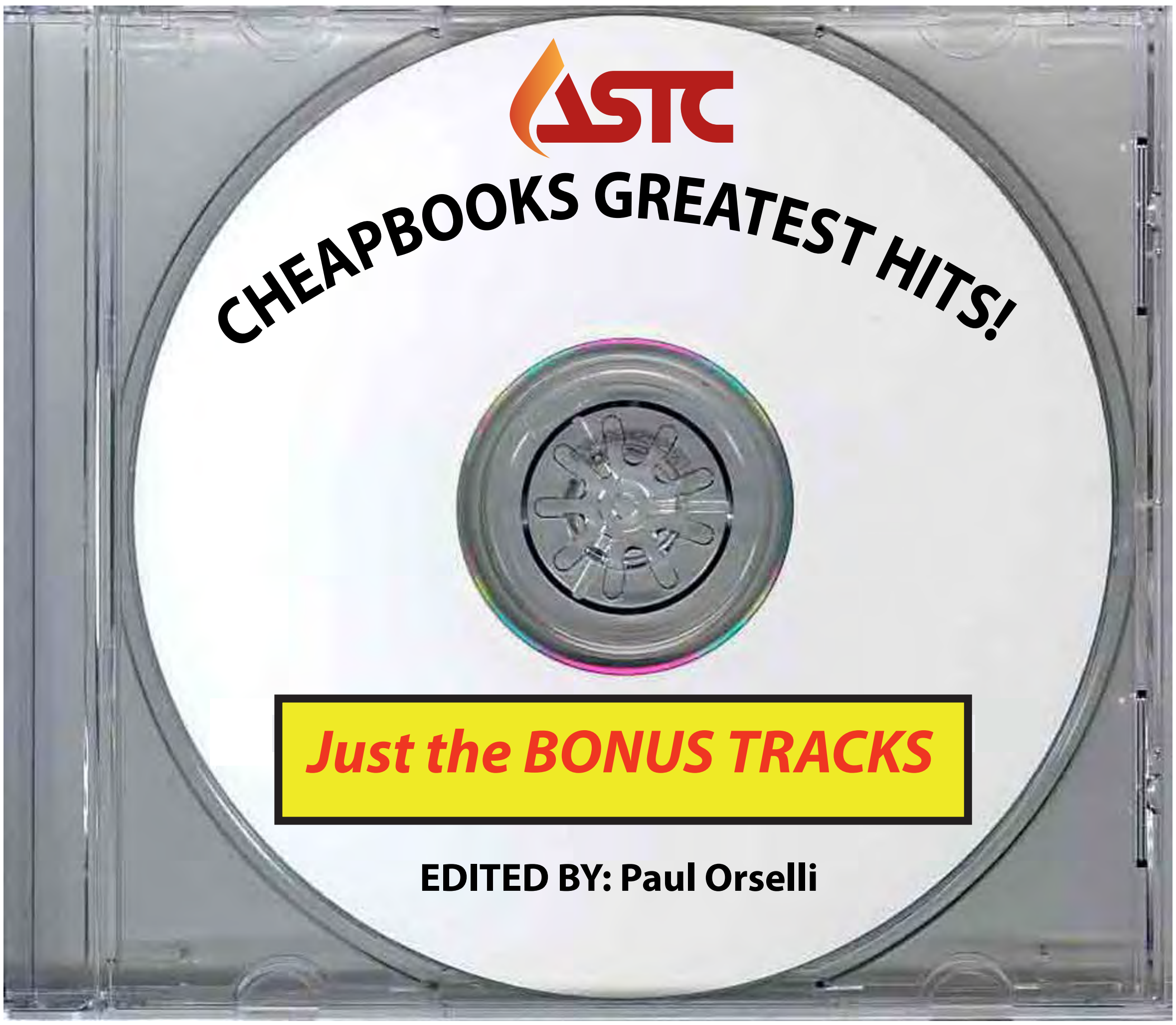

ASTC
CHEAPBOOKS GREATEST HITS!
Just the BONUS TRACKS
EDITED BY: Paul Orselli

INTRODUCTION to The EXHIBIT CHEAPBOOKS

The idea for the Exhibit Cheapbooks started during sessions at the annual Association of Science-Technology Centers (ASTC) Conference with the purpose of sharing "cheap" exhibit ideas and creating a written record of how to replicate these simple and successful exhibit components.

The first "Cheapbook" was compiled and edited by Paul Orselli and published by ASTC in 1995. Subsequent volumes appeared in 1999, 2004, and 2014.

The Exhibit Cheapbooks have always celebrated the "worldwide" nature of museums. You will find varied exhibit ideas from museum colleagues from around the world inside each volume. Sincere thanks to everyone who has shared their ideas and expertise! And special thanks to ASTC for allowing all the Exhibit Cheapbooks material to be shared freely online.

Think of these Cheapbook entries not as detailed shop drawings, but rather as creative jumping-off points for your own exhibit building.

Have fun!

Paul Orselli, Chief Instigator
POW! (Paul Orselli Workshop, Inc.)
1684 Victoria Street
Baldwin, NY 11510
< paul@orselli.net >

Disclaimer
The exhibits and other descriptions of equipment in The Exhibit Cheapbooks have been compiled using reliable sources, representing the best opinion on the subject as of their publication dates. However, no warranty, guarantee, or representation is made by the contributors, the editor, nor ASTC, nor any other entity as to the correctness or sufficiency of any information herein. Neither the contributors, the editor, ASTC, nor any other entity assumes any responsibility or liability for the use of information herein, nor can it be assumed that all necessary warnings and precautionary measures are contained in this publication.

Credit

Exhibit Cheapbook 4 – (BONUS TRACKS ONLY)

Table of Contents

Bass Quake

This is an exhibit that I prototyped during a British Interactive Group Fabricators Week at least 10 years ago. The exhibits from that week were never published for various reasons, so it has never really reached a wider audience.

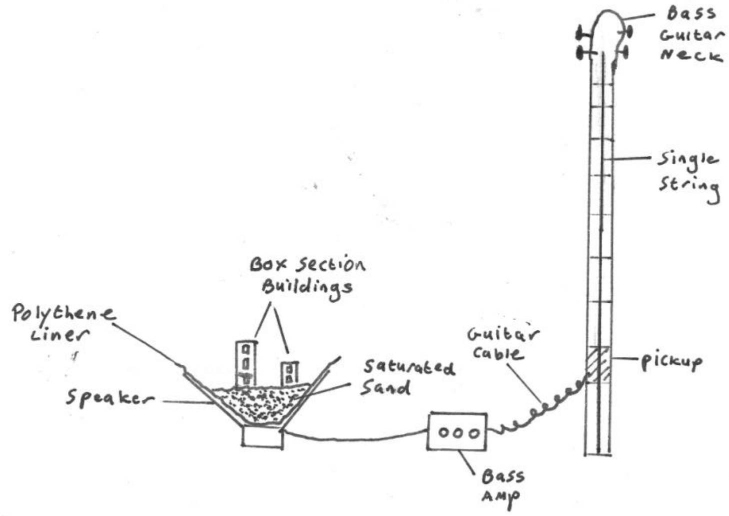
The purpose of the Bass Quake is to create an exhibit-scale version of the kind of liquefaction effects seen in sandy sediments during earthquakes, which cause buildings to sink into the ground.
Earthquakes produce pressure waves that move through rock and the soil above it, producing many of the effects we are familiar with. Liquefaction occurs when pressure waves of this kind hit water-saturated. low-density, sandy soils. Under normal circumstances these appear to be just as solid as any other soil, but if large or repeated loading is rapidly applied, water pressure can increase to the point where it overwhelms the contact stresses between the sand particles that have been making the soil act like a solid, with the result that the soil switches to acting like a liquid. As a result, buildings, infrastructure, and even cars that have been happily supported by the soil immediately sink into it. When the shaking stops, the ground reverts to solidity, trapping everything that sank. This was seen very clearly in San Francisco's Marina District during the 1989 Loma Prieta quake, the 1995 Kobe quake in Japan, and the more recent quake in Christchurch, New Zealand.

Loma Prieta Liquefaction
(this is from http://california2008.wikispaces.com/ and licensed under a Creative commons Attribution Share-Alike 3.0 License)

Liquefaction following Christchurch, NZ earthquake

To recreate this effect in an exhibit, I decided to generate the pressure waves using a bass guitar – sound waves are reasonably analogous to earthquake P-waves. In fact, to simplify matters I just used a single bass guitar string stretched on a neck and running over a couple of pick-ups. This I connected to a small amp and a large speaker, set up so it faced upwards. I lined it with polythene damp course membrane plastic to give a decent waterproof lining, then filled it with builders sand and added water so that this was saturated, but still solid (like making Ooblek, you'll know you've hit the sweet spot when you see it; it's when it's firm, but pressing on it makes water appear on the surface).

To simulate buildings, I first used solid wood blocks, but as water effects don't scale, these, even when weighted, weren't heavy enough to sink, so I switched to hollow metal box section (hollow end down), which worked perfectly.



To create the "quake," users pluck the bass string, the sound creates pressure waves in the sand, the sand liquefies, and the buildings promptly sink and keel over. Cool!

I had expected users to have to hunt around on the fretboard to find the right note to hit the resonant frequency that would cause the liquefaction. In fact, as all you need to do is overwhelm the contact stresses of the sand, it works over a pretty wide range, which makes it a lot easier to use, even if it removes some of the business of exploring to hit the right note. It is reliable and the buildings go down every time.

There are several challenges I see in scaling up to a full gallery exhibit:

- Keeping the water out of the speaker. The polythene was fine for a prototype, I just folded it into the speaker and left enough sticking out the top to avoid any water going over the edge. With repeated use and potential contact with the box section there's risk of the membrane getting holed. Electricity, water, and visitors are not a good combination.
- Keeping the sand saturated. Over the day this is going to dry out; fortunately the tolerances are good so you don't need to keep it at an exact level of saturation, but it is likely that at some point it may get too dry to work well. Explainers will need to be aware of this and know how much to top it up without leaving it swimming in water.
- Resetting the buildings. The effect is way better if you are starting with the buildings sitting on top of the sand, not already half sunk in. There is no guarantee that users will work this out and a proportion will probably enthusiastically twang away with buildings that have already sunk and get a disappointing result. You need to do whatever works best for your institution to encourage the reset.

