Feature

Leather Soul – Airship Pirates

Charles Wayman* and Kendra Wayman*

A band of Steampunk Airship Pirates at the 2012 Worldcon 70 masquerade showed off a remarkable flying suit with mechanically functional parts. The entry garnered several major awards, and a Dreamcatcher award from the Silicon Web Costumers' Guild for the flying suit. Here is how they built it.

Concept

The central character of our story is Meredith Brazneh (Brazz-Knee) Boutin, a young woman living in a Steampunk Victorian era. Brazneh is a high spirited, adventurous young lady, who has recently joined the pirate airship "The Leather Soul." The crew of the airship use its unique flying suits to to board other airships and pillage them.

Inspiration

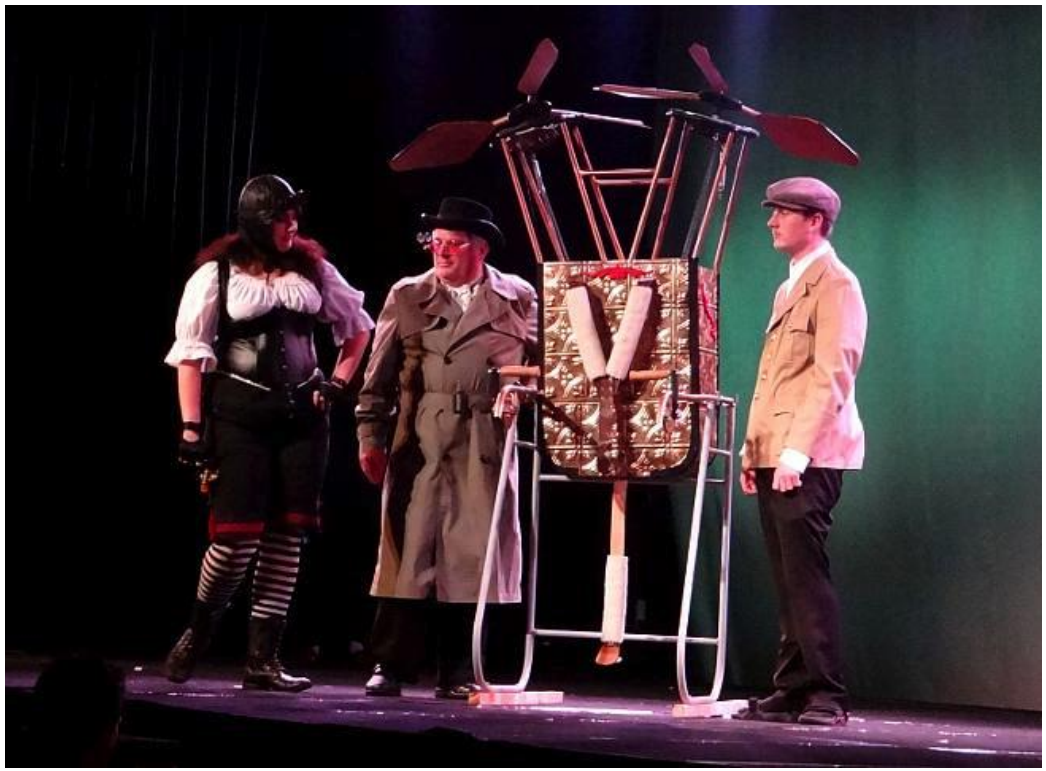
My daughter Kendra and I attended the 2011 Worldcon Convention in Las Vegas. This was the first Worldcon I had been to since the mid '80s. I have had a "bucket list" dream, to win a first prize at a Worldcon masquerade. On our way home from that Worldcon, Kendra and I were discussing some of her creative cosplay ideas, and I had the sudden inspiration to create a backpack flying suit.

We spent the rest of the trip back discussing how the suit would look, and I had a fairly clear concept by the time we arrived home.

Overall Implementation

Since I'm kept very busy in my day job, I did what any engineer on a fixed schedule would do, I threw money at the problem: The suit ended up costing over $2000 in materials and equipment to make it happen.

