



## **NanoLab:**

*One by One*

*Lots of Atoms*

*Atoms Build on their Own*

*Seeing Tiny Things*

*Play Nano Scientist* (pretend chip processing area)

*What do you wear in a Clean Room?* (dress-up area)

Video

Introductory audio

Reading area

## **Fact or Fiction**

*Build an Imaginary NanoBot*- building station

*Build an Imaginary NanoBot*- display cabinet

---

### **Setup and Takedown:**

Moving overview

NanoLab & Reading area: layout, setup and takedown

Fact or Fiction: layout, setup and takedown

Tools

Spare parts

Consumables

Banner guide

### **Documentation:**

NanoLab: changing gloves

NanoLab: sewing gloves

NanoLab: dome construction & access to motor/mechanism

NanoLab: documentation- motor/mechanism and electronics

Audio Players: access & changing headphones

## Moving overview: *NanoLab, Fact or Fiction, and Reading Area.*

These exhibits are shipped on seven rolling crates with casters. The crates are all 42 ½" wide. One (with two corner cabinets with motors) weighs about 500lbs, the rest weigh 400lbs or less.

Elevators: rolling crates will fit into an elevator that is 7' deep with 7' tall x 43" wide opening. If necessary, the crates can be disassembled, then the components unloaded and moved with pallet jack and/or dollies in smaller elevators. The cabinets with attached walls are 6'5" tall.



### Rolling Crates:

Five of the rolling crates are 42½” wide x 68” long and 83” tall. They might fit through standard double-doors that are 7’ tall (you would probably have to remove some door closing hardware).

- Two of these crates each hold two NanoLab corner cabinets with attached walls (31 ½” x 31 ½” x 6’5” tall).
- Two crates each hold one NanoLab entry cabinet with attached walls (*Play nano scientixt, & What do you wear in a clean room?*) that are 31 ½” x 48” x 6’5” tall.
- One crate holds Fact or Fiction display cabinet with attached wall panel.



One rolling crate is 42½” wide x 68” long and 68” tall, with the Fact or Fiction building table in it.



The seventh rolling crate is 42½” wide x 84” long x 71” tall. It holds the three “bridge wall panels” for the NanoLab, and three back wall panels for Fact or Fiction (fourth wall ships attached to the display cabinet), plus the six stools and bookshelf unit for the Reading Area.



Moving Individual components . Individual components can be unloaded from the rolling crates, and can all be moved through a standard doorway that is at least 36” wide and 6’8” tall, using a pallet jack. Two people can comfortably lift and move any of the components; they typically weigh under ~100lbs, aside from three NanoLab corner cabinets with motors that weigh ~150 lbs each.



There is also a small lifter with the exhibition that is handy for helping to move individual cabinets during setup, and for adjusting heights.