Submitted by Ian Simmons

Bermuda Bubbles

Bermuda Bubbles is an example of an exhibit that has evolved over many years and through many hands. It began as a demo by Dr. Mike Gore, then Director of Questacon, the Australian National Science Centre. Mike is one of the great science demonstrators and he showed how he could sink a model ship in an aquarium by throwing in handfuls of Alka-Seltzer tablets. As the foam rose the boat sank in a neat demonstration of Archimedes' Principle.

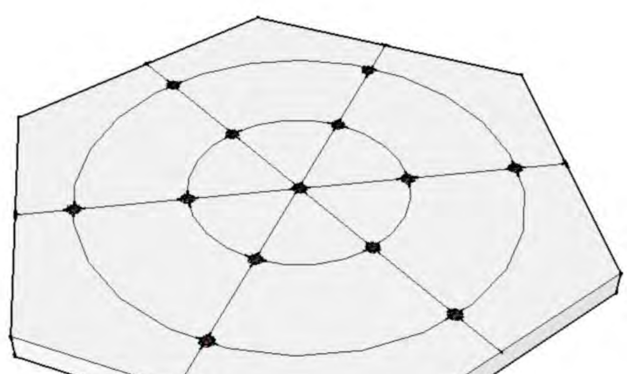
Bermuda Octagon

Some years later in the guise of methane hydrates, this was proposed by a TV programme *Equinox*, as a mechanism behind the Bermuda Triangle pseudo-phenomenon. The suggestion was that crystals of methane hydrates on the sea floor would catastrophically decompose, causing a foam of methane to rise sinking boats and asphyxiate their occupants. This coincided with the 1993 British Interactive Group (B.I.G.) Fabricators Conference and a team from Snibston Discovery Park (Ian Simmons, Paul Duckworth, and James Maxted Khan) made a version of the demo using a cylinder of balloon gas.

We thought that this would make a great exhibit and just to make sure no one thought we believed in the Bermuda Triangle we made a version in an octagonal aquarium called naturally "Bermuda Octagon."

The exhibit consisted of a hand pump made from a pneumatic cylinder, feeding into a 6-litre air receiver, from a defunct compressor which led via a push valve into the tank.

The manifold in the bottom of the tank was a Perspex box with 17 pneumatic silencers arranged on 8 radial arms from the centre so that the foam was most dense at the centre of the tank. We had used aquarium air stones as diffusers but the rate of flow soon broke them, hence the silencers.



Aeration manifold showing position of diffusers

The exhibit worked nicely with a good level of physical involvement in the pumping, but over the years we saw that too many visitors walked away without pumping enough air to see the full effect. In time the boats would take on water and become less buoyant, leading to an unimpressive sinking.

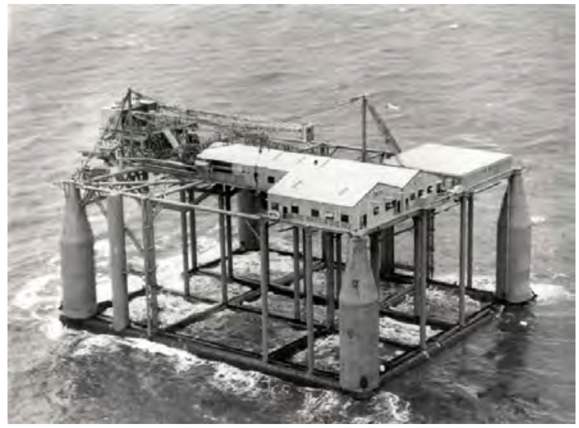
In 2005 I was asked to propose exhibits on the oil industry for the new VilVite Science Centre in Bergen. This was a project in part to celebrate the centenary of the oil company Norsk Hydro, which was only a year away, so we needed well-known, sure-fire quick builds.

In revising this exhibit concept we made some simple changes:

- The air was fed via a pushbutton from a pneumatic supply, so that the model was certain to sink every time.
- The model was changed to an oil rig.

Methane hydrates or clathrates were again topical as a problem, causing blow outs in deep sea drilling and also as a potential source of energy.

At this time there was an oil rig in Bergen's outer harbour being prepared for use in the North Sea.



A Semi-Submersible Oil Rig

The legs looked like lemonade bottles, so we modeled it with lemonade bottles. The oil rig's superstructure is mainly a skeletal mesh of beams with no significant displacement, the deck is pierced and could not trap air bubbles as it sank, and best of all, the lemonade bottles could be emptied to get just the right level of buoyancy to keep the rig balanced above water but to rapidly sink when the bubbles reduced the upthrust. Even better the lemonade didn't support algae growth in the bottles and kept them pressurised so that the air or water couldn't leak in and sink the rig.

The Oil Rig Model showing lemonade bottles, and holes in superstructure for air to escape.

The completed Bermuda Bubbles at VilVite Bergen, Norway.

Design Critique
The tank needs to be quite tall (e.g., 1.4 m) to allow the turbulence to subside as the foam rises, and there needs to be enough space for the displaced water to rise. Flush mounting silencers are best, just in case the boat hits them when it sinks.

The prosaically named “Sink Boat” at At-Bristol is proportionately taller and so gets away with a much simpler manifold, simply a 1 cm tube in the centre of the base.

The top of the tank needs to be vented, but also covered to keep dust out.

The superstructure needs to be visually impressive but have a minimal displacement.

The compressed air needs to be from an un-oiled line and filtered. I have had reasonable success with two small 12V tire inflation pumps. If you did use a pump there needs to be a trap to stop water running back into it.

I used an adjustable monostable on the air valve so that it stays on for a minimum of 10 seconds.

Water treatment is minimal; I have used BCB (Bronopol) tablets or liquid which are used in therapeutic bubble tubes. The exhibit is best positioned out of direct sunlight as this encourages algae.

Thanks are due to the Workshop crews at At-Bristol, Techniquest, and VilVite, in particular Dan Bird, Mike Ellams, Neil Davies, Owain Davies, and Svein Anders Dahl.

Submitted by Harry White,

Cabinet of Your Curiosity

The Cabinet of Your Curiosity has enthralled young visitors to the Discovery Room at the American Museum of Natural History since 2001. This simple chest of colorful, oddly sized drawers houses a wide selection of specimens from across areas of natural history. Deceptively simple, the activity provides a wide range of facilitated and free exploration activities.

The activity as it exists today was originally developed by Ann Prewitt, the content developer and former director of the Discovery Room. Simple enough in execution, it consists of a custom built cabinet with 50 drawers, each containing a mineral, shell, plant, bone, fossil, or invertebrate specimen from the Museum’s collections. The drawers are of varying sizes to accommodate different types and sizes of specimens and are brightly colored to add a sense of whimsy and excitement to the activity. The drawers are lined with felt to protect the objects from repeated the inevitable jostling as the drawers open and close several times per day.

For most children, the simple act of opening a drawer to be greeted with a new object at each turn will keep them engaged for several minutes. Many children grab a seashell and press it to their ear, or hand it to their caregiver to listen to the sounds of the ocean. Others will carry a tarantula specimen over to a sibling to illicit a quick shock. All of these activities build familiarity and interest in the diversity of the natural world.

However, with proper guidance and facilitation, the activity becomes one in which children use pattern recognition and observation skills to develop an understanding of the meaning of classification systems. Above the drawers, a set of shelves holds four “collection” trays. With prompting, children grab a tray and receive a challenge, either through a printed card or verbal instruction, to build a collection of five objects. Printed cards in the cubbies next to the trays prompt children to build collections of minerals, things from the ocean, things with backbones, things without backbones, fossils, things that are the same color, or things that are beautiful. However, the possibilities are quite broad and children have the opportunity to build whatever kind of collection they like. Some of the more creative have been things that are icky, things that bite, things with spirals, and on and on.

Seeking to extend the activity, an engaged facilitator or caregiver can ask the child to present their collection as if they were making their own museum exhibition. The facilitators ask the child to describe why they chose each of these objects, highlighting some of the similarities and differences between them over the course of the conversation, and encouraging the child to organize their collection into groups based on objects that are more similar than others in the collection.

For example, a child who collects five objects from the ocean may begin to notice patterns in those objects. Some of them have spiral shapes on them. Some have star shapes visible on them. Some may have legs or fins. Grouping these objects begins to take meaning for them, allowing them to recognize similarities between various gastropod mollusks (spiral shapes in various snail shells) or echinoderms (star shapes on sand dollars, sea urchins, and sea stars). For older children, it works well to define a category such as an echinoderm, challenging them to find objects that meet a specific set of taxonomic criteria (star pattern of five visible on top of the body, open mouth at the center of the underside of the body).

In one particular interaction, a young boy age 7 built a collection of “icky things” that included a tarantula mount, scorpion mount, giant walking stick, baby snake, a horseshoe crab molt, and a cicada molt. Through subsequent conversations with myself and his mother, he began to notice that some of his collection items had 6 legs, some had 8, one had 4, and one had 10. We began to discuss the differences he could see in the skin texture of each of his animals, highlighting differences between vertebrates and invertebrates. After 20 minutes of self-guided and facilitated interaction, the child could describe what it meant for an animal to be an arthropod, an insect, and an arachnid. His interest and appreciation for these “icky” things helped him build knowledge about the relationships between and classification of a wide range of organisms, and gave him the ability to look closely and notice these differences throughout his experiences in the Museum and out in the park.

When selecting objects for the cabinet, it is important to keep various types of classification groups in mind to make sure your visitors have a wide range of options to choose from. Using around 40-50 drawers should offer nearly endless opportunities for interaction. Below is a sample list of objects that we’ve had success with in our exhibit over the last 12 years.