The way I work on such things is to make endless trips to the hardware store. Most of the materials were obtained from Home Depot and Orchard Supply Hardware. Mechanical parts were ordered online from McMaster-Carr.



"Leather Sole Airship Pirates" - Charles, Kendra, and Paul Wayman. Awards: Best in Class, Master; Mechanical Work, Master, Dreamcatcher.. Source: Mid-American Fan Photo Archive.

Frame of Suit

The frame of the suit is constructed from 1/2" ID thin walled rigid electrical conduit. This conduit comes in 12 foot lengths. It was cut to size using a table saw, equipped with an abrasive metal cutting blade.

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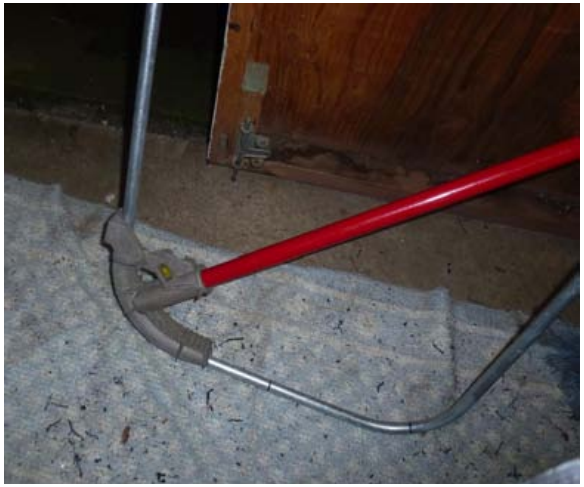
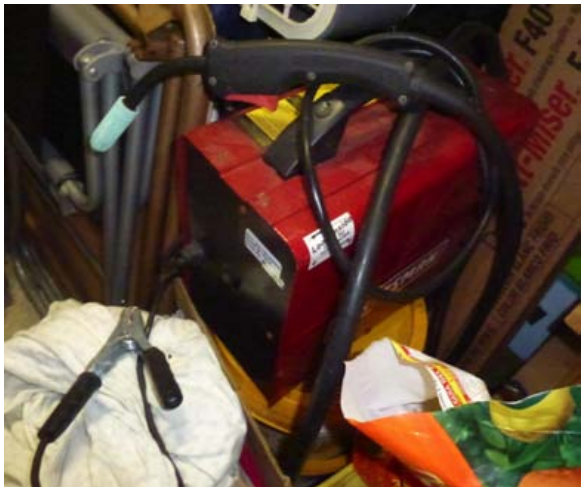
The electrical conduit was bent into the basic shapes used in the frame via a conduit bender. It was quite a challenge to determine the correct positioning of the bender on the conduit to achieve the desired overall shape and dimensions.


Conduit bender bending a piece of conduit.

Once the conduit was bent into the desired shape, and all pieces were cut, the pieces were welded together using a wire welding machine.

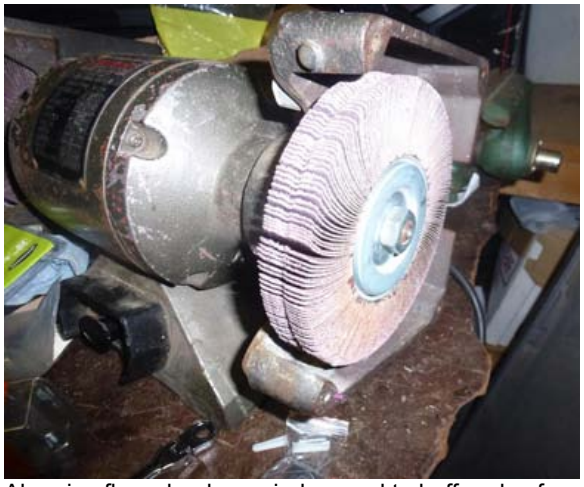
Since the electrical conduit has a zinc coating over the steel wall, it was necessary to use an abrasive flap wheel to remove the zinc coating from the ends prior to welding (Zinc makes nasty sparks, and produces a toxic gas if exposed to the heat of welding; it also prevents the welding process from working properly).