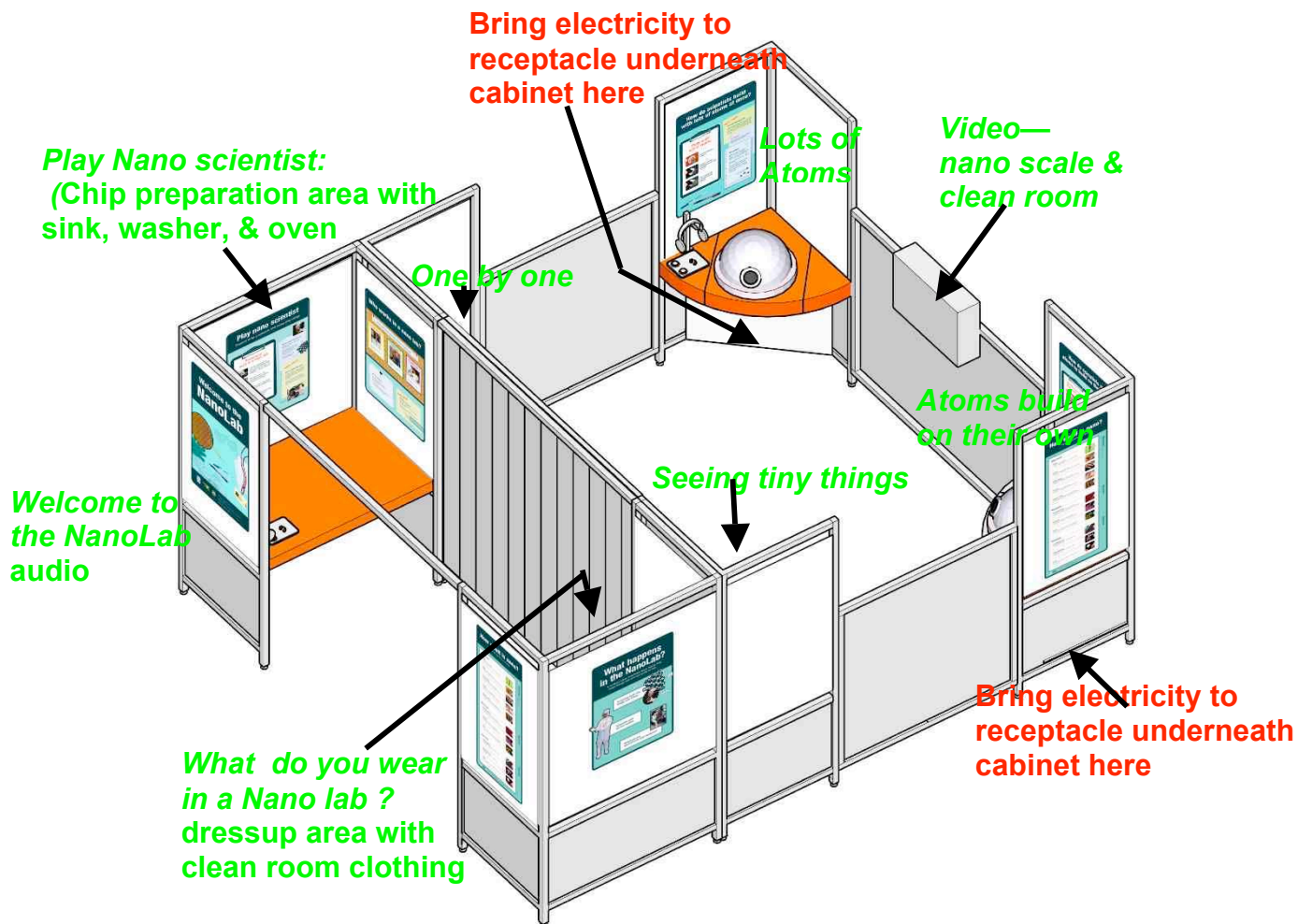


# NanoLab & Reading area: overview and layout

## Nano Lab & Reading area



# NanoLab & Reading area: overview and layout



Footprint: 11' 3" wide x 14'0" deep (walls are 13' 3" deep, plus the intro audio unit) x 6'5" tall

# NanoLab & Reading area: overview and layout

## Locate parts:

Two shipping crates (43 x 68) that each contain two tabletops with attached corner walls:

*One by One* tabletop and attached corner walls

*Lots of Atoms* tabletop and attached corner walls

*Atoms Build on their Own* tabletop and attached corner walls

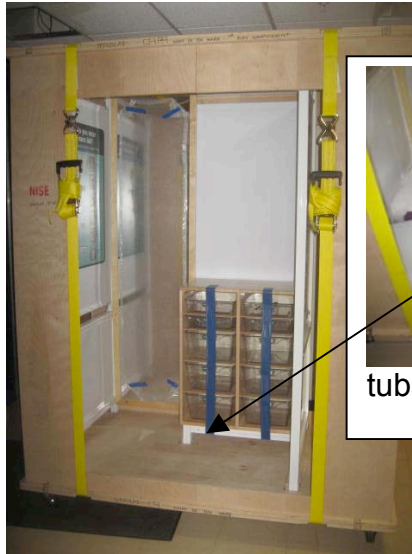
*Seeing Tiny Things* tabletop and attached corner walls



Two crates like this.