Various marine invertebrates: helmet shell, scallop shell, fossil clam shell, barnacles, giant triton shell, leopard cowrie, abalone, horseshoe crab molt, purple shore crab, chambered nautilus shell, top shell, brain coral, mushroom coral, sea star, sea urchin, sea biscuit, sand dollar, fossil brittle star in matrix, crinoid, ammonite, trilobite;

Terrestrial invertebrates: dung beetle, tarantula, scorpion, giant walking stick, cicada molt, cicada killer wasp, rhinoceros beetle, morpho butterfly, atlas moth;
Vertebrates: fossil fish in matrix, fossil shark's tooth, mink skull, beaver skull, salamander, bullfrog skeleton, raccoon skull, seahorse, deer leg bone, lizard skull, baby snake, pheasant feather, ostrich feather, turkey feather;
Minerals: garnet, amethyst, quartz crystal cluster, salt block, polished agate, malachite, fluorite, copper, geode;
Plants and fungi: giant pinecone, pressed seaweed, Philippine mahogany seed pod, lotus seed pod, cinnabar fungus, lichen, fossil fern leaf.

Marine invertebrates comprise the bulk of this list because they are relatively easy to obtain, durable, and generally very enticing to young children. It is best to keep a supply of replacement items handy as many of these objects are easily slipped into pockets. However, we've found this to be an extremely rare phenomenon and find the success of the activity to far outweigh the minor hiccups with object replacement. If you do install your own curiosity cabinet, don't be surprised to receive an occasional package containing a lost object and an adorable note from a child who has been forced to apologize for their thievery.

Submitted by Daniel Zeiger

Design an Outfit

Design an Outfit is part of Open Studio, a lightly facilitated Maker exhibit at TELUS Spark in Calgary. The exhibition hall consists of four areas: Making Movies, Making Music, Making Awesome Things, and Expressing Your Style.

Expressing Your Style was one of the harder ideas to develop exhibits for. There is a thin line between getting older kids and teens to think about style and giving them an opportunity to be super mean. After a lot of piloting we developed what became the anchor exhibit for this area. It's simple, like it was always waiting for us to discover it.

This is our first pilot test of Design an Outfit. Not every visitor was into it, but the ones that were exclaimed things like, "I've been waiting my whole life to try something like this!" and then spent 30 minutes to an hour designing a dress.

Most of our Maker exhibits consist of consumable materials, a challenge, and some kind of infrastructure for testing or displaying the thing you made. For some reason we seemed to think that Expressing Your Style would need a different format, but in the end the basic model worked best for Design an Outfit--once we figured out what to use for the infrastructure for testing and displaying the thing you made. Mannequins were the secret.

At Design an Outfit people fold, craft, pleat, and drape fabric and fabric-like materials over foam mannequins. We have found this exhibit to be especially popular with girls, but it also has traction with boys especially when we give the mannequins hats. (We know this is a strange catalyst, but it works.)

Infrastructure:
Design an Outfit consists of several off-the-shelf foam dress forms in various sizes. The dress forms are bodies only, no legs. We have found that female and kid mannequins are the most popular so the exhibit consists of one male mannequin, three female, and two kids.

These are the mannequins we use.
www.eddies.com/t_prod_detail/773/154024/1/10.html
They are dress forms from a company called Eddie's Hang Up Display. You can probably source similar mannequins closer to your location. They just need to be suit forms/dress forms (the body goes slightly past the waist), made of hard foam, and covered in cotton. We recommend using cheap ones because you will have to replace them every year.

We use these mannequins because they are inexpensive and sturdy. We replace them about once a year.

To get the mannequins ready for the exhibit we modify them slightly. We reinforce their bases and bolt a bigger piece of wood to the base to make it sturdier. We also replace the mannequins' heads with magnetic pin cushions (another off-the-shelf item called Grabbit). These hold the t-pins when visitors are not using them.

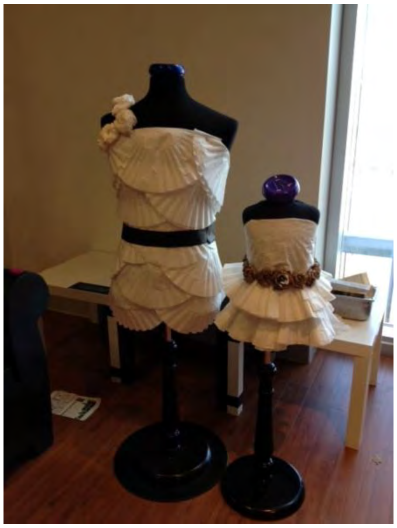
Visitors use t-pins to create the outfits, by sticking the pins through the fabric into the mannequin body. Fabric can get caught in the little space at the top of the t-pin, which can be enough to stop visitors from removing the pins themselves. We recommend dipping the top of each pin in epoxy to close the gap (but this isn't as much of an issue if you're using non-traditional materials).

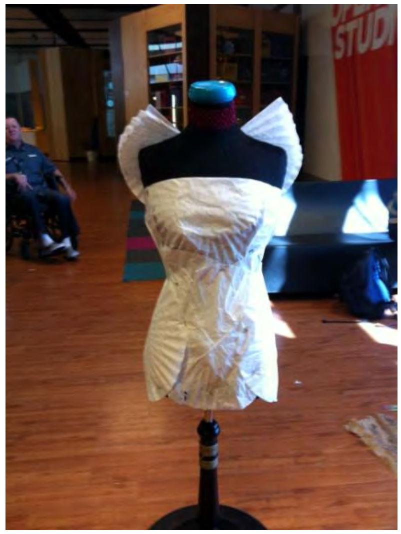
*** You might be asking yourself why not use normal pins? The ones with the little heads get stuck in the fabric and are hard to get out. When people step on the ones with plastic heads, the heads get smashed and leave a dangerous unheaded pin, which are the worst.

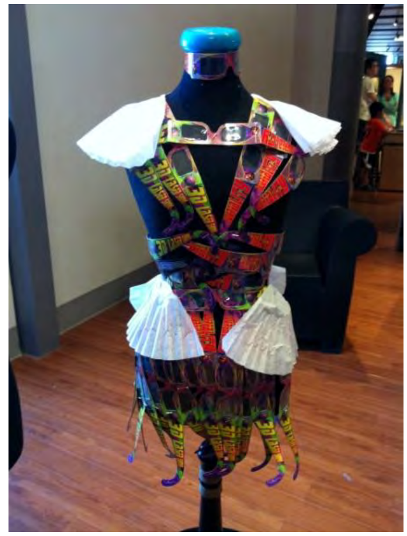
Materials
The basic exhibit materials consist of bins of large pieces of fabric. We provide smaller hotel pans of embellishments like ribbon, buttons, bottle caps, or pop tabs. To make the challenge harder and keep our facilitation staff experimenting, we provide recycled sheet-like materials such as paper packing materials, newspaper, plastic bags, or coffee filters. Sometimes we just use what we have a lot of, like 3D glasses or the plastic sheets that you find when you take a computer keyboard apart.

All of these unique items spark different kinds of outfits. It is amazing to see how you can manipulate what people make by what materials you provide.

We stopped having scissors at this exhibit. When we did provide scissors all of the materials get cut into tiny pieces. When we don't, everyone can happily design without them. There are scissors at other exhibits in Open Studio and we don't mind if they get borrowed.







Challenges
We try to have a challenge or reference images at the exhibit (e.g., "design an outfit for a party in the future" or reference images of dresses made out of plastic shopping bags. Most people don’t need the challenge in order to get started, but it helps people who need more of a push. (One of my favorite things we tried here was when a facilitator posted the challenge “Try to create an outfit without cutting all of the fabric into tiny pieces.” Snark, good for motivation.)

Iteration
Maker exhibits can be simple to execute but take practice to maintain. We are constantly iterating the exhibit to make it better.

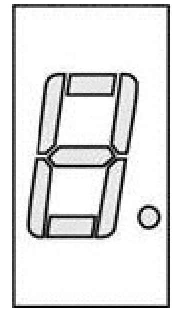
- We added the pin cushion heads to the mannequins to curb the speed at which we were replacing t-pins.

- We had other adjacent clothing design exhibits when we opened Open Studio. Design an Outfit was so popular that all of the materials and infrastructure of the other exhibits would migrate to Design an Outfit through the course of a day. Instead of fighting it, we doubled the size of Design an Outfit.

- Visitors who are into it will stay at this exhibit until their parents force them to leave. We added seating and eventually reading material to make it easier for parents to stay longer.

Submitted by Dana Schloss

Dig-It!



The Dig-It! device allows visitors to engage with LED character displays which are so common in digital clocks and watches. Each of the seven segments that are combined to display a single character can be switched on and off individually, so that the visitor can create characters and symbols at will.

