

A Roll Drop: *the solution to limited fly space*

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The Problem. The Whidbey Playhouse, a community theatre in Oak Harbor, Washington, has the same problem that many theatres have: a lack of fly space. Playhouse productions were often limited to single scene box sets. The Central Whidbey Lions Club in Coupeville designed and built a roll drop mechanism to add greater diversity and depth to productions. Not only does the theater lack fly space,



there is a challenge because of the Mansard style ceiling shown in the designer's sketch of Julian Wiles' *FrUITCaKes*; the 2012 Playhouse Christmas production.

Design Criteria. Rapid scene changes are a must to hold the audience's attention. A 15 second change is pushing the limits so that was set as an upper bound for our audience. A roll drop/ olio seemed to be the only acceptable solution. Hanging a 60 pound moveable drop with a steel hem pipe over actors and stagehands requires attention to overhead safety. There are designs for manual roll drop systems both single and double rigged. The drawback to a manual system is that it is difficult to ensure positive control at all times. Since the theater depends on rotating volunteer crews, often with little experience as stagehands, a manual system was ruled out.

Professional theater solves the problem with a motor driven, worm gear, winch assembly, with equipment from companies such as Thern and Stagecraft Industries. The empty drum system can weigh between 300 and 750 pounds. These systems are prohibitively expensive for a small theatre. The Playhouse stage needs to be reconfigured between productions—about six productions each year. Only one or two people are available to move the drop assembly from one position to another. The theater

sidewalls are 9.5' to the 4:12 pitch ceiling. The standard Playhouse flat is 10' and that requires a standoff from the sidewall of at least 12". At 24" from the sidewall the head space for a 10' flat is over 12".

Because of our requirements, everything pointed towards a unique design for the Playhouse using a tubular motor and planning on flying drops of about 10'. The tubular motor solved the freewheeling overhead weight issue since the drum rotates only when power is applied.

After an exhaustive search of tubular motor manufacturers only one motor was found that fit the design needs:

Somfy® LT50 Standard 515S2 110 volt 4 wire Star Head Motor , torque 132 (iin-lb), speed 38(RPM), unit weight 6.1 lbs. A multi-purpose tubular motor used to power numerous products (roller shutters, awnings, roller blinds, etc.)¹



With a 4" diameter drum this motor generates 66 in-lb of torque. The travel speed starts at 39.8 fpm and increases to 49 fpm as the drum fills and 53 in-lb lifting force decreases as the length of the lifting arm (radius) increases by the thickness of the fabric wound on. The effective lifting force over the range of fabric take-up is about 60 in-lb. The following picture shows the components that were assembled to make the roll drop system:²



The following table summarizes that which is accepted in professional theater and the design criteria that the Playhouse system achieves.

Length of drum ¹	Max soft goods width	Drum diameter	Drum RPM	Travel speed	Height of drop	Soft goods thickness ²	Max ³ soft goods weight
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¹ This motor is available in a radio controlled model. It was decided that positive control was best through a manual operated switch. The unit has settable up and down limit switches built in. The unit could be wired into DMX512 allowing control from the lighting both. The Playhouse does not anticipate using this option.

² Product literature from tubuar motor manufactures will often equate torque and force. Torque(τ) is defined as: $T = r \times F = r F \sin(\theta)$. Since we are only interested in lift $\sin(90^\circ) = 1$ and $T = r \times F$. If the radius or lifting arm is measured in inches and the force in lbs then the units for torque are in-lb. Since torque is constant, measured at a radius of 1 inch the lifting force IS 132 LBS. At 2" the lifting force is 66 lb. With 10 layers of fabric 1/16" thick are wound on the radius becomes 2.625" and the lifting force decreases to 50 lbs.

Typical system supplied by stage equipment manufacturer							
24 ft	22 ft	5.56"	22 rpm	20-40 fpm	40 ft	1/8"	330 lb
Whidbey Playhouse installation designed and built by Central Whidbey Lions Club							
20 ft	19' 6"	4.0"	38 rpm	40-49 fpm	10 ft	1/16"	50 lb

¹ Drum lengths can vary depending on need. The WPH installation can be extended up to 30' in length limited by the pitch of the theater ceiling.