The use of a wire welder takes a fair amount of practice and skill to get good quality welds. It is also important to wear

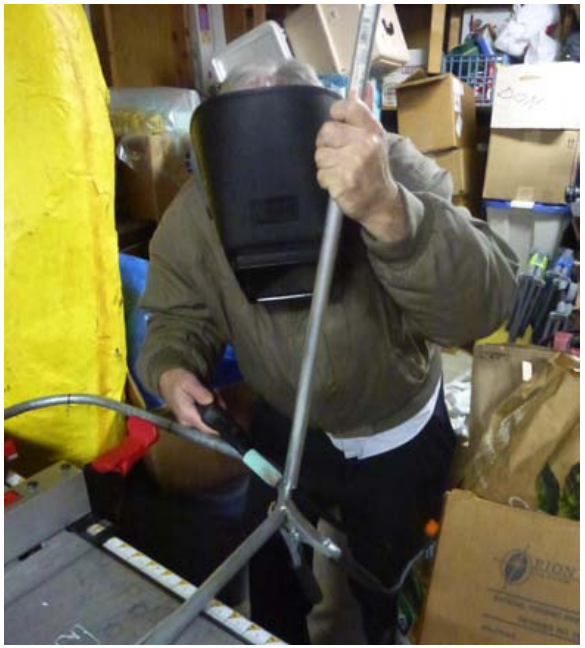

Wire welder machine.

long sleeve shirts and gloves (the welding process spits sparks, and the pieces are HOT after the welds are done. It is also a good idea to keep a bucket of cold water nearby, to dunk the pieces in after welding.

For safety, use SPF 50 sun screen on any exposed skin, and wear a welders mask. The arc from the welder produces UV rays.


Abrasive flap wheel on grinder used to buff ends of conduit.

Good ventilation is needed to prevent the toxic smoke from burning flux from building up. After completing the suit, I consider myself “barely” competent to use the welder.


Wearing safety gear, welding two pieces of conduit

In summary it may be better to take your parts of a welding shop than to do it yourself, if it is only a small job. If you plan on doing a lot of different things it may be better to buy a welder.

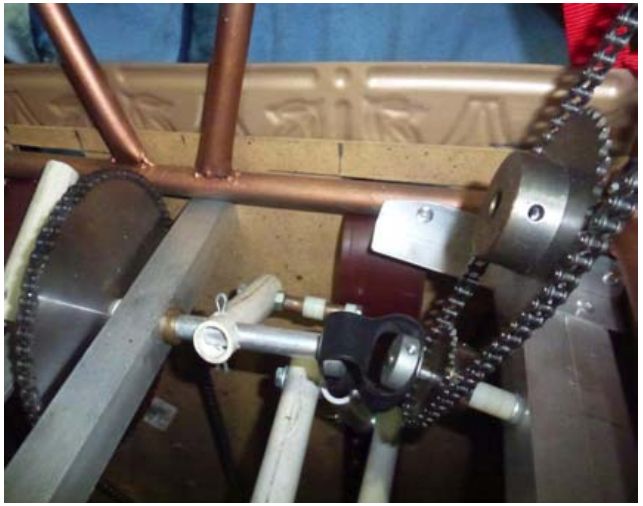
Mechanical Details of Suit

The mechanics of the suit are fairly simple: A battery powered drill drives a sprocket, which in turn drives a #25 chain. The large sprocket on the main drive shaft has 72 teeth, and the small sprocket on the drill has 9 teeth. This gives a torque


Propellers crossing one another.

amplification of 72/9=8, thus the powerful motor on the drill has its speed reduced by a factor of 8, and its torque increased by a factor of 8. This provides plenty of power to run the various moving parts on the suit.