LEFT PHOTO: shipping crate (43 x 68) with *Play Nano scientist* tabletop/sink, with walls on 3 sides

RIGHT PHOTO: shipping crate (43 x 68) with *What do you wear in a Nano Lab?* cabinet and attached mirror, with walls on 3 sides



tubs with parts shipped here



# NanoLab & Reading area: overview and layout

Shipping crate (43 x 84) with  
4' long x 4' tall "bridge" panel section  
4' long x 4' tall "bridge" panel section  
6' long x 4' tall "bridge" panel section with attached display monitor  
two plain 6' pieces of white metal post  
one plain 6' piece of white metal post with plastic strips attached  
bookcase for *Reading Area*  
six orange stools in boxes (for *Nano Lab & Fact or Fiction*)  
(plus three wall panels for *Fact or Fiction*)



Plastic tub with setup hardware, allen wrenches, tools, etc. is shipped *inside Fact or Fiction* building table



**Cabinet keys!**  
*Hopefully the previous venue left one out on the countertop.*

# NanoLab & Reading area: overview and layout

## LAYOUT considerations:

Clearance: the back wall of the NanoLab can go up against a gallery wall to make it easier to hide the extension cords to the two corner units.

The NanoLab ideally will have a lot of clearance around at least one of its left or right sides. The *Reading Area* is intended to go on the left or right side of the *NanoLab*, with two NanoLab banners facing the reading area. You'd want at least 8' of space there, including the bookshelf and the round rug that is 6" in diameter, plus clearance for visitors to walk around.



However, the *Reading Area* can be located elsewhere in the exhibition (with the bookcase up against a wall of some kind).

If necessary, the *NanoLab* can go against your gallery walls on the left or right sides; during setup you'll need several feet around the outside of the *NanoLab*, so that someone can get behind the walls to get to the hardware to attach the three 4' tall "bridge panels" that go between the four corner stations; then you'll need to lift/slide those assembled section(s) into place against your wall(s) before attaching the remaining cabinet sections-- protecting your floors as necessary.

Almost all of the banners are single-sided and face into the NanoLab to provide instructions and information for each exhibit. There are two banners facing the outside on both the left and right sides; one "*How Small is Nano*" banner about scale, and one "*What Happens in the NanoLab?*" banner.

Sound: the video on the back wall of the NanoLab has audio playing on a speaker mounted above the monitor. All the remaining stations have audio information at them, but with headphones for visitors to listen. All the audio is in either English or Spanish, as selected by the visitor.

Electricity: two extension cords need to be provided to male receptacles underneath the "*Many at a Time*" and "*Self Assembly*" corner cabinets at the back wall of the NanoLab; the rest of the NanoLab has built-in wiring/connections that get powered from those cabinets.

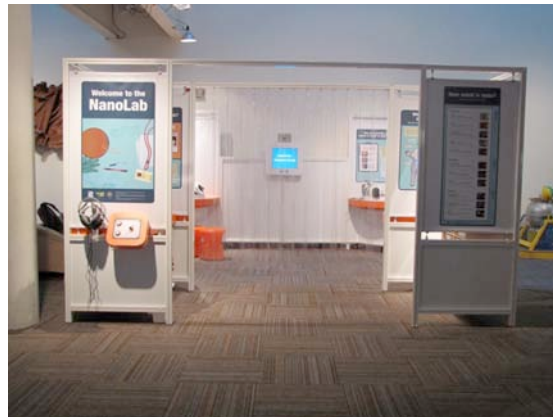
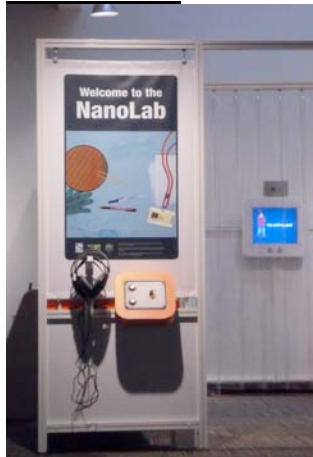
# NanoLab & Reading area: overview and layout

## NanoLab Activity stations:

NanoLab is an immersive mini-exhibition with a variety of experiences for museum visitors of all ages.

In the **entry area**, children dress up and role play as nano scientists. The activities and graphics introduce the concept that some nano scientists work in special laboratories known as clean rooms, which have a carefully controlled environment.

Intro- Audio: Introduction to the NanoLab.



*What do you wear in a NanoLab?* Visitors can put on a real lab coat, goggles and disposable gloves. The labcoats have namebadges of real nanoscientists. Visitors can see themselves in the mirror there.



# NanoLab & Reading area: overview and layout

Play Nano scientist. This station has a pretend sink, washer and oven. Visitors can take a pretend wafer (laminated photo of a real wafer) and pretend to process it.