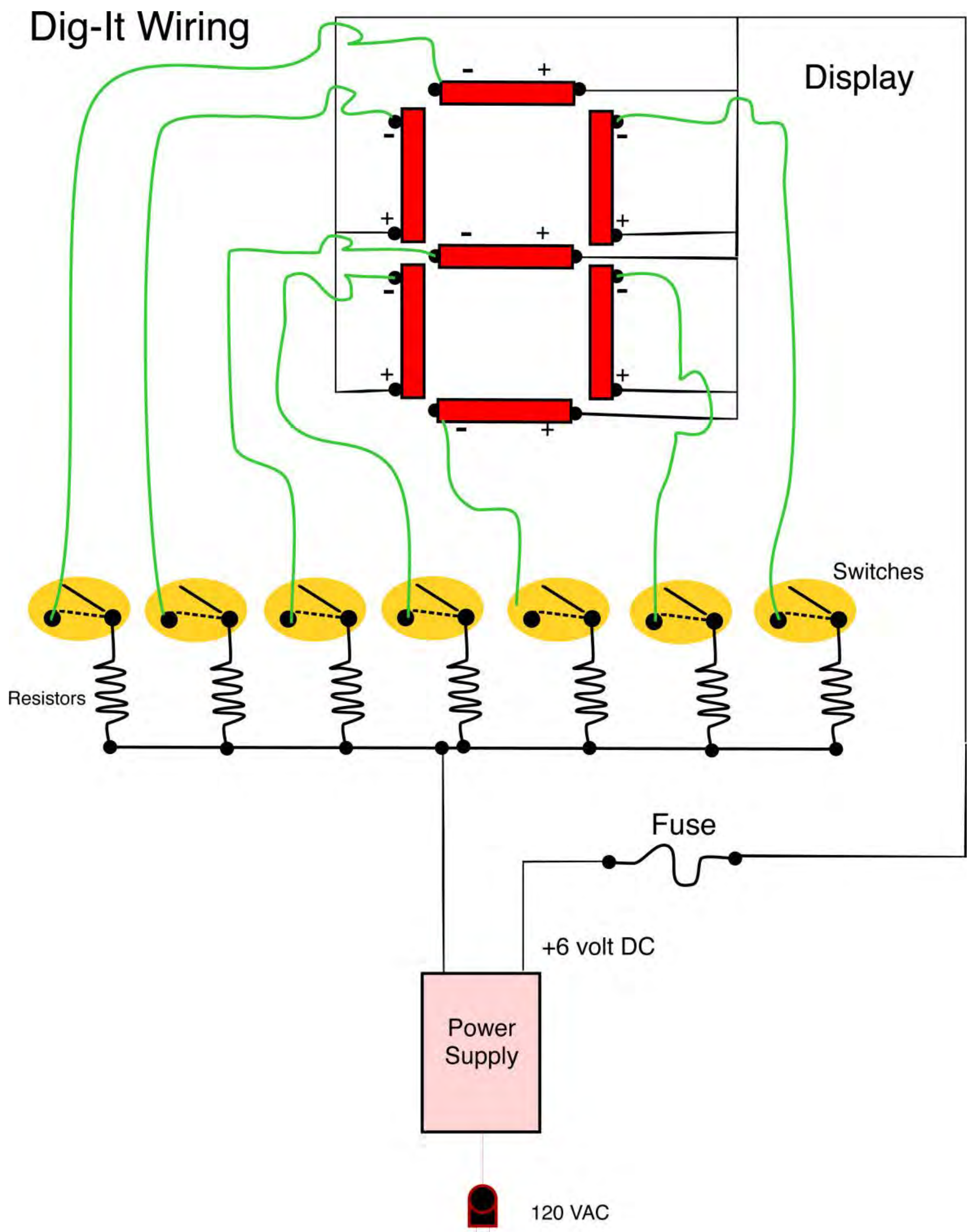
Many variations of the device are possible. Once you get the circuit working, you may put your imagination to work on presentation. KISS is always a grounding principle, however.

The basic components are the following:

a. The display: Either a pre-packaged seven-segment display available from electronic stores, a custom assembled array of seven bar-shaped lamps, or a pre-packaged unit extracted from a digital alarm clock or other device.
b. Power Supply: 3-6 volt DC, such as might charge a cell phone
c. Seven switches. They could be toggle switches, or momentary. Many styles available. A mix of styles might be considered. Any device that will open and close to complete an electric circuit.
d. Cabinet for mounting the display and switches, and to house the power supply.
Having the wires, switches, and display in clear view could be a desirable option.
e. Wires to interconnect the switches and display segments and power.
f. Current Limiting Resistor for each segment to prevent over powering the LEDs
g. Use extreme caution, as usual, if 120v AC line power is part of the power supply, so the visitors are never exposed to the line voltage.

This exhibit was first created by the author circa 1990 at a Fabricators Workshop in the UK. The workshop was initiated by Science Projects of London and several new, at the time, science centers in the UK.

Photo shows one of the original configurations done by TECHNIQUEST in Cardiff, Wales, UK. It used momentary buttons mounted at the tips of “fingers” on a graphic on the panel. Such a non-verbal label made it pretty clear how to get started.



Submitted by Ken Gleason

Gravel Travel

I have included this exhibit in my science and math roadshows for the last 10 years!

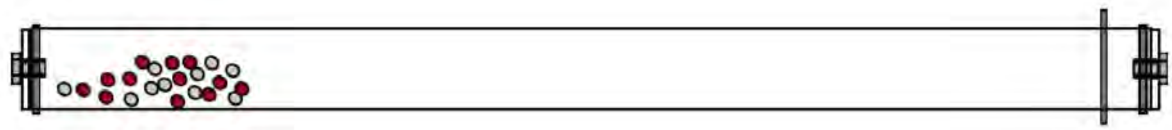
It is very simple to use. Pick up a tube and watch the beads, or sand particles fall through the water. Observe the different behaviours of the particles when the tube is turned vertically or to a slope. Time the particles (just by counting) falling down vertically and then down a slope. Is there an optimum angle where the particles travel fastest? Compare the different tubes.

I like this exhibit. It is relatively simple to make. It is easy to display. It can be used without the instructions. Children experiment; they like the way the particles move. There are also many narratives. It relates to research in the 60s in the study of ash flows, and again in the last decade in the study of avalanches. A similar experiment was performed on a grander scale using 50,000 ping pong balls and a ski slope. It might be observed that the cluster of particles when going down the slope tries to form a foil shape. There is the thought that it models the same behaviour as birds, or cyclists in formations - the particles take it in turns to be at the front!

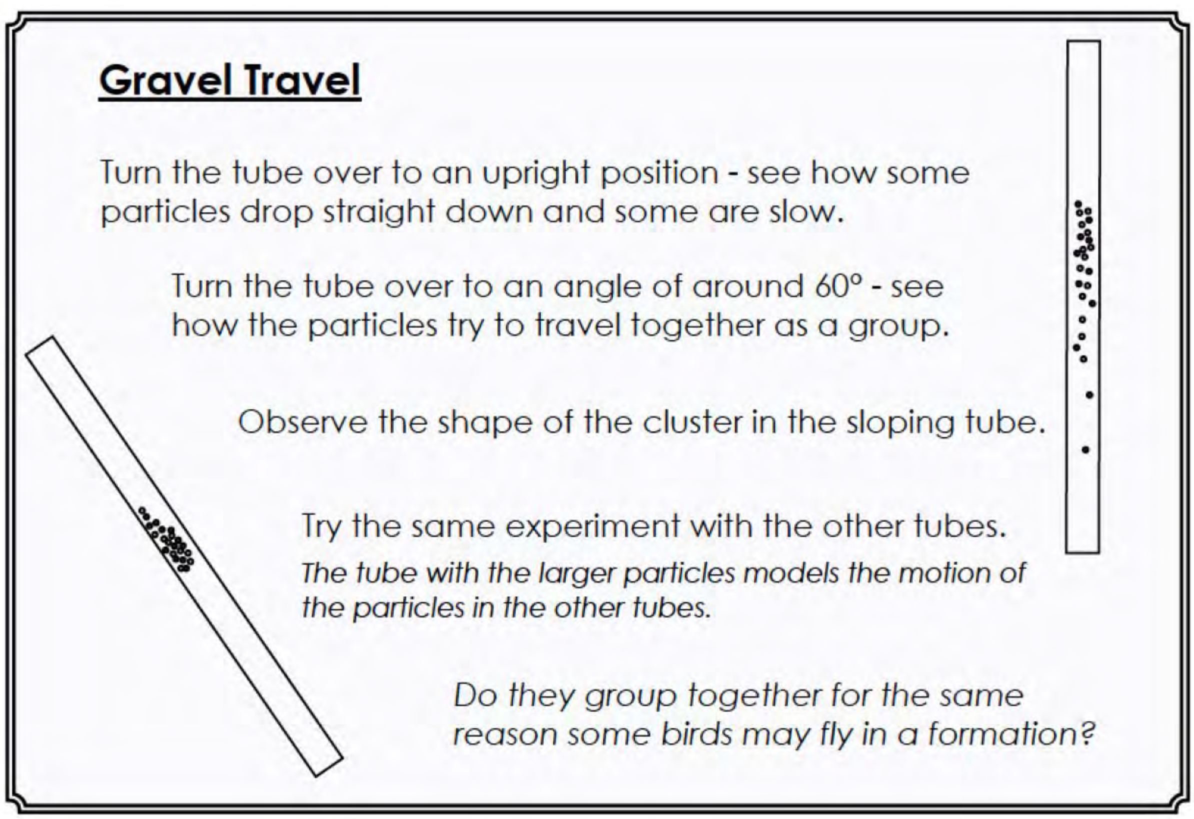
This exhibit uses three acrylic tubes. Mine are 600mm x 40mmOD. They are capped off with a circle of acrylic glued in place with Tensol 70. These circles have a tapped hole to receive an M8 stainless steel bolt. One tube contains 30mm of black course sand (as for sand blasting), a second tube contains 30mm of fine coloured beads and a third contains 30mm of 5mm coloured acrylic spheres. The tubes are filled with water.

I use a square of PVC Foamex plastic with a hole just slightly larger than the tube to stop the tubes rolling off the table. This is kept in place by wrapping a rubber cushion around each end, which protects the tubes when not placed carefully on the table.

Occasional maintenance over the years includes undoing the bolt to remove an air bubble and to top up. I have had one break a few years ago - I just went home and made a new one!



This is my label....



Submitted by Selwyn van Zeller,

Moon Crater Shadows

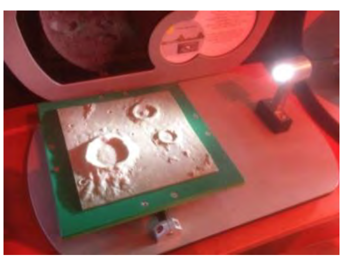
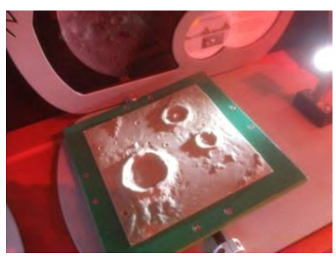
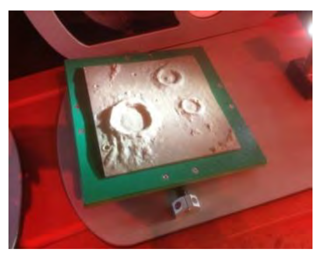
This exhibit was constructed as part of the new "Earth Story" exhibition that we made for our "Observatory Science Centre." The Observatory has large historic telescopes, one of which astronomer Sir Patrick Moore used to map the Moon. It is the shadows which give lunar craters such a dramatic appearance when viewed through a telescope, rather than the crater itself, and we thought it a good idea to produce a simple exhibit to show this.

