rest of the lift arm.)

Check for straight and square, cover the bearings, and finish welding the joints ... top, bottom, and inside the spacers.

This is now a heavy duty component. Depending on the speed used to move the finished prop, this extra level of durability may come into play. If this is over-built, it won't be a problem. The additional weight here is directly above the lift cylinder and therefore won't introduce any unnecessary leverage woes with the lift arm assembly.

Part 2

It's time to add pneumatic cylinders to the bellicose prop moving machine.

I have been making my own clevis mount brackets all along. Shop made mounts can be any shape or size - completely customized per prop, per application. The photo above shows the lift cylinder clevis mount ready for welding.

A short length of 2" pipe is used as a template for the mount.

The cylinder for the lift motion has a 3/8" mounting hole. 3/8" holes were drilled in scrap lengths of 1 inch X 3/16 inch flat bar.

The holes are centered across the 1 inch width, and 3/8" in from the end.

Measure the length of the cylinder's clevis mount protrusion. Note the distance between the mounting hole and the cylinder's (round) casing. You need to maintain enough clearance in this area for the cylinder to pivot and not bind on your mounting bracket.

Cut the 1" flat stock to proper length. The end with the mounting hole will need to be rounded. For safety reasons, I would suggest rounding these corners after the bracket is made.

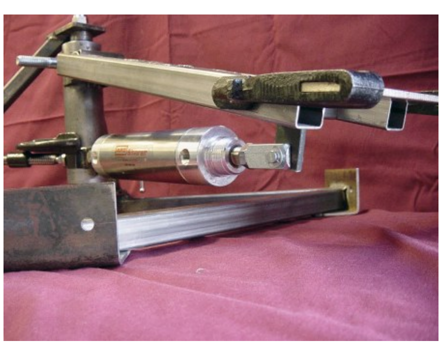
1" angle stock is used again for mounting the flat bracket to the round spindle.

3/8" flat washers are stacked to a thickness just slightly more than the cylinder's clevis mount surface.

A 3/8" bolt is installed and finger tightened, and the whole assembly is clamped together. Take some extra time to clamp each part a little at a time, checking for straightness and square as you go. Tighten the bolt and check everything one last time before tacking the joints. If your alignment is still good, weld completely. Sometimes it's difficult to weld the inside junction(s) of these brackets. Other times the weld bead would interfere with your cylinder's clearance.

In these cases, three passes with your welds will usually be sufficient. Three passes *guarantees* complete penetration across the joint while adding more material bulk. (More material added properly equals higher strength.)

This "tee" shaped bracket will be welded to the lift arm. This is made of 1 inch square tube cut to proper lengthand 1" X 1/4" flat bar drilled and cut to length. This hole will be used to attach the cylinder's rod end clevis to the lift arm.



The second photo here shows the cylinder and brackets positioned on the machine.

The shop made cylinder mounting brackets are installed on the air cylinder and clamped in position on the machine.

The cylinder's fully retracted and fully extended positions are correct. Nothing binds during rod travel. No moving parts will come in contact with anything during travel. The total assembly is straight and square.

Cover the cylinder and tack the new brackets in place. Remove the clamps and check for any possible shifting, twisting, etc. Once satisfied, remove the air cylinder and finish the welds.

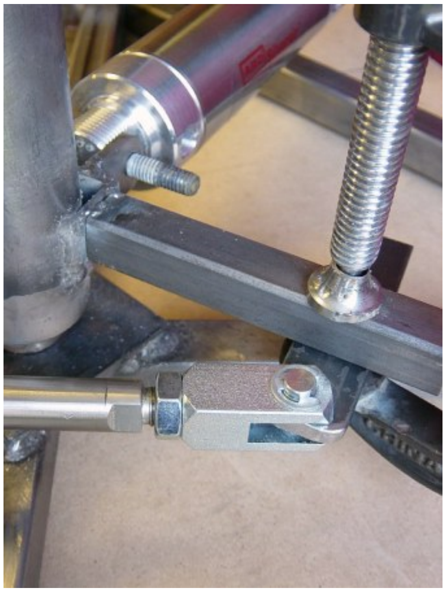
These photos show the Bellicose machine with lift cylinder retracted, then extended.

This is a 2 inch bore, 4 inch stroke ARO cylinder. This larger bore cylinder will deliver plenty of power for the lift motion.