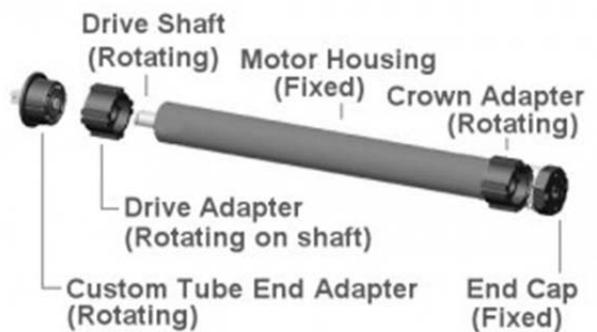
² Estimate from Rose Brand catalog. Likely fabrics: Poly muslin, 12 oz. canvas, painter's linen, heavy weight muslin, sharks tooth scrim

³ Likely soft goods weights vary from 0.61 lbs/yd (scrim) to 3 lb/yd (canvas) for 126" widths. A 20' wide by 10' high drop will require a maximum fabric weight of 20 lbs plus a 1/2" steel hem or bottom pipe weighing 17.5 lbs for a total weight of 37.5 lbs. If a 3/4" hem pipe is used total weight increases to 42.6 lbs.



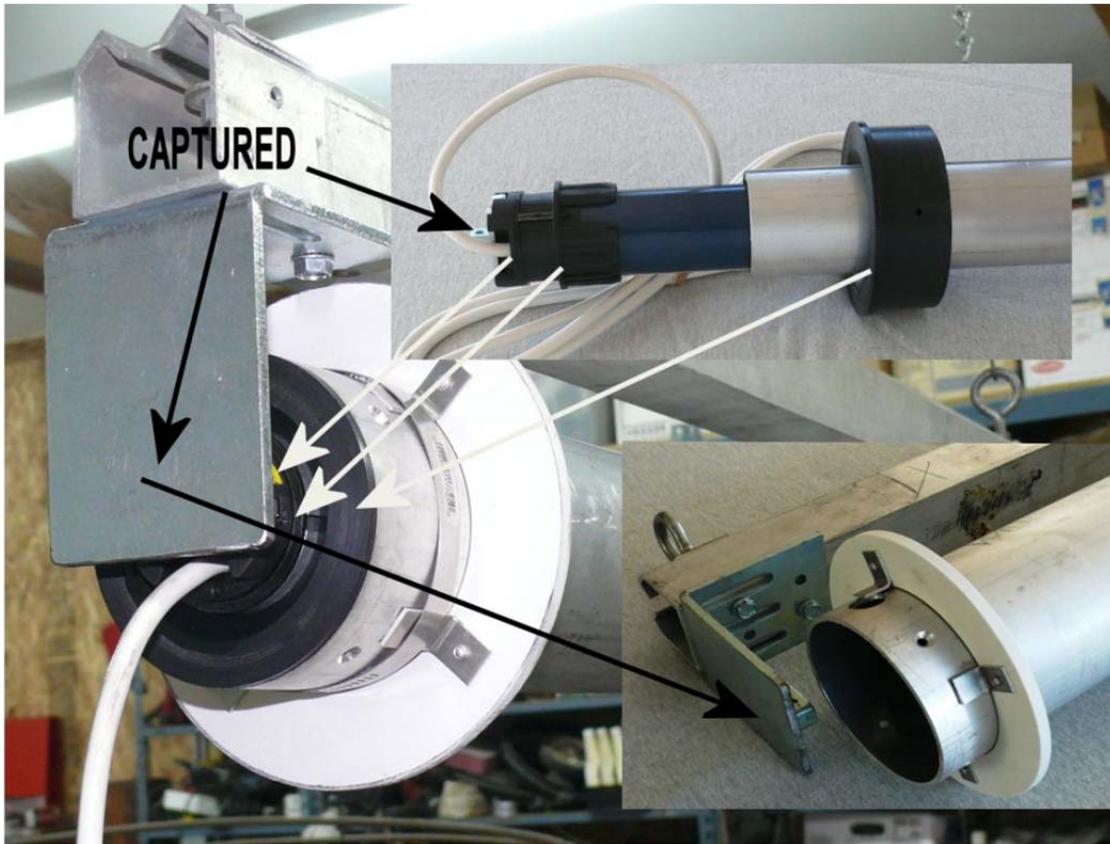
The assembled working prototype is shown at the left:

An empty drum weight for the system of about 30 pounds was the design goal. This was easily achieved by using 4" aluminum irrigation pipe. Tests of irrigation pipe with anticipated nominal load gave an acceptable deflection over 20' of about 1/2". Irrigation pipe was not readily available. Four inch diameter, 1/8" wall

