TURBULENT ORB
by Ned Kahn

MAINTENANCE INSTRUCTIONS

GENERAL INFORMATION:

The Turbulent Orb is a large polycarbonate sphere filled with an iridescent, colored, fluid that makes flow patterns visible. The sphere is mounted on top of a pedestal which can be spun in either direction and at different speeds. The fluid in the sphere shows swirls and waves of internal fluid motions produced by the actions of the visitors. The turbulence of the fluid in the sphere is reminiscent of the turbulent flows that occur in planetary atmospheres. This exhibit shows the complexities of fluid motion that can be produced by very simple circumstances.

Maintenance:

Clean fingerprints off the plastic sphere with the plastic cleaner supplied. Surface scratches may be polished out with the Novus products supplied (DO NOT use alcohol or solvents on the plastic!).

Powder-coated steel stands may be cleaned with soap & water. Black oxide steel stands should only be wiped with a rag, or rubbed down with Watco Oil if rust formation becomes a problem. Avoid water-based cleaners on the steel parts.

After several years the liquid inside the Orb will lose its luster and necessitate changing the fluid as described under "Refilling the Vessel".

Polishing Instructions:

Materials Required:
- Novus Plastic Polish #1, or automotive wax
- Novus Plastic Polish #2
- Novus polish instruction sheet
- Polishing cloths

The plastic (polycarbonate) spheres require some special care to maintain their optical clarity.

As soon as the sphere is fitted to the base, POLISH IT IMMEDIATELY, with the Novus #1 plastic polish or automotive wax. This will help prevent minor scratches by making the surface more slippery. We did not polish the spheres before shipping so that they would be easier to handle during setup.

The sphere manufacturer recommends that any wiping be kept to a minimum. For this reason, we do not recommend daily cleaning unless absolutely necessary.

When cleaning is required, use the #1 polish with a soft cloth such as the ones we have supplied or a 100% cotton rag.

For scratches, use the #2 polish, as instructed in the Novus brochure enclosed.

Avoid the use of any abrasives other than the polishes in this kit.

Please note that scratches are almost impossible to remove completely. However, careful polishing will minimize their appearance and help maintain the beauty of the exhibit.

Installing the plastic sphere:

The plastic sphere is shipped in a crate. Set the crate on a table or saw horses about 32" high to facilitate setting it into its stand. Open the crate (see diagram). A black retaining ring is clamped to the flange neck with two socket head screws. Check that it is positioned so that it will end up under the retaining screw in the side of the base with about 1/16" clearance. When installing the orb into the stand, be sure the retaining screw has been removed from the side of the steel base, (located just below the handle). Once the Orb is in position, use a flashlight to see through the retaining screw hole and check that the retaining ring is just below the opening.

Remove one side of the crate (see diagram). It will take as least two strong people to carefully roll the Orb out of its crate and into the top of the base. Check that the beveled locating ring sets down properly into the top of the stand. Peer into the threaded retaining screw hole in the side of the base to be sure the retaining ring is below the hole, and re-insert and tighten the retaining screw.

Initial Set-up :

It is important to polish the plastic sphere before returning the exhibit to the exhibit floor, as the slippery surface makes it more difficult to scratch. See Polishing Instructions above.

Removing the Vessel:

The sphere is retained in the base with an allen cap screw located below the handle. Find this screw and remove it before lifting on the sphere. The exhibit was shipped in a crate which provides a cushioned surface for resting the plastic Orb on. Be sure that any thing the sphere comes in contact with is free of grit that can cause scratching. Lift straight up on the sphere until the retaining ring is clear (about 8 inches,) and roll it onto the crate padding.

Draining the Orb:

The sphere contains about 20 gallons of water. There are no harmful substances in the water so it can be drained anywhere suitable. A small 1/8" pipe plug is located on the cap for topping off the sphere during filling. This opening is too small for draining and we suggest removing the cap from the neck to allow the water to rush out. Two allen-drive button-head fasteners hold the cap in place. Remove these and lift the cap out. You may need to pry it up with a pair of screwdrivers to un-stick the O-ring seal.

Note: The delrin cap is hydroscopic. If it has swelled to the point where it will no longer slide in and out of the neck (without the O-ring), it will be necessary to machine with a lathe, a slight amount of material off of the diameter of the plug portion of the cap. The O-ring of course should retain a snug fit into the bore of the neck.