In the exhibit described here, a model of a lunar crater is attached to a plate which can be tilted on a pivot. The crater is illuminated at a low angle from one side using an LED lamp and shadows become extended to reveal the features of the crater as the platform is tilted.

The exhibit has a fine history. James Nasmyth, the Scottish industrialist known for his invention of the steam hammer and other significant machines, was also a keen astronomer and made sketches of the moon as observed through his 20-inch diameter telescope constructed around 1850. He calculated the height of the lunar features from the lengths of their shadows and made plaster models which he then photographed in sunlight, culminating in the publication of *The Moon* in 1871.

Construction:
In our modern day version of Nasmyth's *Archimedes* crater a century and a half later, images from the internet were used to help construct the initial model which was formed using modeling clay, a pleasant pastime which, although not always entirely successful, was a good way to appreciate the Moon's topography. *Archimedes* crater is special, now that we have almost been there. Nasmyth thought that the craters were of volcanic origin and his models have a knobby appearance and abrupt slopes, rather than the smooth contours we are now familiar with from the Apollo missions.

A silicone rubber mould was made from the clay model and a shallow box formed around it. Fast-Cast resin with filler was poured in and bolts for attachment suspended in the mix, bolt-heads down. Some experimentation with the filler proportions was required to get that authentic Lunar Surface look. The best model was then selected to be mounted on the platform.

It is worth noting that we could now use 3-D printing but where's the fun in that?

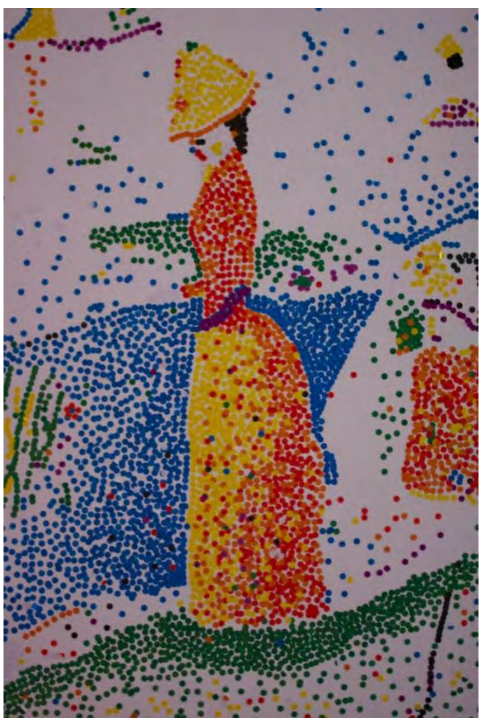
Submitted by Stephen Pizzey and Sheila Snowden.

Pointillism: Stick-it

This was a cross between an exhibit, an activity, and a communal art piece on gallery.

A digital projector was used to show a famous pointillist painting by Georges Seurat, *A Sunday Afternoon on the Island of La Grande Jatte*, on a 12' x 8' white board. The projection alternated between this image and plain white for five seconds each. Alongside the board was a tray of stationers' sticky coloured dots (8mm diameter) in various colours. Some step-stools were placed nearby so even children could reach the top of the projection.

There was no signage. Visitors simply added their stickers onto the board.

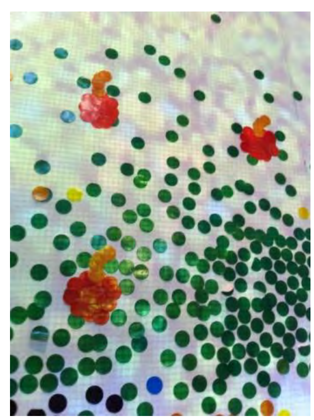


The interactions were varied and interesting, from looking and walking past to becoming sticker compulsive. We even sold a few annual passes on the back of families coming back and back to see it grow, and to finish "their" section.

Advantages are that it is cheap (we used an existing projector) and the scale can vary. The running costs were well under £300 for three months.

Part inspired by 'The Obliteration Room' *www.thisiscolossal.com/2012/01/yayoi-kusama-obiliteration-room/*, we then made it our own.

We didn't fall into many of the pitfalls we could have, more by luck than judgement. The choice of image was key – plenty of detail for visitors to pick out their own bit, a good range of colours and an opportunity for colour mixing and just enough room for subversion.



We gently curated the image after hours, removing the very few names that were added, taking away the stray stickers that were roaming too far from the image (we didn't want to encourage them in the rest of the gallery) and a couple of unsuitable additions (such as a revolver). We left most of the gently subversive additions such as flowers on the grass, apples on the trees etc.

It was very difficult to encourage visitors to fill in the less interesting background. Our second attempt tried to address this by using Paul Signac's image of Félix Fénéon http://www.moma.org/collection/object.php?object_id=78734 for a piece for the 2013's Maker Faire UK in Newcastle.

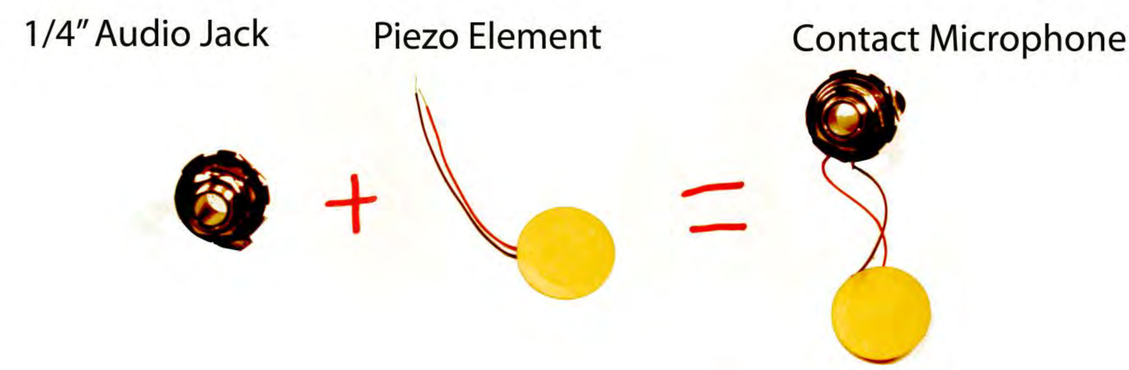
Submitted by Elin Roberts

Play the Room (Sound Exploration)

The science of sound isn't a mystery. If an object is struck it vibrates; these vibrations displace the air around the object and causes a chain reaction. When the displaced air comes in contact with our ears it travels through the ear canal and hits our eardrum, causing it to vibrate. The information is sent to our brain and interpreted in multiple ways, such as the direction, familiarity, and distance of the sound.

Play the Room is an exhibit that provides people of all ages an opportunity to amplify the sound of everyday objects and experience sound in new ways. I initially conceived of it as an exhibit for the Preschool Place at the New York Hall of Science, but for various reasons the focus shifted and it has become an activity that has been at the heart of our *Experimental Sound Studio* camp and after school programs.

The activity begins with everyone making a contact microphone. This is a great project to introduce soldering to various ages. There are only two solder points to connect the piezo element to the audio cable or jack, and the leads can be connected either way so there is little room for error. The simplicity of the construction provides a platform for the learner to focus on how to use the soldering iron.



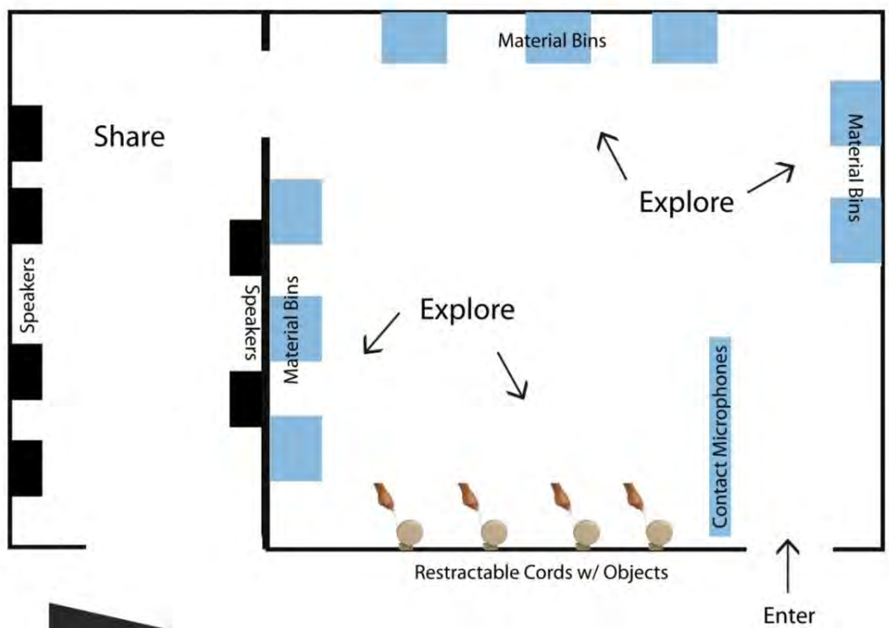
What is a contact microphone? A contact microphone uses a piezo element to sense vibration but, unlike other microphones, it doesn't pick up vibrations in the air very well; instead it senses vibration through solid objects. When the contact microphone is placed flat on an object and that object is struck, the piezo crystals inside the element sense the vibrations and transfer them to electrical energy. The contact microphone then sends the electric impulses to the amplifier, which transfers it back to sound energy.

In our program we connected the contact microphone to an amplifier with a ¼-inch audio cable. In order to make it portable we used a Vox headphone amplifier and plugged our headphones in (see picture to the right).

Exhibit version Play the Room: Audio Exploration

Once the contact microphone is built it is time to *Play the Room.* We start this activity by discussing musical instruments; deconstructing them to see what materials they are made of. We compile a list of materials and ask, "Where else do we see these materials? Wood? Plastic? Metal?" Then we explore the everyday materials in the room with our contact microphones to discover the potential of using everyday objects as musical objects for experimental sound recordings.

Room Set Up
The exhibit was designed for a room in the Preschool Place area at the New York Hall of Science. The flow of the room is meant to guide the visitor through an audio exploration of everyday materials and discover the sonic possibilities housed within them.