The main drive shaft is coupled to two secondary drive shafts via a flexible rubber universal joint coupler. I had these laying around so I used them. In hindsight it would have been better to buy a rigid U joint.

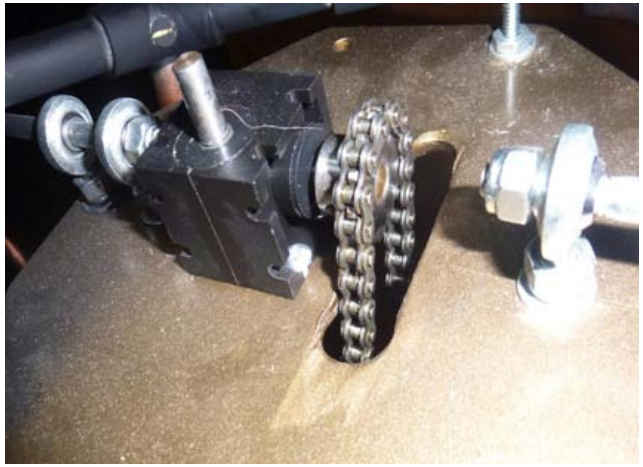

Drive shaft connected to secondary shaft with universal joint couples

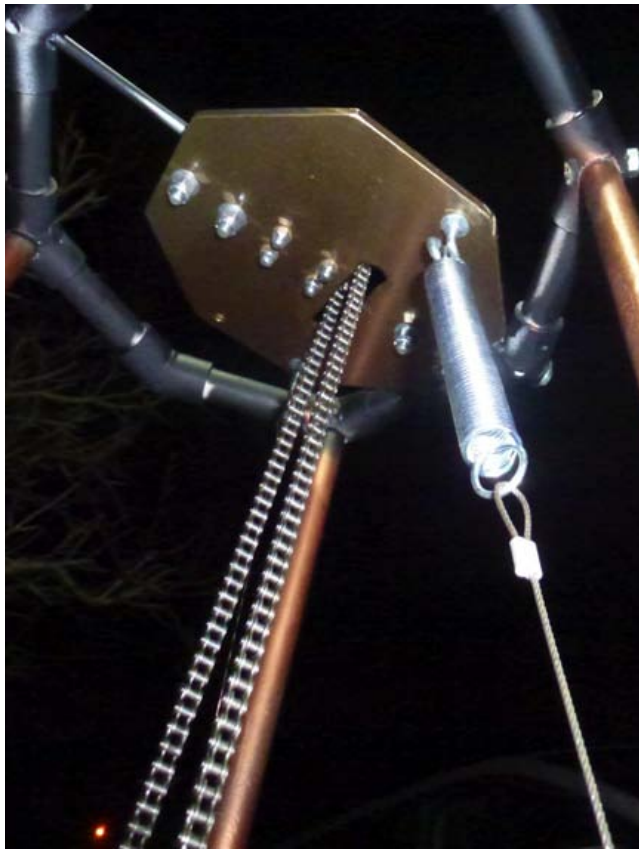
The secondary shafts are aligned perpendicularly to the propellers on the top of the suits. Two lengths of #25 chain connect sprockets on the right angle gearbox, which drives the propeller to sprockets on the secondary shafts at the bottom.

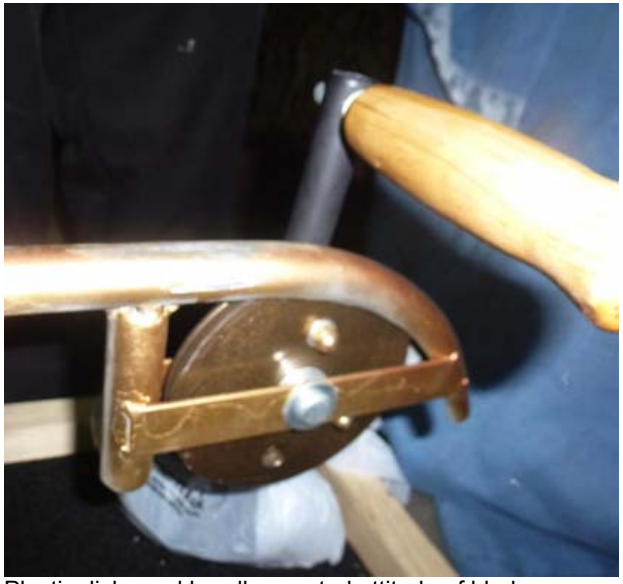
As the main drive shaft rotates, the propellers are driven. Note the interleaved action of the propellers. If the two propellers do not move in exact synchronization, they may hit each other. A lot of thought went into making the propeller arcs be able to cross each other without colliding.