Filling the Orb:

Drain the sphere and clean the inside of all spots.

Fill it 3/4 way with distilled water, add 3 quarts of the iridescent liquid supplied by the Exploratorium, and 1 Oz. of Schilling blue food coloring. Fill it so the water level is about 2-3 inches from the top of the neck. If the water is cold, you may want it to sit for a day to warm up. Some of the dissolved gasses in the water will be released as the water warms up.

Air bubbles trapped where the flange meets the sphere will be difficult to remove completely. The sphere can be tipped to get most of the air out. (Be sure the sphere doesn't scratch while it is tipped.) The three ring sectors that the flange screws tighten into are beveled on the ends to allow bubbles trapped outside the rings to move towards the neck. The Exploratorium uses a syringe pump to suck the bubbles out. A length of 1/4" O.D. tubing is used that has a wire wrapped around the outside to keep it in a bent position. This aids in controlling the end so it can be moved around the flange where the bubbles are trapped.

A method without using a pump is to set the Orb on the stand with the flange pointing straight up. Spinning the orb will push the air to the center (axis) where it can then float out through the neck. Spin the orb up slowly, watching that the vessel does not become imbalanced and roll off of the stand.

Remove the center plug from the cap (1/8" MPT). Push the cap into the neck so the threaded holes line up with holes in the stainless sleeve and insert the 10-24 x 5/8" allen-drive button-head. Tilt the sphere straight up to allow air trapped in the neck to escape.

Then keep filling the neck to the very top of the fill hole while bumping the neck around to be sure no bubbles are hiding in a high spot under the cap. After the bubbles stop emerging, the pipe plug can be refitted.

Tip the flange down as far as possible to see if any bubbles appear. If a bubble larger than two inches appears at the top, you will probably have to purge the orb again. If a bubble of 1/2" to 1" appears, it may be absorbed by the water after a day or so.

Set the sphere back into its stand and replace the allen cap screw that retains the sphere before allowing the public to access the orb. It will probably need to be polished again after filling.

Flange Seal:

The fasteners in the flange should never need tightening, nor should unqualified personnel attempt to adjust or disassemble the flange. Do not remove any of the screws from the flange.

The flange is sealed to the plastic with a cast polyurethane gasket. This gasket sets into a groove machined in the flange. The 6 socket-head fasteners that clamp the gasket are tightened in assembly until the gasket just begins to bulge. Over-tightening these fasteners will cause the plastic to distort and the gasket may pop out of its groove. The stainless steel button-head fasteners thread into three Delrin sectors that bear against the polycarbonate orb. The heads of the screws are sealed to the flange with sealing washers to prevent liquid from seeping past the threads.

Replacing the Polycarbonate Sphere:

The following instructions are for fitting a new polycarbonate sphere to the existing flange assembly in the event of the sphere being damaged beyond repair.

Remove the vessel and drain the orb as outlined in this manual. Try to re-use the old sand, since the glass clusters that have clouded the water are diminished.

Remove the 6 fasteners that retain the flange assembly. Rinse off these parts and inspect them for signs of potential leaks. Inspect the gasket for tears or extreme deformation.

The gasket is made from polyurethane casting compound which exudes a silicone release agent. It is compliant enough to conform to just about any kind of irregularity in the polycarbonate, making the use of gasket sealant unnecessary, if not futile.

Wipe any grease off of the gasket, and assemble the parts onto the new sphere, referring to the assembly diagram. Getting the fasteners properly started and tightened is not easy, and should be done by experienced personnel only. The stainless steel fasteners will strip easily and are a bit short for getting the assembly started. It is recommended to use longer steel cap screws to assemble all the pieces into position, then replace the steel screws with the stainless steel ones. The fasteners are only tightened enough to seat the

gasket so that it just barely begins to bulge. Tightening more than this does not improve the seal, and usually causes the gasket to eventually pop out over the flange lip.

Before filling the orb, set it on the stand with the locating ring in position. Spin the orb to check for wobble. A slight amount of correction can be done by varying the fastener tightening on the flange. Large amounts of wobble can be corrected with tapered gaskets which are generally avoided for field repairs, but may have been included with the replacement sphere. Please call or fax the Exploratorium if there are any problems.

Next fill the vessel as outlined in the vessel filling section of this manual.