In the **main lab area**, visitors use four interactive exhibits and watch a video that introduces the metric scale down by successive powers of ten, and shows nanoscientists at work in a real clean room. The exhibits and video introduce basic methods and tools used in research on nanoscale devices and materials.

Three stations in the inside of the NanoLab allow visitors to experiment with three different ways that scientists build with atoms at the Nanoscale:

- (1) *One By One* activity (bottom up)
- (2) *Lots of Atoms* activity (top down)
- (3) *Atoms Build on their Own* (self-assembly)

# NanoLab & Reading area: overview and layout

One By One: Visitors put their hand into a glove, and reach in a dome. They use a pair of forceps to pick up metal balls (“atoms”) one at a time and place them into plastic bar inside the dome that has a pattern of dimples; when all the dimples are filled in, it will say NANOLAB. Visitors can tilt the bar to empty the atoms. This activity is more challenging as the base of the dome is vibrating, simulating the motion of atoms at the atomic scale.

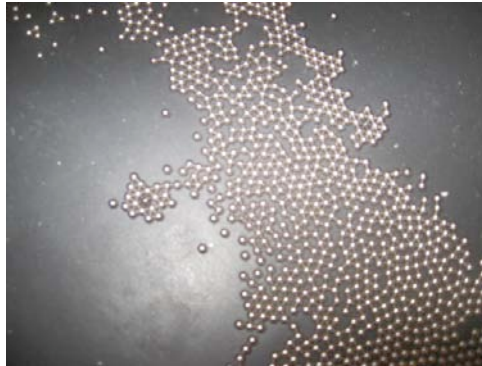


Lots of Atoms: Visitors put their hand into a glove, and reach in a dome to grab a plastic bar which they can use to move metal balls (“atoms”) around; at some locations of the base, the balls cluster together automatically in eight locations that form a square (there are magnets underneath the base to attract the steel balls). This is more challenging as the base of the dome is vibrating, simulating the motion of atoms at the atomic scale.



## NanoLab & Reading area: overview and layout

*Atoms Build on their Own (Self Assembly):* Visitors put their hand into a glove, and reach in a dome and move the balls (“atoms”) around and watch as they form small clusters; in this station only, some balls are magnetic, while most are plain steel, so the balls tend to clump together into sections packed neatly. This is more challenging as the base of the dome is vibrating, simulating the motion of atoms at the atomic scale.



*Seeing Tiny things (Atomic Force Microscope):* Two visitors work together here. There are four different metal blocks, each with a different pattern of raised plastic balls. One visitor puts a block into a holder, and slides it into the dome where you cannot see the pattern; the second visitor puts their hand into a glove, and reaches into the dome to feel the raised dots, trying to determine what the pattern is. Pushing the button at this station turns on a light underneath, that illuminates the sample.



# NanoLab & Reading area: overview and layout

Video: A narrated set of photos introducing visitors to scale by zooming in by successive factors of ten, followed by a video of scientists getting dressed in clean room suits and working in a real clean room.

Visitors push either English or Espanol buttons to start the player; once started the player will go through the entire set of photos and video (about 6 minutes total), before the buttons are active again.. There are “attractor screens” that cycle through automatically when the video is not playing.



In the reading area, visitors read books related to nanoscale science and nanotechnology. A wall graphic and picture book called “How small is nano?” use the human body to explore relative size.



## NanoLab Setup

UNLOADING CRATES & MOVING HINTS:



Moving Individual components . Individual components can be unloaded from the rolling crates, and can all be moved through a standard doorway that is at least 36" wide and 6'8" tall, using a pallet jack. Two people can comfortably lift and move any of the components; they typically weigh under ~100lbs, aside from three NanoLab corner cabinets with motors that weigh ~150 lbs each.