The objects are sorted by an object's use; for example, an egg slicer, spoon, and whisk would be in the same bin labeled *Kitchen Items*, and a zipper, thread, and fabric would be in a bin labeled *Sewing Materials*.

In addition to the bins there are various small objects such as keys, small toys, and wire attached to the wall with retractable cords. The visitors are invited to use the contact microphone and pull the objects off the wall - shake, rattle, or strike the object and listen to the variety of sounds it can make.

The contact microphone provides the visitor with an opportunity to hear what familiar objects sound like in ways they may not have experienced before. When a sound is amplified it not only makes it louder but it also isolates it, which allows visitors to focus on each sound.

Visitor Experience
When the visitor first enters the exhibit space they receive a contact microphone wand and pair of headphones.

Contact Microphone Wand Prototype – Laser cut wood box, piezo element attached to top of the box, inside the box it is attached to a pcb board which acts as the amplifier to transfer the vibrations back into sound energy. The Vox headphone amplifiers we used in our Experimental Sound Studio program inspired this.

Once they have their Contact Microphone Wand they are free to explore the room, dig through the material bins and discover sounds. The signage around the room and facilitator provide prompts for visitors encouraging them to try different ways of experimenting with the tools and materials.

My Favorite Sounds
Once the visitors are finished exploring the room they enter the Share Out Space where they have the opportunity to grab their favorite sound or the one that surprised them the most and play it over a speaker for everyone to hear. In here we plug the contact microphones into the amplifiers with ¼-inch audio cables to amplify the sounds.

Submitted by David Wells

The Sound of a Rubber Band

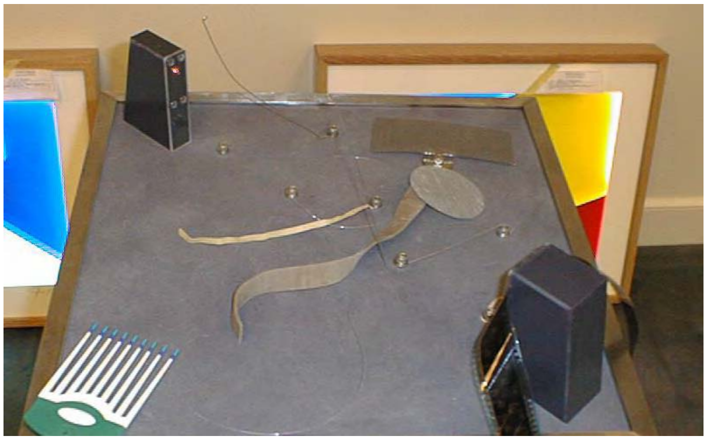
This exhibit is somewhat open-ended in that visitors can conceivably do something with it that has never been done before. But like other good open-ended exhibits it rewards a few seconds of activity by visitors with a fun and surprising experience. It is hard to say exactly what this exhibit is 'about," but a few of the topics it demonstrates are:

1) the transition from vibration to sound as the frequency gets higher;
2) using common electrical objects in a novel way;
3) how movie soundtracks are optically encoded; and
4) the relationship between frequency and how it sounds.

This exhibit contains a low power laser that shines onto a photosensor that is connected to an amplifier and speaker. As you break the beam with your hand you hear a thump. As you run your fingers through the beam you hear thump, thump, thump, thump. If you run a pocket comb through the beam you can make the same sound a record stylus makes scratching across an LP. As you vary the speed at which the comb moves you can generate low and high pitched sounds. When you pluck a rubber band in the beam the speaker makes a sound like a bass guitar.

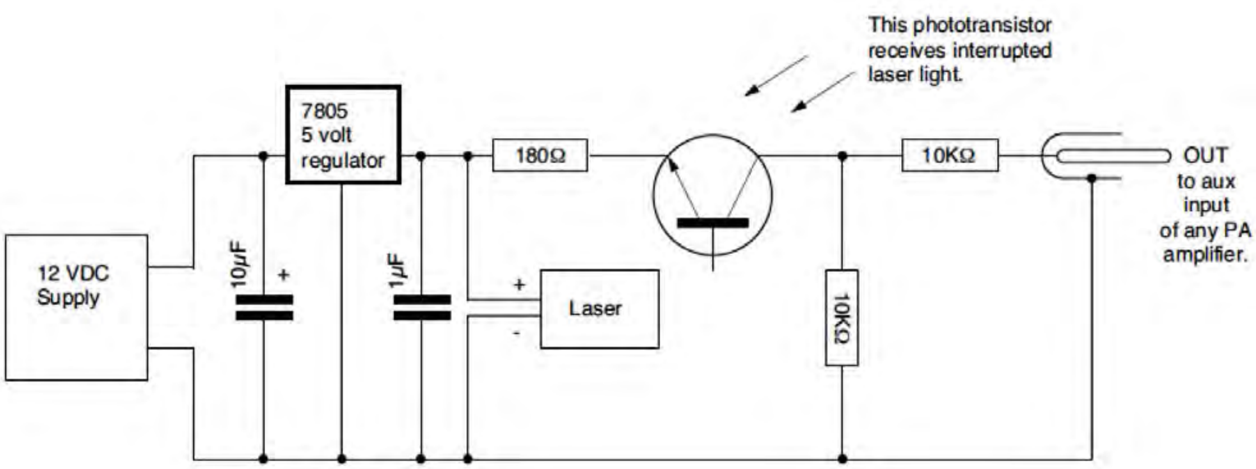
For the laser, you can look for a class 2 LED laser module online. You could also adapt a laser pointer. For safety, look for a laser source that is class 2 rather than class 3a (which many laser pointers are). You can also arrange the components of this exhibit in such a way that it would be difficult for the laser to shine directly into a visitor's eye. Typically the laser is fixed in place and it shines all the time onto the photosensor. If you attach some rods or other devices to hold rubber bands between the laser and detector, you not only make the exhibit more usable but you create an obstacle that prevents visitors from placing their head so close to the table that the laser can shine into their eye.

You can even make a little plastic holder through which a piece of 35mm movie film can be pulled to play the optical soundtrack. It is easier than you might think to get suitable movie film. I simply go to movie theaters and ask for outdated trailers. These are provided free to the theaters and after a few weeks are thrown out – or they pile up until someone like you comes around and asks for them.



To play the optical soundtrack on 35mm film you will need to cut a slot in a block of plastic for the film to slide through. Drill a hole through the block perpendicular to the slot for the laser to shine through. Typically the laser beam will have a larger diameter than the focused spot of light that made the optical soundtrack. The sound will be muddy and indistinguishable unless you make the laser beam smaller before it shines through the film. The best way I've found to do this is to take some aluminum duct tape and make a pinhole in it. Put this just before the film. The light emerges from the laser, shines through the pinhole, then shines through the movie film, and finally shines onto the photosensor.

There are several ways to make the photosensor. In past years several electronic surplus houses sold tiny glass-encapsulated solar cells. These could be plugged directly into the Aux, Phono, or Mic input of a PA Amplifier. Another alternative is to use a visible phototransistor but then you'll need a resistor and low voltage supply to convert the varying current through the phototransistor to a varying voltage to drive the PA amp. Phototransistors come in the perfect sized package. If you are good with electronics you could connect a photodiode and amplifier.



For the PA amp, I typically use the least expensive model that Radio Shack carries. Another option would be a guitar amp and speaker combo. For a speaker I have typically dropped a 12-inch full range driver into the top of a 5-gallon polyethylene bucket. The speaker typically fits perfectly and can be cemented to the top of the bucket which provides an acoustic suspension enclosure. Here I was probably over-influenced by a short story by Thomas Pynchon in which the characters gather around a woofer set into the top of a garbage can and drop cigarette ashes onto the woofer cone to watch them bounce around to the music. In the case of this exhibit, it can be very instructive to touch the speaker cone as you run your other hand through the laser beam. You can feel every transition and come to understand the relationship between vibration and sound. In some museum environments, the speaker might last long enough unprotected this way and you could justify spending $20 every once in a while for a new speaker. In museums where visitors are a bit rougher, you probably need to find a speaker grille to cover the speaker. Look for one with large open holes. These will let people look through to the speaker cone. Inevitably some dust specks will fall onto the speaker cone and jump around as the cone moves.