Attitude control of the propellers is accomplished via the left and right handles on the front of the suit. By pushing the handle forward, the corresponding propeller tilts forward. By releasing the handle the propeller tilts backwards. This motion is accomplished via use of stainless steel aircraft cables. A spring provides the return force.

The octagonal frames at the top are constructed of ¾" PVC pipes, coupled with 45 degree elbows (8 pipes and 8 elbows). The pipes were drilled with the necessary access holes to fit the various pieces together, pressed and bolted into place.


Gear box at top, and propeller shaft.


Bottom of attitude control plate.

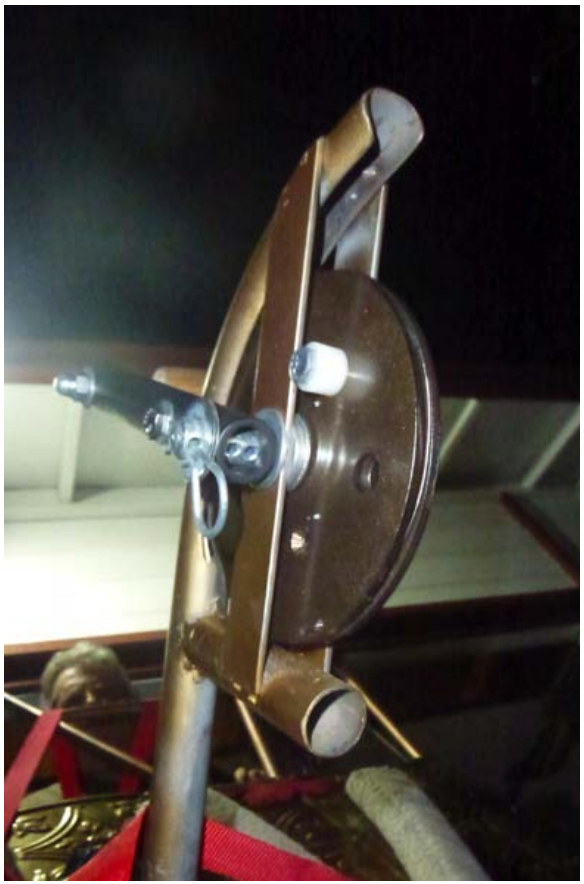

Plastic disks and handles control attitude of blades.

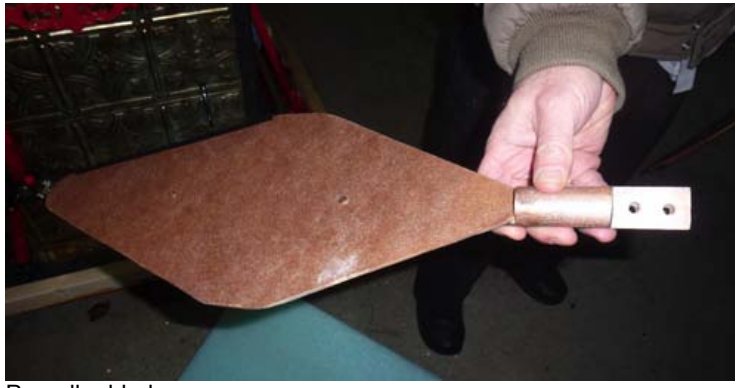
At the operators end, the cable winds around a wheel made of three sandwiched disks of acrylic plastic. The disks were purchased pre-cut at the local TAP plastics store. I bought four with a 6 inch diameter, and 2 with a 5 ½" diameter. Holes were drilled into the disks to allow them to be bolted together large, small, large, to provide a groove for the cable to ride in.