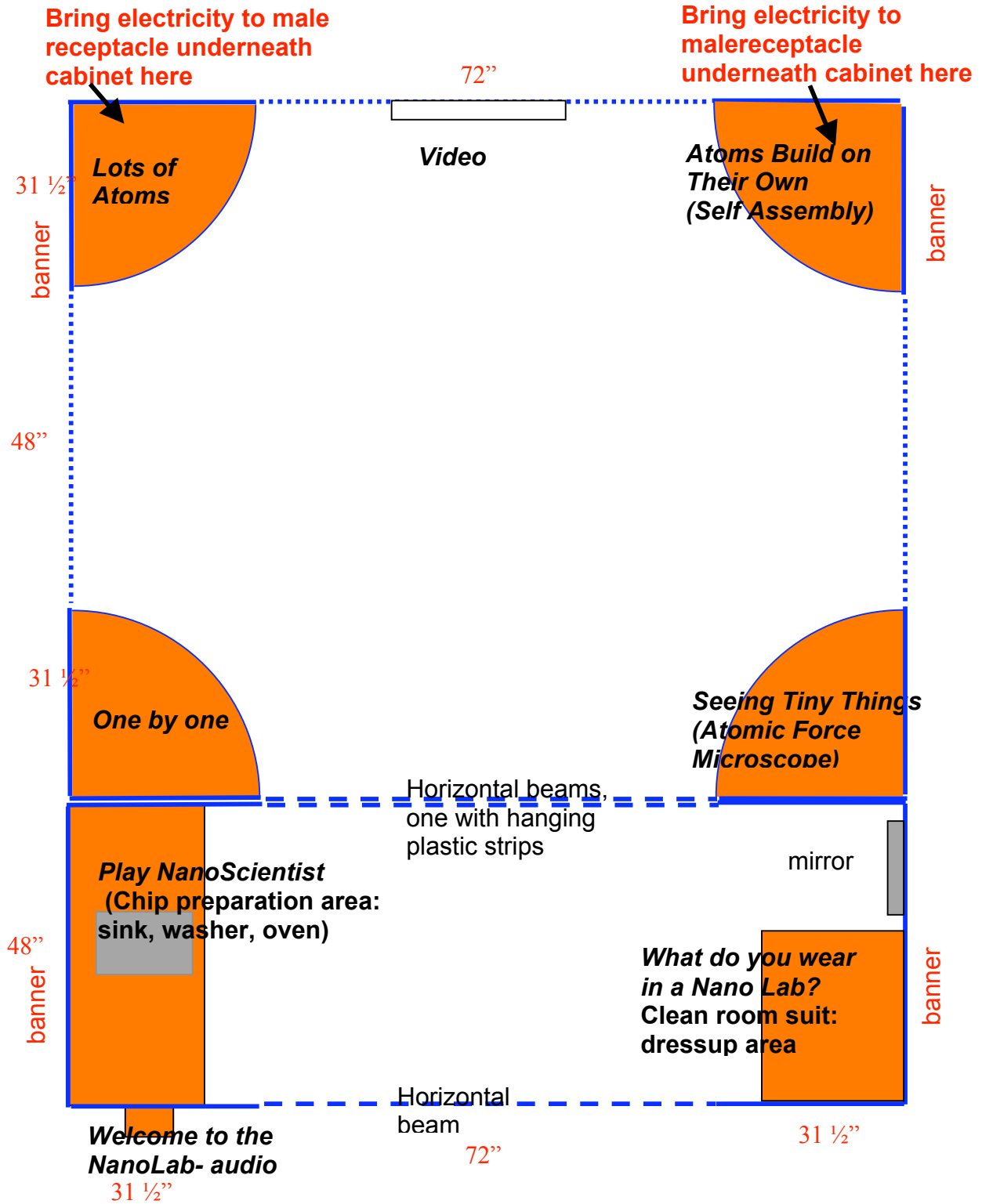
## NanoLab setup

There is also a small lifter with the exhibition that is handy for helping to move individual cabinets during setup, and for adjusting heights.



# NanoLab setup

Position the four corner cabinets as shown in the diagram.



# NanoLab setup

**IMPORTANT:** adjust leveling feet on the three corner cabinets with vibrating black drumheads so the countertops are level; otherwise the tabletop will vibrate a lot. The leveling feet will arrive all the way up (controlling the height for the shipping carts). Use  $\frac{1}{2}$ " wrench. Level and  $\frac{1}{2}$ " wrench in with setup parts.



## NanoLab setup

Remove the short 6" pieces of cover over electrical fittings on the corner cabinets at the bottom, so there is space for the molex connectors and cable that stick out a few inches from the bridge panels that go between the cabinets. Squeeze the plastic cover, tilt it up, and lift it out of the channel.