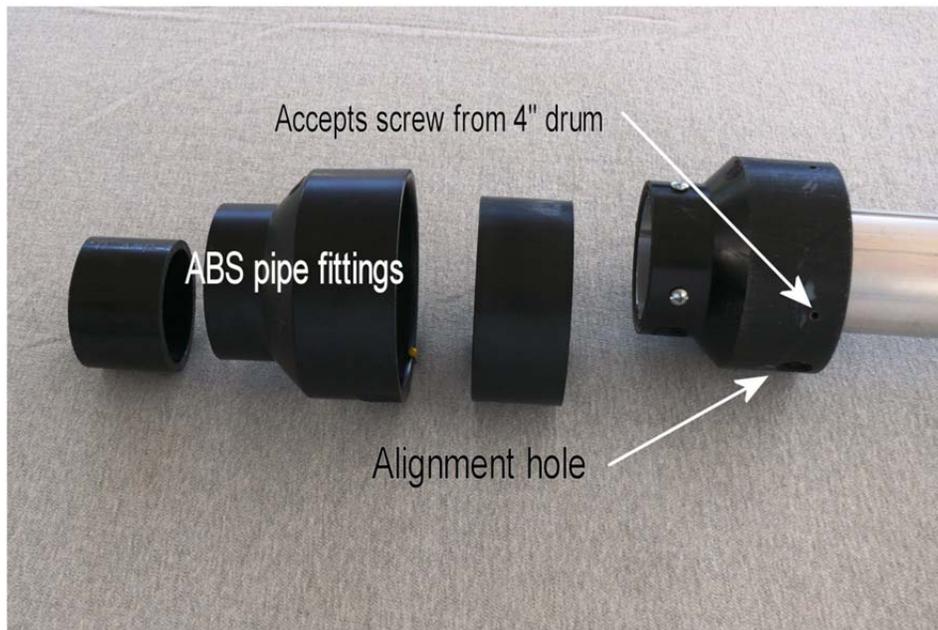


aluminum tubing was used even though it was much more expensive and heavier. Yale School of Drama articles lists 1/2 to 3/4 inch as acceptable amount of deflection. We used 1/2" as our gold standard. With 1/8" wall aluminum tubing the deflection is 0

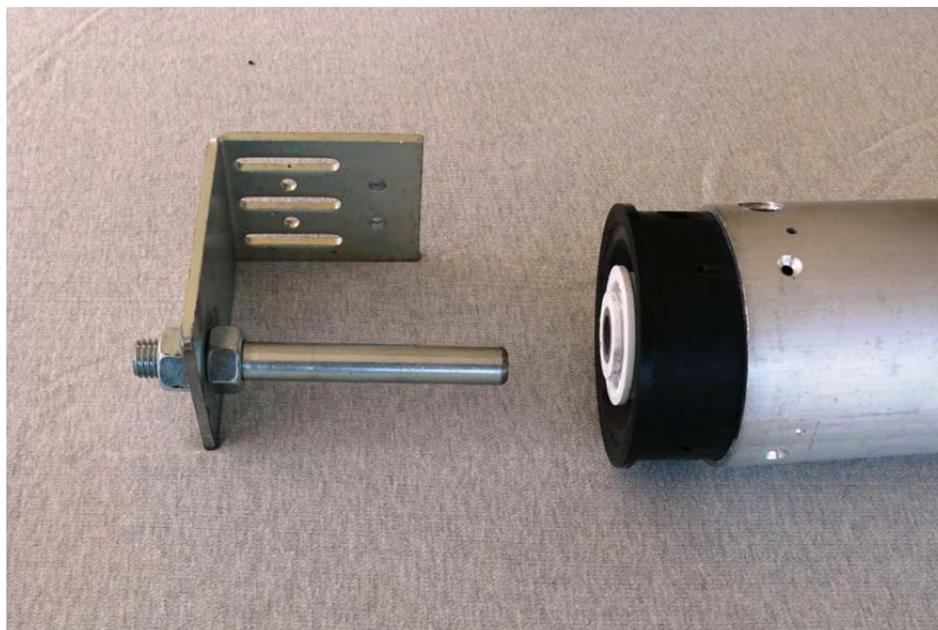
Building the system. The heart of the system is the Somfy® motor. The generic drawing of a tubular motor helps understand how it works. The end cap is fixed and captured by the mounting bracket. The following photo shows the as built configuration of the motor end of the tube with the end cap and crown adapter. ABS pipe fittings have been glued and machined to align and assemble the components.