The disks are mounted into the forward sloping handles via welded pieces of steel strip and held in place by a ½" steel cotter pin shaft.

Perhaps the hardest single part of building the suit was creating the slots in the pre-bent conduit to allow the disks to be recessed into the conduit. This was done by sandwiching two metal cutting blades into the table saw, equipped with spacers between them. The conduit was clamped into place atop the saw, and the blades were gradually raised beneath the conduit to allow them to cut the slots. It took over a day to get that right, but I'm quite pleased with the result.

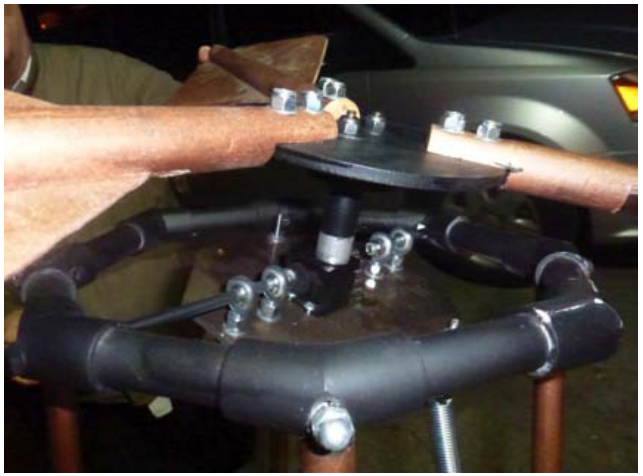
The propeller assemblies are actually very light: The blades are made from fiberboard, and ¾" diameter wooden dowels. The table saw was used to make the basic cuts to the dowels for the propeller shafts.


Disk from beneath riding in the slot.


Propeller blade.

The blade was tilted at 30 degrees then the ends of the cuts were trimmed with a wood chisel.

The propeller hub is constructed from a 6" diameter ¼" thick acrylic disk. The lower section is a piece of 2" diameter Delrin plastic for machine ability. Acrylic is brittle, and tends to crack when drilled. Delrin is more flexible, but much more expensive. Finally, a 1" diameter aluminum shaft is used to couple the propeller hub to the

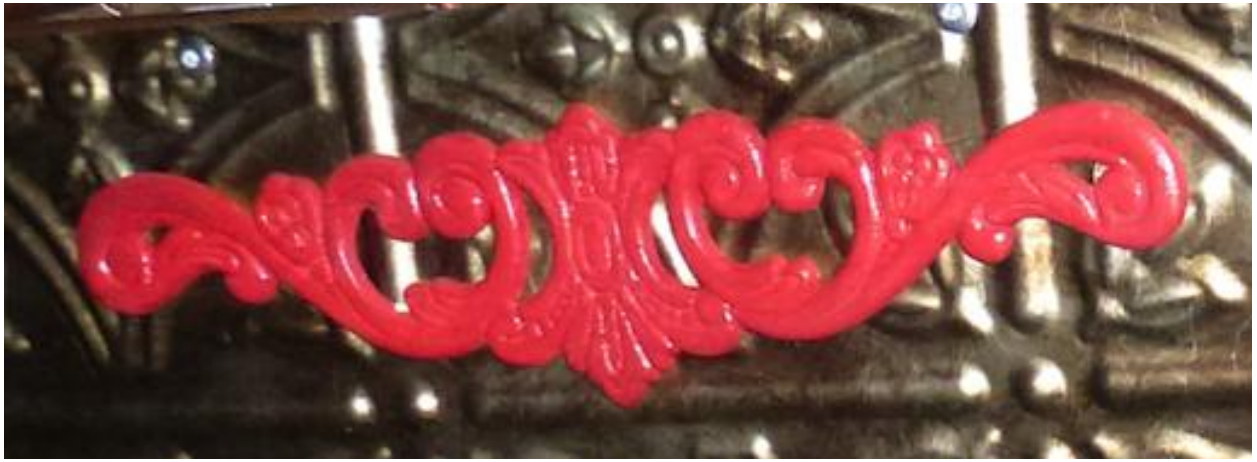

Propellor hub assembly.