There will be five covers to remove: connections that go to either side of the narrow bridge panels, and one on the left side of the *Atoms Build on their Own* cabinet (for power to the TV). You do not need to remove the right hand cover under *Lots of Atoms* (to the left of the bridge panel with TV) as it doesn't have a power cord.

The two narrow bridge panels are oriented so that the electric cover at the bottom is facing the inside of the NanoLab. The panels are not interchangeable: look at the bottom at the electrical connectors, and identify which location each panel goes into by matching the male and female pins in the electrical connectors in the bridge panel and cabinets.

To attach a bridge wall: it is helpful to use the lifter to hold the wall during setup. Slide it underneath the corner cabinet and bring it up until it just touches the bottom bar, and you can use it as a height reference as well as support for setting the bridge panel in place. Then move the lifter over and rest the bridge panel on the lifter, which will get it at right height.

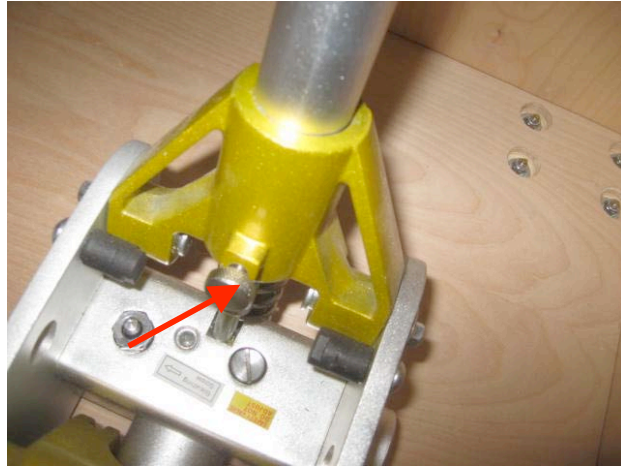


# NanoLab setup

\*\*\*\*\*

## LIFTER INSTRUCTIONS:

Insert handle, and tighten nut.



To lower it, turn the top handle counterclockwise (as viewed from the top) about 1/2 turn, and it will lower itself down.



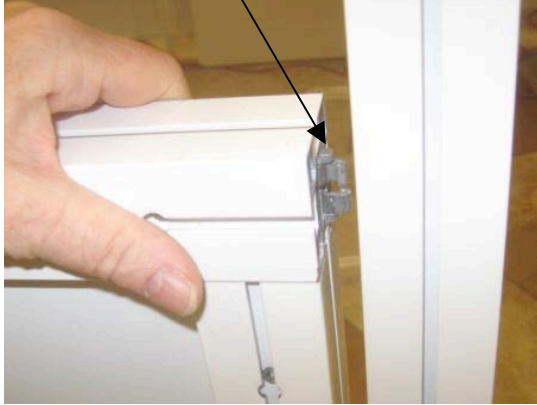
To lift, turn handle clockwise ~1/2 turn until it stops, then pump handle up and down.