Submitted by Joe O’Connell

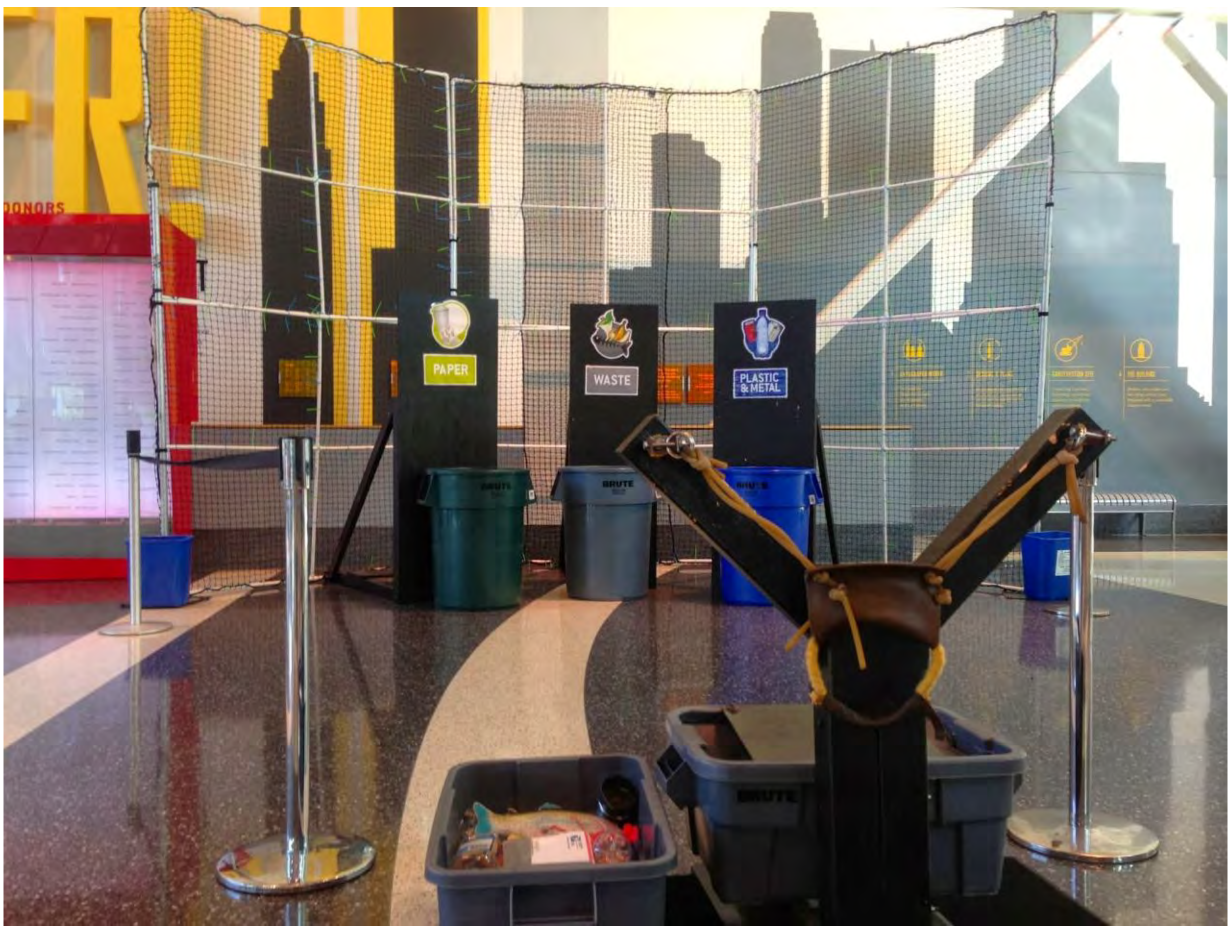
Trashketball

It began as a simple thought: Why do we have such a plethora of merchandise in our gift shop related to a video game in which you launch "agitated fowl" from a slingshot? We have nothing like that in the whole science center! But, boy is it popular!

So, inspired by the enthusiastic purchases of these items by our guests, I set out to extract the scientific concepts from the game, and recreate them in a 3D arena. I wanted to find a way to bring trajectory and arc into an experience that, aside from being a ton of fun, also displayed additional relevant and educational scientific themes in a totally original way.

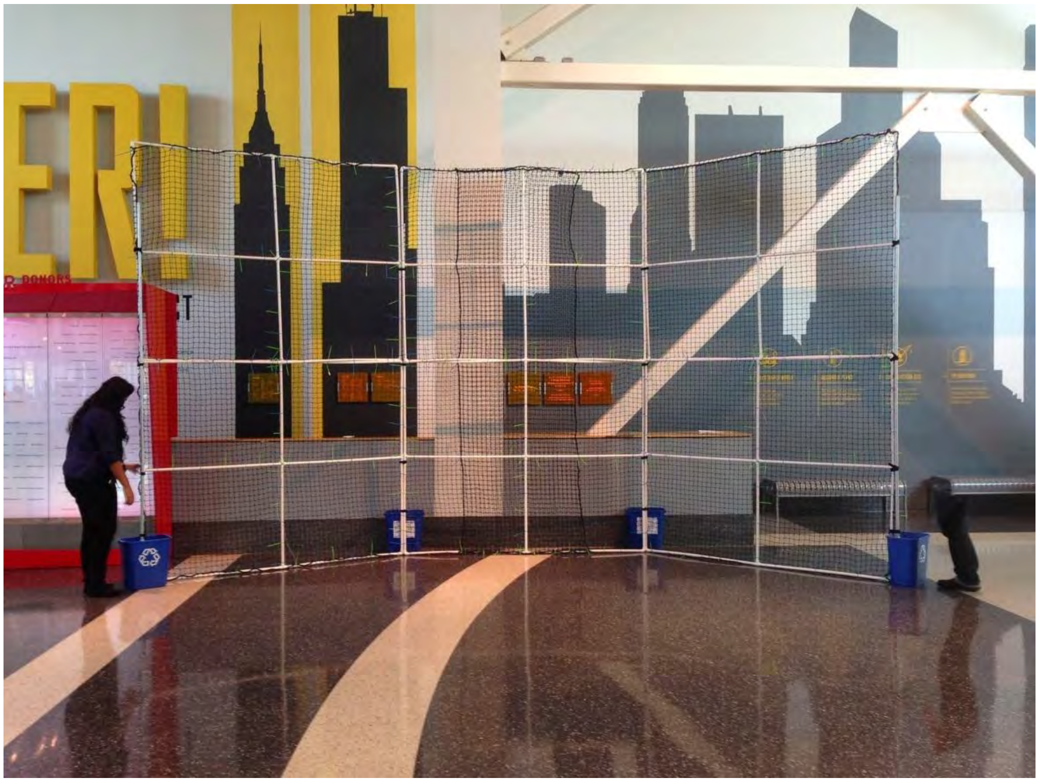
The Public Programming team and myself were brainstorming about Earth Day-related programming, when the practical application for launching things from a slingshot "hit" me. Build a giant slingshot and use it to sort recyclables into their proper bins! And, after a lively development session, the concept of Trashketball was born.

Below, we will look in depth at the two major components that make up Trashketball: the Slingshot and the Collapsible Backstop. I will, however, also list the additional materials used to create this exhibit/program.



The Collapsible Backstop
When considering guests launching projectile recyclables at high speeds, of course, the inevitable thought of “Well, what if they miss the bins?” came to mind, and I began designing something that fit the following criteria:

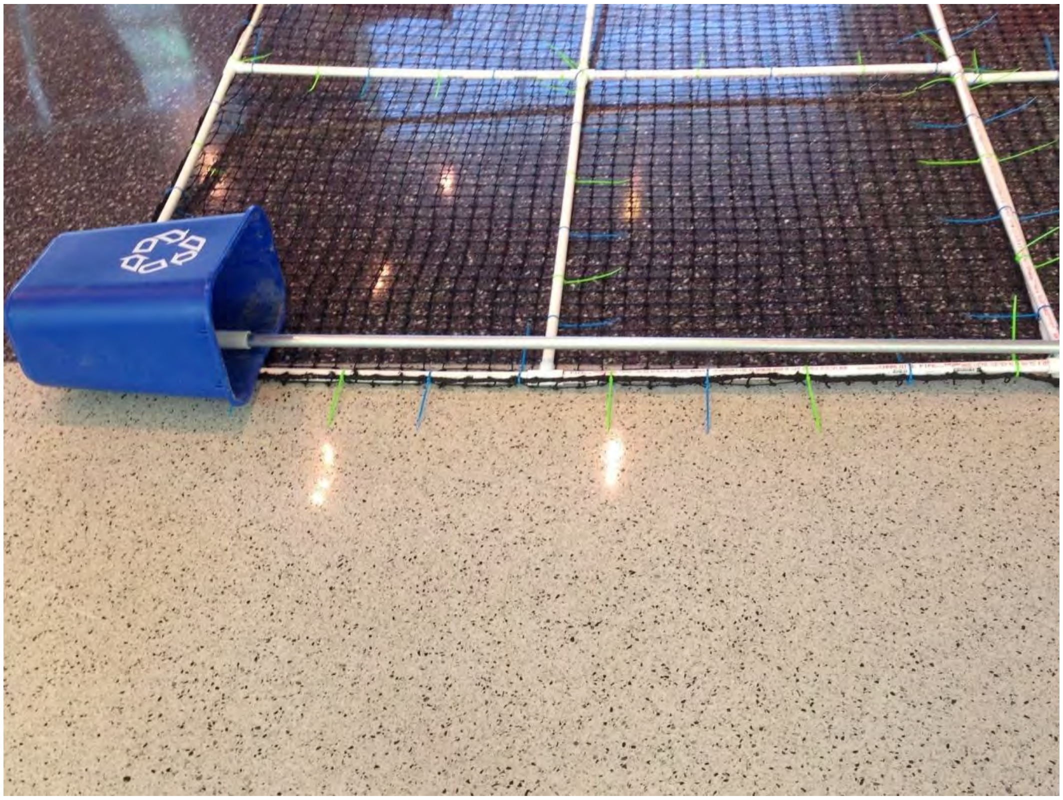
1. Tough enough to catch a fast-flying recyclable
2. Covers a large enough area to prevent “rogue recyclables” from flying past it
3. Cheap enough to fit our budget
4. Didn’t take up too much of our limited storage space when it was off the floors



A Backstop is the large cage on a baseball field, behind home plate, used to stop the balls thrown from the pitcher. This backstop, however, could not be permanent and would need to be stored somewhere when not in use during the week. That became the most challenging part of the design process. I drew inspiration from the traditional cardboard presentation trifolds used in science fair projects.