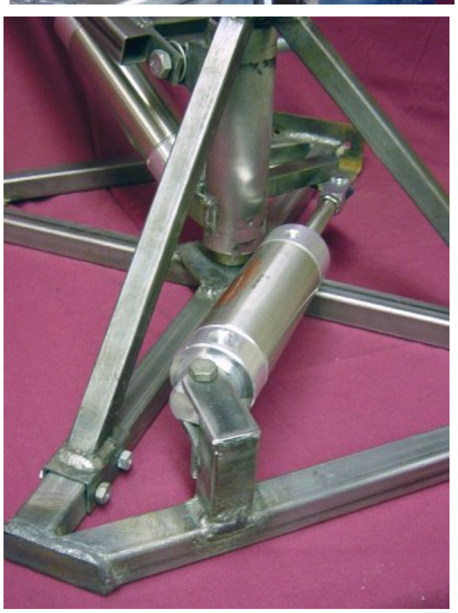
At 80 p.s.i. line pressure, this will deliver roughly 250 pounds of pushing force at the rod clevis. Figure in a six foot long lever plus the weight of the lever and still up to twenty pounds of prop weight can be moved efficiently.

This is the swing cylinder clevis mount bracket clamped for welding. Same procedure, different configuration.

The swing cylinder must be elevated to clear the machine's base during travel. 1 inch square tube stock is used to raise the bracket and provide a sturdy base for the bracket.



With the cylinders and their mounting brackets connected, it's easy to clamp the brackets to linkage components for test fitting. Clamp each end securely and manually move the part. If needed, reposition the mounting bracket and test again. Once satisfied with the joint's range of motion and acceptable clearance(s) it's safe to tack the mounting brackets in place. Remove the clamps and test the motion again.



Finished and mounted swing cylinder assembly, mounting brackets, etc.

Extending the Lift Arm

As previously mentioned, the lift arm for this machine will be fairly long. Any combination of substantial weight and sudden changes in motion would cause a long, thin arm member to flex. To eliminate this flex without using a heavy walled single tube (which would add even more weight at the end of the arm) I decided to break the arm into two segments.

The first segment, shown here, will resemble a simple truss section.

Parallel lower bars provide most of the linear strength for this arm assembly. By running them side-by-side, chances of side flexing are greatly reduced. The dual lower arm bars are angled near midpoint to lay parallel the ground as much as possible. This low profile characteristic should aid in reducing the apparent size of the whole prop when at rest.

Using this angled midsection, it's possible to add a lightweight span and gusset segment made of 1/4" round bar. Under stress, the arm would have the tendency to bend "down" beyond the cylinder rod's mount point. By adding the span and gusset pieces, the stress is transferred across the whole arm segment.

In order for the lower bars to flex now, the 1/4" span bar would have to pull apart from either end of the arm segment.

One-inch welds secure the 1/4" bar, so chances of that joint pulling apart are minimal.

1 1/4" square tube is added to the end of this arm segment to accept the next segment.

Bolt holes are predrilled, and will match holes in the next segment.

Two angled views of the bellicose machine fully assembled (up to this point in the build) for testing.

An additional 40 inch bar has been added to the lift arm, bringing the total length to nearly seven feet.

The end of the lift arm is angled up to accept the prop torso/character. The degree of this angle must be greater than the lift arm's fully extended arc angle so the prop body doesn't come in steady contact with the arm.

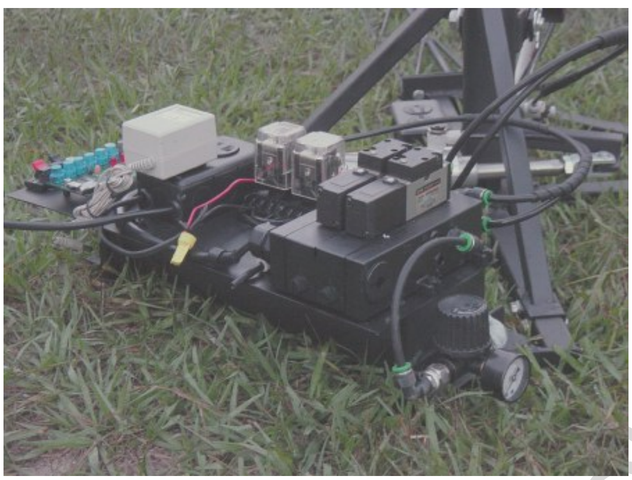
This might not be a concern depending on your design, but this character will be mounted to a limited swing pivot point (shown above.) The spring in this joint is only used to balance the prop body. Adjusting the spring at the rear mounting bracket will determine the prop body's static "center."