gearbox. Note that both propeller assemblies can be removed via set screws on the propeller hubs. When we went to Chicago the propellers were packed separately from the rest of the suit, and were assembled prior to our first walkthrough.

Finish Work and "Fiddly Bits"

The frame of the suit was painted with a "Beaten Copper" Rustoleum spray paint. We also used a dull black paint to give the plastic pieces an iron look. It is important to note, that virtually the entire suit is constructed of 21st century materials, but we did our best to make it "look" Victorian.

Skin material made from plastic wall covering.



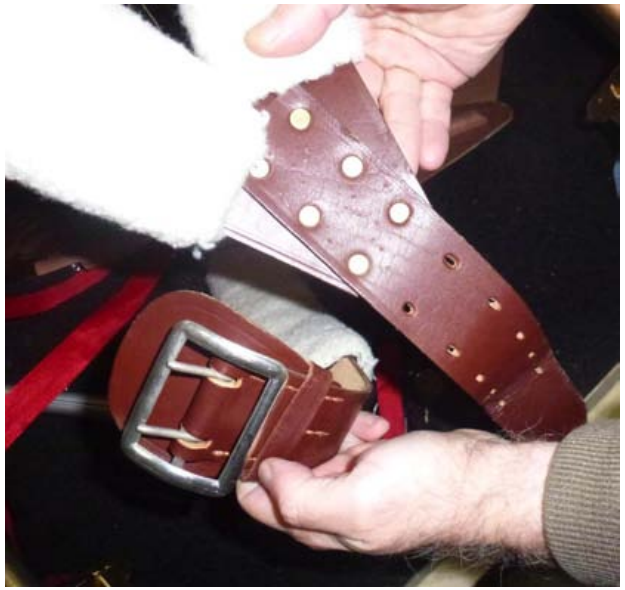
The red decorations were purchased at Home Depot and are meant for decorating doors. The decorations were pre-painted with spray paint then hot glued into place.

The skin of the suit is made of a plastic wall covering material. We spotted this at Home Depot, and its worked brass look screamed "Steampunk". The skins were individually cut and fitted via tin snips. The skin behind the operator's position is reinforced with a piece of fiberboard so the mechanical bits inside the suit don't dig into the operator's back.

The skins are secured to the frame via 3/16" aluminum pop rivets, which left us in a quandary as the rivet heads are somewhat anachronistic. To cover the rivet heads, we went to the local fabric store and bought 2" wide black cloth ribbon, then hot glued it to the riveted seams. To cover the arcs it was necessary to cut and overlap the ribbon.

The leather harness for the operator was made by purchasing two identical leather belts at the local army surplus store. The buckle end of the belt was cut and riveted to the frame via a pop rivet

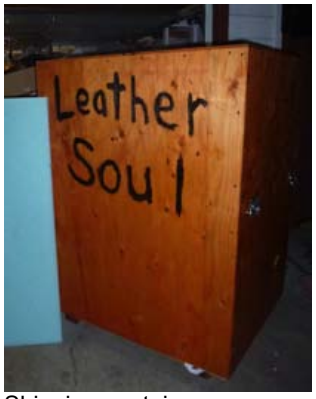
The upper Y shaped belt was constructed by cutting the other belt in half then using a razor knife to cut the leather to allow the pieces to mate together. The two pieces were mated to the hole end of the first belt via leather rivets done by our local



Harness assembly.

cobbler. The shoulder and crotch padding pieces were made from rolled synthetic sheep skin sewn together to keep them from unrolling.

