

Water Wheel at The Southeastern Center for Contemporary Art, 1991.

## A Water Wheel for Technorama by Norman Tuck

#### Step up onto the platform and turn the handle to activate the sculpture.

You can hear the roaring noise of the water flowing within the spinning chamber. You can smell and feel the water vapor that rises from the agitated stream of water.

### Introduction

I put together this booklet to help the **Technorama** Museum in Winterthur, Switzerland fabricate a new **Water Wheel** for permanent outdoor use. The new piece will be made under license and is to be entitled **Water Wheel 2**.

The booklet documents the **Water Wheel** as it was originally constructed in 1979 and reassembled in 2016 and offers instructions for reproducing the piece. Included are a few recommendations for improving safety and the accessibility. Also included are specifications for an alternative fabric apron so that during the winter months the piece can be brought indoors with Styrofoam and colored tissue paper substituted for water.

The book should is be used together with the video, **Water Wheel Assembly 1**, which can be found on the web at https://vimeo.com/161704260.

I wish to thank **Technorama**, Barbara Neff and Thorsten Kunnemann for their support.

## Dedication

This book is dedicated to Remo Besio whose continued friendship and consistent belief in my abilities have enriched my life.

**Update:** Sadly, Remo died of cancer on March 14, 2016. He never had the opportunity to see this booklet. However, I was able to tell him about the dedication, and he seemed humbly pleased.

Remo will be sadly missed by all who had the opportunity to know him.

Norman Tuck, 2016

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Figure 1 - Technorama, 1993.

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The book should is be used together with the video, Water Wheel Assembly 1, which can be found on the web at https://vimeo.com/161704260.

Visit www.normantuck.com for videos of the Water Wheel and other kinetic artworks by Norman Tuck.

Contact Norman at norman@normantuck.com.

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## A Water Wheel For Technorama

#### **By Norman Tuck**

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### \*Fabrication Drawings by Dick Falkard.





Figure 2 - Three Views

## Description

The **Water Wheel** is an interactive artwork in which museum visitors spin a giant flexible chamber containing either water or a colorful mixture of lightweight materials. It was created at the University of Minnesota in 1978-79.

## Assembly instructions for the original Water Wheel, together with a parts list, can be found on page 26 of this book.

The piece uses a sheet of clear plastic sheeting loosely stretched between two large metal wheels that are mounted on welded steel structures. A small quantity of water (2 to 4 liters) forms a pool at the bottom of the plastic sheeting. When the mechanism rotates, the pool becomes a flowing stream. At faster speeds the water cascades like a roaring waterfall within the spinning chamber. At top speed centrifugal force locks the water within an outer valley of the flexible material.

Although originally created to churn water, the **Water Wheel** was later exhibited in formal gallery situations where there was a fear that water leakage might damage carpeting or hardwood flooring. In these circumstances Styrofoam peanuts, tissue paper, ribbon and confetti were substituted for water. These dry materials exhibit fluid dynamics similar to flowing water, with the added beauty of a blizzard of slowly falling lightweight "snow".

## **Dimensions** \*

Maximum Outside Dimensions (Spinning). = Approx. 144 inches x 144 inches x 144 inches	
Distance Between Wheels = Approx. 76 inches	Water Contents = $2 \text{ to } 6$ Liters
Wheel Diameter = $74$ inches	Axle Height = $70$ inches
Platform Height = 16 inches	Platform Width x Length = $49$ in. x 40 in.
Tower Width x Length = $35$ in. x $35$ in.	Hand Wheel Diameter = 34 inches
Apron, Water Use = 288 in. Loop x 96 in. Wide	For Dry Use = $288$ in. Loop x 108 in. Wide

Minimum Weight in Tower = 50 pounds

\*February, 2016 Installation.



Figure 3 - The Exploratorium - 1994

## **The Steel Structure**

A variety of mild steel rods and plates were welded together to form the **platform**, the **tower**, and the **Wheels** (Dimensions, See Page 4).