A Delusional Keybanger is used to control the programmed sequence of events.

Two mechanical relays are used to power effect lighting from the Keybanger's output signal.

A dual solenoid manifold block powers the air cylinders.

An inline air regulator sets the overall pressure for this machine.



Over the course of my haunt prop building "career," I've embraced a familiarity with the body making dilemmas.

In most animated props, it seems that two major issues present themselves every time ... the body must be lightweight and it must be durable. To date I've yet to find the perfect material for this purpose, so I suppose the next best thing would be experimentation. For the bulk of this particular body, I used a flexible foam product that's typically sold as "pool noodles." This was actually sold in a flat 3/4" X 6" X 5-foot section.

After the glue cured fully, One arm was carved to the rough shape pictured above. This foam material won't take much more detail than this stage because the cell structure of the foam is much too loose. As a result, the idea (now) is to get the shapes correct with the foam, and achieve surface details and textures with a fabric and latex skin.

The second photo above shows a good sized Styrofoam block glued in place. After cure time, this block should be easy enough to shape into a menacing skull.

A fabric and latex skin is applied to the foam body.

Clearly, this skeleton prop is stylized beyond the accepted realistic skeleton.

The proportions are exaggerated to my preference The skull has an expression of sorts.

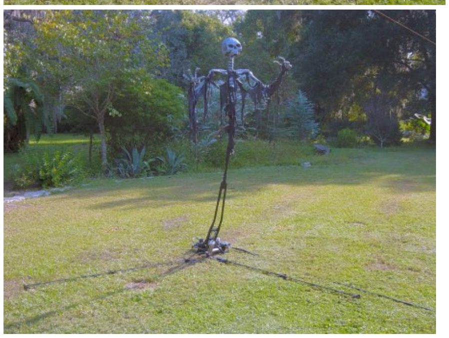
The vertibrae are sized and located for appearance only. In keeping with this theme, the paint job is different. This fellow was base coated gray, followed by washes of white and blue.

(My apologies for the over exposed photographs above.) A light blue colored surface here will show more blue color under haunt lighting conditions.

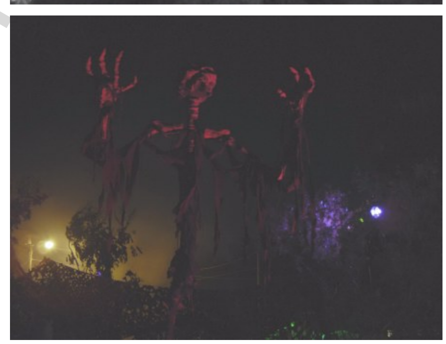
Major "depressions" and shading areas are airbrushed black prior to dressing. Some, many, or most of these areas (?) could be difficult to paint once the prop is dressed.

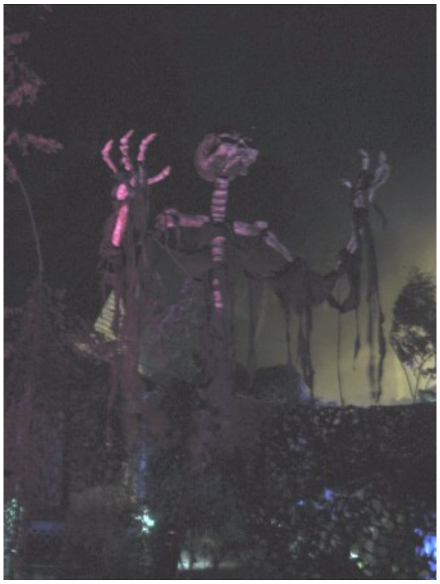
Black fabric is cut to rough shape and soaked in a reduced latex bath. The application of latex will add a slight degree of stiffness to this fabric once set. Narrow strips of another type of black fabric are used to tie the first layer in place while adding dangling lightweight pieces. Once in place, these strips are distressed while the latex on the first fabric layer is allowed to dry fully.

Daylight photos of the finished Bellicose machine at rest and at full extension, slightly over eight feet tall.



2006 haunt images.





For any interested person, these are links to basic drawings of the Bellicose machine sections as built here.