To deliver the suit safely to the show, we built a plywood shipping crate. This crate is equipped with casters which can roll over most surfaces. The interior of the crate is padded and contains hooks to allow the suit to be secured with shipping straps. We brought extra tools and parts to repair anything that might have broken on the suit when getting it to Chicago. Luckily, nothing broke (probably because we were prepared?).

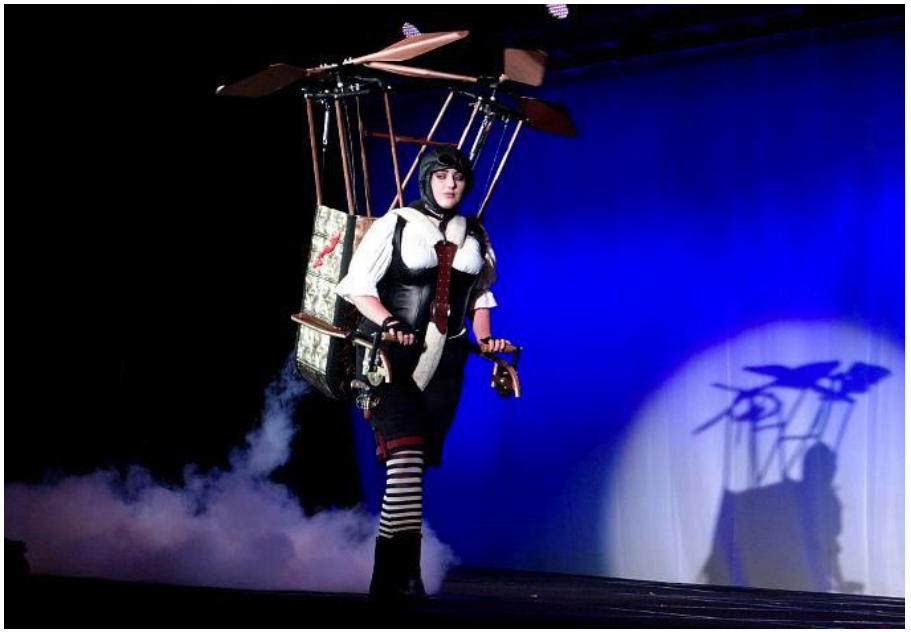


Shipping container.

Putting the Steam in Steampunk

The suit engine exhaust was accomplished via a CO2 fire extinguisher: The bottle for the fire extinguisher sits inside the suit, and the nozzle protrudes from the back. The extinguisher we used has a total of ~15 seconds of discharge time before it runs of gas, thus we really couldn't afford to test it thoroughly before use. The handle of the extinguisher is pressed by a cam follower driven by the main drive shaft, and discharges for a short time on each revolution. As mentioned earlier, we knew the drill motor had plenty of torque, so we were fairly confident the cam follower could activate the fire extinguisher.


Cam follower and fire extinguisher.


Kendra, Wayman in her flying suit. Source: Mid-American Fan Photo Archive.

Just prior to going on stage in Chicago, I went back and put the CO2 bottle into its final position, then pulled the safety pin on the fire extinguisher. I hoped like hell it would work as I helped Kendra into the suit and walked offstage. Fortunately it did!.

Summary and Conclusion

Building and showing our "Leather Soul Steampunk" flying suit was a grand adventure. It took about 50 trips to various stores, many hours of searching online for parts, and 3 months of working evenings and weekends to complete the suit and get all the inevitable bugs ironed out. Would I do it again? Absolutely!

Charles Wayman *is a computer engineer who lives in the heart of the Silicon Valley. He has enjoyed reading sci-fi literature since he was very young. He likes tinkering with gadgets and had fun building the steampunk backpack with electronic and mechanical components. Like all "mad scientists" he promises greater heights for his next creation but refuses to provide a clue about it.*

Kendra Wayman *has acted in school plays for the last four years. Her main interests are in cosplay, and she has created costumes for "My Little Pony." She enjoys hand sewing and is learning machine sewing.*