The grating material used to support the visitors and the weights was a heavy, industrial surplus woven steel grating that may have been used for shaking coal, stones, or iron ore. It is made of 3/8-inch thick steel rods woven and welded together on a  $2\frac{1}{2}$ -inch grid pattern. Any kind of strong, steel grating material may be used.

The **rim** of each **wheel** was made from "U" shaped steel channel that was rolled to form a circle. The spokes and axles are cold-rolled, steel rods welded onto a central steel hub. The width of the inside of the **rim's** "U" channel should be wide enough to contain the hose clamp material, together with the fabric of the **apron** and **drum head**.

The steel structure of the **Water Wheel** was hot-dipped, zinc galvanized in large tubs. The zinc surface has been highly resistant to corrosion and has aged well, without rust, and given the piece a beautiful patina. Stainless steel may be substituted for the mild steel structural elements.

The **weights** that stabilize the **tower** should be large, heavy natural rock, preferably found in rivers or the ocean where they have been smoothed by the flow of water (see rear cover photo).

Four self-centering, ball bearing pillow blocks are used in the **Water Wheel.** The pillow blocks are bolted to the steel plates that form the top of the **platform** and **tower** structures. The bearing arrangements are shown on pages 10 and 11.

The amount of water used in the **Water Wheel** varies according to situation and preference, but it is usually between 2 and 5 liters. Please use your discretion when filling the piece with dry materials (Styrofoam peanuts, colored ribbon, colored tissue paper, confetti, etc.) for indoor use.

A rubber "**cane tip**" has been used on each leg to keep the piece from traveling while in use and to protect the floor surfaces.



Figure 4 - Platform, Side and Front Views



Figure 5 - Tower, Side and Front Views



Figure 6 - Wheel - Platform Side



Figure 7 - Axle Assembly - Platform Side



Figure 8 - Wheel - Tower Side



Figure 9 - Axle Assembly - Tower Side



Figure 10 - Suggested Safety Rails for the Platform

## **Platform Safety Rails and Step**

An array of steel bars (1/2 inch round rod) should be added to the platform to create a railing to prevent children from falling forward from the platform.

A step surrounding the entire platform may also be added.



Figure 11 - Installation at the Science Museum of Minnesota, 1999.

## **Minnesota Safety Modifications**

In 1999 the Science Museum of Minnesota decided that in the interest of crowd safety, they would; surround the piece with a walled fence-like barrier, add an acrylic panel to prevent children from falling forward from the platform, and replace the handle with a solid, round disk.

I believe that the fence is not necessary, and that additional steel bars should be substituted for the acrylic panel (see page 12).

See Pages 14 and 15 for a discussion of appropriate wheels and handles.





Fig. 14 - Wrapped Sailboat Wheel

## Wheels And Handles

#### Three types of handles that have been used in the Water Wheel.

The **Original Handle** was a solid stainless steel handle that worked well. However, it was perceived as being dangerous when several children were on the platform cranking at the same time.

The **Wooden Disk Hand Wheel** was a solid wooden disk that worked well in Minnesota, where the wheel contained only Styrofoam peanuts. However, at 17 inches it seems too small for spinning the wheel when using water instead of Styrofoam. 32+ inches is recommended for spinning water. I recommend varnished fine plywood with an indented rim.

A **Cord Wrapped Stainless Steel Wheel** works well and looks good. I was able to locate one on eBay. It was manufactured for use in a large sailboat. However, its open, spokes may create a "pinching" hazard if the visitor places his or her hand through the open wheel. Pages 14 and 16 show the wrapped wheel.

The recommended solution is try to obtain a Wrapped Sailboat Wheel (eBay?) about 32 inches in diameter.



Figure 16 - Sailboat Wheel



Figure 17 - A Hose Clamp



Figure 18 - San Francisco, 2016



Figure 19 - Pool of Water



Figure 20 - The Steel Grating



Figure 15 - Wheel Rim with Drumhead and Apron

## What Holds the Drumhead and Apron to the Wheel Rim?

**Stainless Steel, Worm-Gear Type, Automotive Hose Clamps** are used to squeeze the apron and the drumhead into the "U" shaped rim of the wheel. Using a group of clamps, rather than a single long clamp, allows the clamps to be tightened evenly around the wheel.