The drive adapter adapts the Somfy® fittings to fit into a 4" aluminum tube. Somfy® does not manufacture a tube this large in diameter. Once all of the parts are laid out it becomes apparent what needs to be done to fit them together. The ID of pipe and tubing are different and dependent on wall thickness so this cannot be done until the tube is in hand. The Somfy® star drive fittings adapted well and the mounting was done by gluing up standard ABS plumbing fittings then machining them on a lathe. The pipe fittings used are shown to the left of the assembled drive adapter. The Somfy® star adapter tube is inside the assembled driver adapter on the right and captured with screws. All of the torque applied to the drum is transmitted through this drive adapter.



The tube end adapter for the idler end of the drum is straight forward. Again a combination of standard pipe and pvc electrical conduit were used to adapt to the Somfy® heavy duty bracket and idler shaft. The bottoms of the supplied brackets were cutoff to avoid interference.



The assembled prototype shows how the motor drum and idler are sandwiched between the brackets mounted on the salvaged aluminum curtain track. Everything is free floating between the brackets. The curtain track is an essential part of the assembly. It need not be curtain track, of course, but a rigid

mounting back is needed to make the system work. The head space required for this installation is about 12".



Flanges were installed on the drum to keep the fabric from spooling off the ends. Flanges are adjustable to the width of the soft goods.

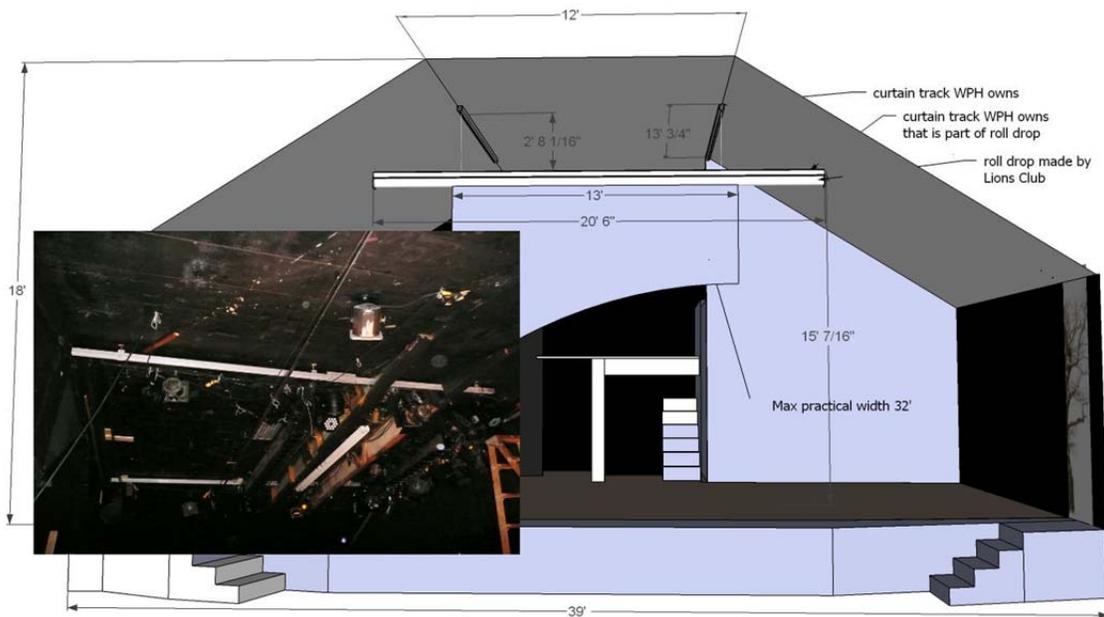
To ensure compatibility between components a drilling jig was used to position the holes. A large alignment hole allows a finger to grasp a component seated deep in the tube and position it so the holes line up.



In the Theater. The following shows the assembled drop for *FrUITCaKes* in the paint shop. In this case, due to space on the set the drum was set at 16' 8" and the drop width is 16' 4".

There was concern that torque from the drum in motion would cause the drop to swing if rigged with chains only to the grid. This has not been the case so far.

Installing this system in The Whidbey Theater presented other challenges because of the roof shape. An abundance of salvaged curtain track rails were available and installed in the grid. The oleo system was suspended from this. The weight of the system with drop and hem pipe is such that one person can move one end up or down at a time to reposition the drop.



A roll drop may be the answer to a lack of fly space and out of the ordinary theater configurations.

Photos and illustration/Jim Rich