Materials

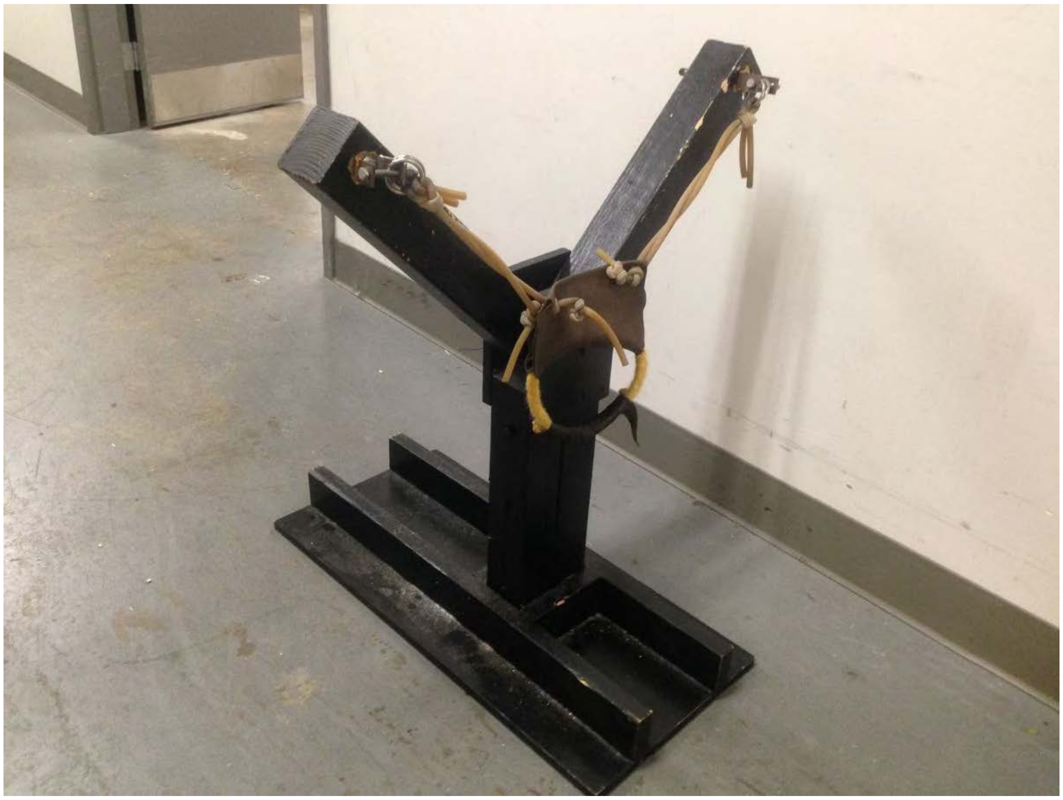
- 2 sections of batting cage net - 12’ x 15’
- Six 6’ x 7 ½’ frames made from ½” PVC piping
- Zip ties
- Velcro tape strips to secure the backstop to poles when erect, and to secure the collapsed and folded backstop together.
- Four 10’ lengths of metal conduit pipe used as support poles
- Four 7-gallon office recycling bins filled halfway with cement, with a section of piping embedded (interior diameter slightly larger than outer diameter of conduit piping), to act as supports for the metal conduit poles.



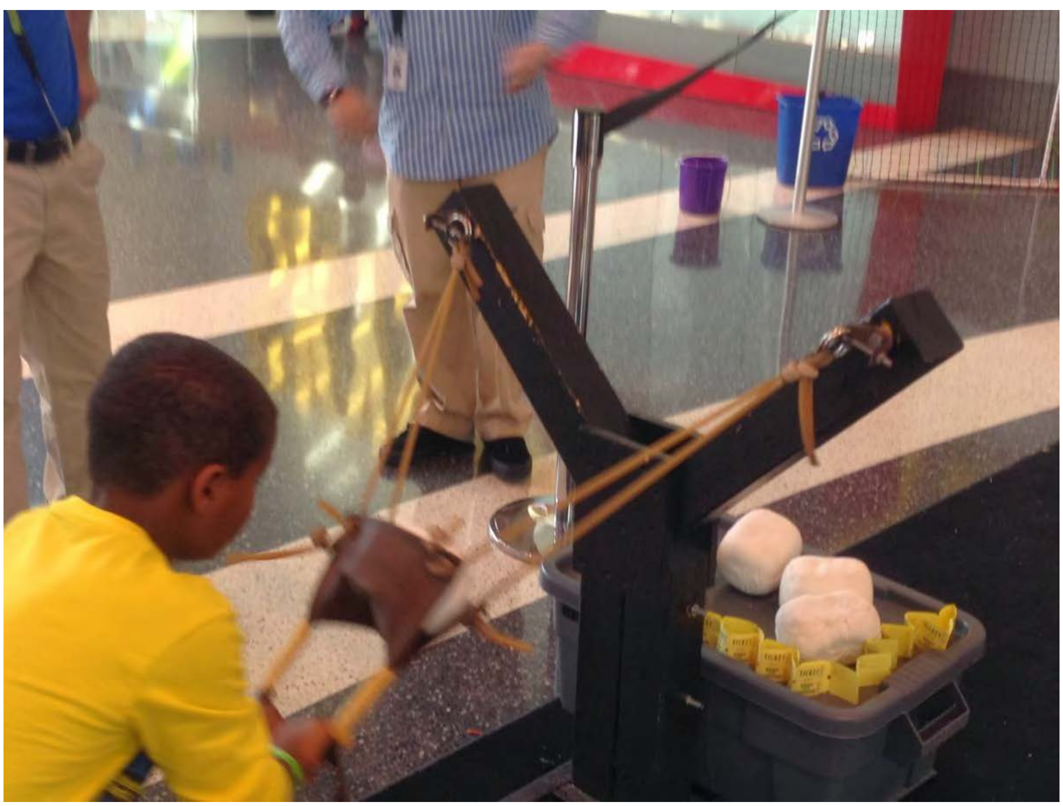
The Slingshot
The design for the Slingshot followed much of the same budgetary and storage spacing criteria as the Collapsible Backstop, but I also couldn't ignore that I felt giving it some "wicked awesome" qualities was paramount.

Materials Used:

- An 8' piece of 4" x 4" lumber
- Plywood base
- Additional 2" x 4" pieces to adhere the Slingshot to base
- Three 10" bolts with nuts
- Two U brackets
- Latex tubing
- For the sling, I used a scrap piece of leather and added grommets on the edges
- Two 50 lb bags of play sand in a Rubbermaid Brute bin to weigh down the Slingshot
- A carpeted rubber-bottom entry rug to provide a nonskid surface under the Slingshot



It is important to note that a large amount of counterweight is needed on the front of the Slingshot to balance the force created when the sling is pulled back.



Additional Materials

- Backboards - These three collapsible wooden backboards were constructed out of ¾” plywood and removable 2x4s as support legs. A bolt is used as a hinge at the base to allow folding for storage. (Pictured below)
- 44-Gallon Rubbermaid Brute trash cans in blue, gray, and green, acquired from an online restaurant supply store
- Food plushies acquired from an online classroom supply store, and other large rubber faux food doggie chew toys were found on various online stores and local 99 cent stores.
- Tons of durable and clean recyclables collected from home and colleagues.
- Stanchions were used to enclose the launching area in between the outer edges of the Backstop and Slingshot.

Concepts Covered

Trashketball allows for participants to experience and experiment with the trajectory of a flying projectile by using the Slingshot to launch the object in an arc to hit the target of the recycling bin. When a guest first begins their experience with Slingshot, they must:

- consider the weight and size of the individual recyclable piece being launched;
- determine which of the three recycling bins to target before launching; and
- begin to roughly calculate the angle one pulls the slingshot back to achieve the arc required to hit the desired target.

Trashketball is facilitated by members of our weekend volunteer staff. While stationed there, I ask that the volunteer engage guests by first picking an item from the bin of recyclables to be launched, handing it to the guest, and asking what the material is.

If it’s one of the faux food items, then they are to ask the guest where it would be launched. Ideally, they will choose the “Waste” bin, giving the volunteer an opportunity to discuss composting as another kind of recycling. If it is a recyclable material, the volunteer is to ask the guest to identify in which of the other two bins it belongs.

Once the target is identified, the volunteer is then able to make suggestions as to how create the arc needed to hit the desired bin.

Moving Forward

Trashketball ran on weekends for five months throughout the summer and fall of 2013. It will return for Earth Day 2014 with a new logo and signage, plus a few upgrades to the existing equipment and accessories.

The Slingshot and Collapsible Backstop have been used in the development and implementation of new programs, as well. They were used as a *Complete the S’More* game during a Thanksgiving “Food Science” themed weekend event (pictured below).

The Collapsible Backstop is currently being used in the development of a larger-than-life-sized paper football game called *Let’s Get Ready to Crumple* in conjunction with the installation of the traveling exhibition, *Gridiron Glory: The Best of the Pro Football Hall of Fame.*

There is no doubt in my mind that the Slingshot and Backstop will be incorporated in many more exhibit/programs covering many more topics and themes at Liberty Science Center. Hopefully, you, the reader, are already thinking about what you can launch from a Slingshot at your institution.

Submitted by Thomas Sullivan,

Wind Tunnel

Wind Tunnel is an exhibit that has been used in numerous iterations at Explora, and various interpretations of this exhibit are in use at other institutions. Our version has evolved over time and for these purposes we are looking at the version used by educators in classroom and outreach settings where some degree of facilitation is always present. Explora also has a permanent version of this exhibit on the museum floor which differs slightly.

From the Educators guide: *Users investigate how air interacts with materials to make them float and fly. Experiments with Wind Tunnels include making simple gliding toys and constructing your own kite.*

Basically Wind Tunnel is a fan, a tube, and a bunch of loose materials. The tube is held vertically in place above the fan with an open area between the two. Visitors select from a variety of materials that they insert into the tube to investigate how they behave in a controlled path of air. A key design element is the open space available between the fan and the tube which allows users to manipulate the air flow with their hands. The fans can also be set at three different speeds for side-by-side or back-to-back comparisons. A common practice is to attempt to get objects to balance or hover in the tube either by controlling the airflow or by choosing materials that allow for this result. Visitors tend to first test with the individual objects at hand and eventually begin to experiment by altering, combining, and constructing the materials. Wind Tunnel has proven to be very engaging for a broad age group and allows for a wide variety of materials to be used with it effectively.

Facilitation often begins by providing users with a half sheet of copy paper which they hold or drop in different orientations to see how its behavior is affected by airflow. Next, the paper is crumpled into a ball and the results are observed. Explora educators find that this strategy effectively sets the basis for the participant's knowledge as they explore with wind/air/flying. Further activities readily allow aerodynamic properties such as Bernoulli's principle, lift, and air resistance to be easily demonstrated.

What you need:

- Vornado model 630B Fan (amazon.com, ~$60 each)
- Graphics Dura-Lar Clear Acetate Alternative, 40” tall, heavy grade (dickblick.com)
- Embroidery hoops, 12” (Hobby Lobby, fabric stores, etc.)
- Mesh screening to cover fan (home improvement store) and zip ties to hold in place
- A support device to hold the tube over the fan
- Materials: craft foam, Styrofoam cups, paper cups, string/yarn, tape, paper clips, aluminum cupcake cups, egg cartons (cut into sections), netting, curling ribbon, mylar, feathers, pipe cleaners, etc.



Submitted by George Moran