Figure 21 - Taping the Drumhead to the Wheel

## The Drumheads

The **drumheads** are made from 6 mil. clear vinyl sheeting stretched over the rim of the **wheel**, like the head of a drum, to keep the contents of the **Water Wheel** from escaping.

I have found that it is sufficient to use only one **drumhead** mounted on the tower side, leaving the **wheel** on the platform side open.

When the **Water Wheel** is exhibited indoors with Styrofoam and tissue paper instead of water, I suggest using an open mesh of the flexible fiberglass material such as is designed for plaster or stucco-work, or immersion into poured concrete.

## How to Attach the Drumheads

You will need two workers, the drumhead material, a roll of 1/2-inch wide fiberglass utility tape, a scissors, a marker, and a knife.

1. Cut a piece of the drumhead material somewhat larger than the size of the wheel.

2. Loosely attach the drumhead material to the tower side wheel by using several short pieces of fiberglass filament tape to tape parts of the drumhead's border evenly to each of the spokes.

Note that the next step is difficult, and it is best to use two people.

3. (See page 18) Securely tape the end of the roll of fiberglass tape onto one of the spokes. Now, pull very, very firmly on the tape as you go around outside circumference of the wheel using the tape to force the drumhead material firmly into the rim. Wrap the tape around the wheel several times until the drumhead is stretched tightly over the face of the wheel.

4. If you expect the piece to be stored outdoors during windy conditions, cut a 3 foot diameter hole in center of the drumhead to allow strong winds to pass through withou damaging the piece (see figure 25).

If you decide to install a drumhead on the platform wheel, use the same procedure.



Figure 22 - Marking the Apron



Figure 23 - The Fill Plug

## **Making The Apron**

To make an **apron** for water use; heat seal the ends of 6 mil. clear vinyl or polyethylene sheeting together to form an approximate 22 to 24 foot long **loop** that is approximately 8 feet wide. Vinyl is much better than polyethylene.

Eventually, after perhaps 2 months of heavy use, the plastic sheeting may begin to crack where it flexes, and must be repaired or replaced. Tape can be used to repair holes and cracks. I use 3M Transparent Weather Sealing Tape (2110NA).

If two d**rumheads** are used to seal the chamber, a water **"fill plug**" can be made from an internally threaded PVC plumbing pipe fitting with a screwed-in plug. Figure 23 shows this unit inserted through a hole in the apron material and sealed with an external hose clamp.

Sewn fabric should replace plastic sheeting when Styrofoam peanuts, colored tissue paper, ribbon and confetti are substituted for water for indoor use. A permanent **apron** was made using rip-stop nylon sailcloth that was provided and sewn into a loop by a professional sail maker. I believe that this material is listed as 1.5 ounce Nylon Spinnaker Cloth. The fabric **apron** should be sewn into a 24-foot loop that is at least 9 feet wide. The fabric apron can be easily repaired by sewing.

## **Preparing the Apron**

To Prepare the Apron for attachment; spread out the apron and measure along the edges of the loop of material. Divide this measurement by the number of spokes on each wheel. Now, make marks evenly around each edge of the apron so that each edge is divided into a number of segments that is equal to the number of spokes on the corresponding wheel. On the original **Water Wheel** one side of the apron was divided into 7 segments, and the other side was divided into 9 segments.



Figure 24 - Taping the Apron to the Spokes.



Figure 25 - Attaching the Hoop using "C" Clamps.

## **Attaching The Apron**

You will need: two workers; the prepared apron, a roll of ½ inch wide fiberglass filament tape, 6 or 7 small "C" clamps, a scissors; a utility knife, and the two long hoops of stainless steel "worm gear" type automotive hose clamps.

1. Create the hoops by assembling several hose clamps together to form hoops that are slightly longer than the circumference the wheels. Make sure that the hoops can be easily slipped over the rims. It is better to use several hose clamps connected together (daisy chained) than a single, very long clamp, so that the hose clamps can be tightened evenly around the wheel.

2. Attach two-foot long pieces of the fiberglass tape to each spoke (figure 24).

3. Use these pieces of tape the Apron's edge to each of the spokes at the points on the Apron that you had previously marked (page 20). The Apron should now hang loosely from several points on the wheel.

4. Position the hoop so that it surrounds the Apron material near the rim of the wheel .

5. Use a small "C" clamp to clamp a section of the hoop to the rim so that it holds the hoop and the apron to rim of the wheel (see figure 25).

6. Go around the wheel, using the small "C" clamps to hold the hoop to the rim (fig. 25, again).

7. After you go completely go around the wheel, the hoop and clamps should be holding the apron onto the wheel. Remove the clamps as you carefully tighten the hoop to force the apron material into the rim of the wheel. At this point you should tighten the hoop only enough that it cannot fall out of the rim as you adjust the apron material.

8. Before you fully tighten the hoop, carefully adjust the apron material so that the apron is gathered around the wheel with several inches of material overhanging the rim of the wheel. This is done by sliding the material under the loose hoop. I have found that it is best if the apron is adjusted with some "irregularities" so as to create "pockets" that will disturb the flow of water to create turbulence as the wheel spins.

9. After everything appears correct, fully tighten the hoop. Use the same procedure to attach the apron to the other wheel.



Fig. 26 - A Blizzard of "Stuff."

## Filling and Adjusting the Water Wheel

Add between 2 and 6 liters of water, and give **Water Wheel 2** a trial spin. It is best to use the smallest amount of water that gives a satisfying experience.

Move the platform and tower away from each other until the apron cannot not touch the ground.

#### **Experiment. Experiment. Experiment!**

Experiment with the amount of water and the distance between the wheels to give the most satisfactory experience when spinning. The two wheels do not necessarily need to be aligned or parallel.

Also, experiment with creating irregularities and "pockets" in the Apron that will make the water turbulant as it flows. This is done by loosening the hose clamps and pulling out the edges of the plastic material.

#### All adjustments are a matter of taste.

When using dry materials, I suggest a mixture of a wide variety of materials including; Styrofoam packing peanuts (not water soluble), ribbon, tissue paper, thin Mylar, etc. Note that sheets of tissue, ribbon and Mylar will sometimes hang suspended in the air. Enjoy experimenting with different amounts of different materials.

Good luck to you. And please tell me how things are going. Suggestions? Modifications? I'd love to hear from you.

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## Sample Texts That Have Accompanied the Water Wheel

#### Text 1

#### Step up onto the platform and turn the handle to activate the sculpture.

You can hear the roaring noise from the turning drum as well as the sound of the water flowing around the drum. You can smell and feel the water vapor that rises from the agitated stream of water.

The Water Wheel contains about five liters of water.

#### Text 2

#### Step up onto the platform and turn the handle to activate the sculpture.

Inside the Water Wheel water is constantly lifted and then flows down the inside of the vinyl drum.

The turning drum makes a roaring noise and you can hear the water flowing as well. It is easy to smell and feel the water vapor which rises from the agitated stream of water.

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#### **Text 3: The Blizzard Maker**

Used when the Water Wheel was exhibited indoors with Styrofoam, colored tissue and ribbon substituting for water.

#### Step up onto the metal platform and turn the handle to activate the sculpture.

Try to adjust the speed of the wheel until you get a pleasing blizzard of Styrofoam peanuts and tissue paper falling through the center of the wheel. This happens when the amount of centrifugal force acting on the orbiting Styrofoam pieces balances the force of gravity pulling the pieces down.

## **Exhibition History of the Water Wheel**

The University of Minnesota, Minneapolis, 1979 (containing water).
PS1, the Sound Exhibition, Long Island City, Queens, New York, 1979 (water).
The Southeastern Center for Contemp. Art, Winston-Salem, NC., 1991 (water).
City Gallery of Contemporary Art, Raleigh, North Carolina. 1992 (water).
Technorama, Winterthur, Switzerland, 1993 (water).
The Exploratorium, San Francisco, California. 1994 (Styrofoam + tissue).
Inventure Place, Akron, Ohio. 1996 (Styrofoam + tissue).
The Science Museum Of Minnesota, St. Paul, 1999 (Styrofoam + tissue).

## **Two Reviews**

"On the outdoor sculpture deck of the Main Gallery is a much simpler viewer-activated piece titled *Water Wheel*. A sheet of clear plastic is loosely stretched between two large metal wheels mounted on a framework that allows them to turn when a viewer activates a crank. A few gallons of water form a small pool at the bottom of the plastic sheet, but when the crank is turned to rotate the mechanism, the water's action mimics that of a stream flowing rapidly downhill. "

Tom Patterson, Winston-Salem Journal, Sunday, January 19, 1992 Page C3.

"In **Water Wheel**, two large wheels form a frame for a plastic bag that has a small amount of water inside. When the crank is turned by hand, the plastic billows out and the movement of the water produces a booming sound like that of waves crashing on the beach." *Blue Greenberg, The Herald-Sun, Durham, N.C.* 

## Assembling the 1979 Water Wheel.

See Figures 2, 4, 5,7 and 9 and view the video, Water Wheel Assembly 1, at https://vimeo.com/161704260.

#### The Parts You Will Need

- 1. This Instructional Book
- 2. Steel Platform with Grating.
- 3. Support for platform side wheel.
- 4. Steel Tower.
- 5. Steel Grating for Tower.
- 6. Heavy weights to be placed on Tower Grating (Large Stones, etc.).
- 7. Handle or Hand-Wheel (see pages 14 and 15).
- 8. Small Square Key for handle keyway.
- 9. The Two Large Wheels with attached Pillow Blocks (bearings).
- 10. The Two Large Hoops made up of stainless steel hose clamps.
- 11. Twelve bolt assemblies consisting of: bolts (2 inch x 3/8 inch), nuts, flat and lock washers.
- 12. The Apron, as described in previous pages.
- 13. The Two, optional, drumheads, (vinyl or mesh) as described earlier.
- 14. Water or a Mixture of Confetti, tissue paper, ribbon, etc.
- 15. Eight <sup>3</sup>/<sub>4</sub> inch rubber cane tips to protect the floor surface.

#### Assembly

1. Attach cane tips (parts #15) to the feet of the Platform (part #2) and bolt the Platform Wheel Support (Part #3) to the ears of platform (part #2) using four of the bolt assemblies (parts #11) (see figure 20), and place assembly in position on floor.

2. Attach the Platform wheel to the Platform Wheel Support by bolting the two pillow blocks to the top of the support (see figure 7).

3. Attach Handle or Hand Wheel (see pages 14 and 15) to axle using Square Key (part #8).

4. Attach cane tips (#15) to feet of Tower, then place Tower Grating (part #5) into bottom of Tower and "clip" grating into place.

5. Place Tower into position and put weights (#6) onto grating.

6. Attach the Tower Wheel to the Tower by bolting the two pillow blocks to the top of the support (see figure 9).

7. Follow the procedures on pages 16 to 23 and view the video to complete installation.





# The Water Wheel as built at Technorama in 2017

Photo Courtesy of Barbara Neff



# The Water Wheel as built at Technorama in 2017

Photo Courtesy of Barbara Neff

## 2018 Update

Pages 28, 29 and 31 show Images of the Water Wheel that was built at the shop at Technorama in 2017. I hope to soon receive photographs of the piece as installed in Technorama's outdoor space.

I wish to, again, thank the Barbara Neff and Thorsten Kunnemann for their support and also than the Technorama staff members that did such a beautiful job of recreating my piece.

Norman



Water Wheel under construction in the Shop at Technorama

Photo Courtesy of Barbara Neff



Inventure Place, Akron, Ohio, 1996