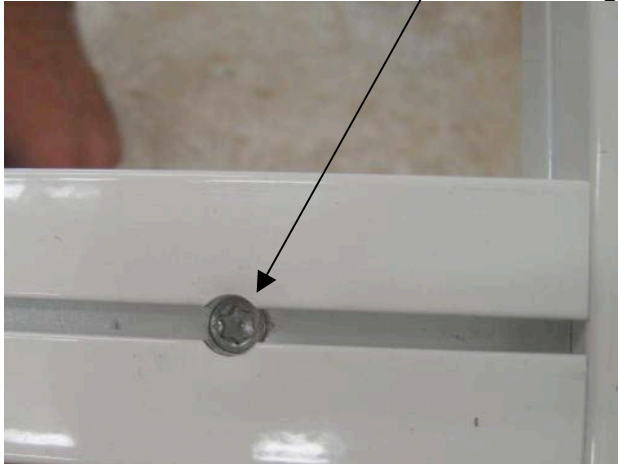
\*\*\*\*\*

## NanoLab setup

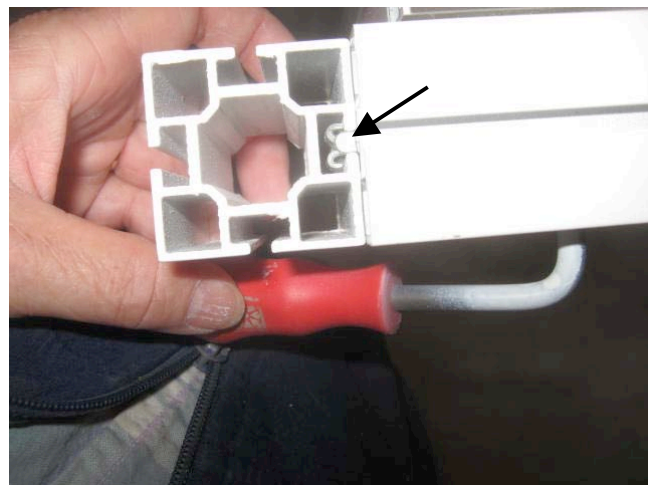
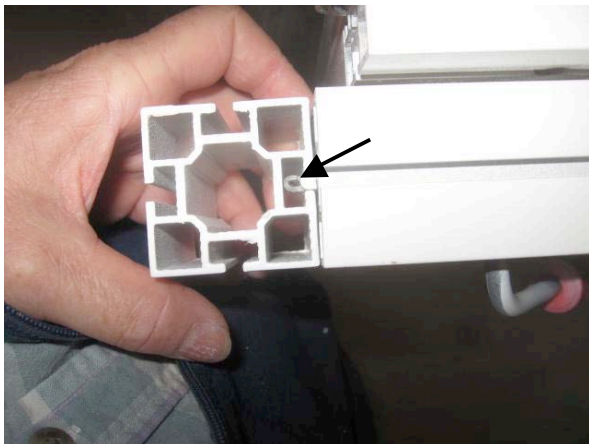
A second person can go around to the outside and secure the panel in place in the four corners. Line up one side of the bridge panel with the corner wall, and slide the bridge panel in place so the fingers go into the channel in the post for the corner wall.



Then use the Octanorm star drive tool to tighten up the screw in the **top** channel:



FYI, the fingers are closed when first inserted into the channel in the vertical post, then turning the star screw spreads the fingers apart inside the channel in the post, securing the bridge panel to the post.



# NanoLab setup

Repeat at the bottom channel:



Repeat for the other side of the wall.

Once all three bridge walls are in place, you can make the electrical connections. In order to have enough play to make the connection, you'll need to squeeze and pry out part of the long piece of cover over the cord running across the bottom of the corner cabinet:



There will be connections on both sides of *Atoms Build on Their Own* (left side to take power to TV, right side to power to *Seeing Tiny Things* lights), and one connection for each of *One By One*, *Many at a Time*, and *Seeing Tiny Things*.

## NanoLab setup

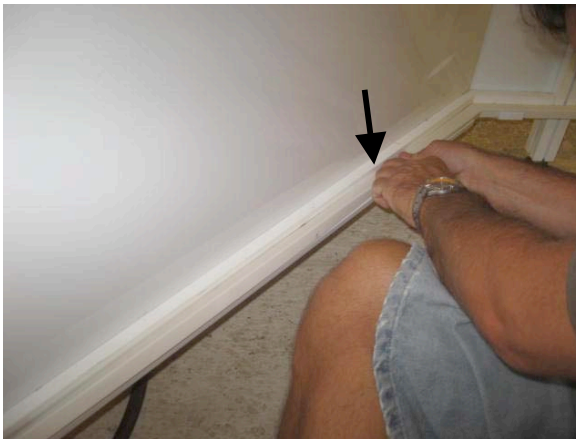
Once the moxex connectors are pushed together, then slide the wires in place in the short cover section. **You must orient the moxex connector so that the pointed, tapered side faces so it will go into the slot in the metal bars,**



**and then line up the plastic connector so that it is in the slot cut in the plastic cover.**



Put the short cover in place- tilt it up at a angle and squeeze to get the plastic tabs into the metal channel. The push the raceway back down in place across the corner cabinet, starting from the far side which is still in the channel.





## NanoLab setup



The four samples for *Seeing Tiny Things* should be inside glove (for shipping); place them in their holder.



The four Nano Lab exhibit stations should now be assembled together with bridge walls.

The samples for *Seeing Tiny Things* should be shipped inside the glove: set them in their tray.



## NanoLab setup

Next, bring the two Entry area cabinets (with attached walls) to the front of NanoLab: *Play Nano scientist* and “What do you wear in a NanoLab?”.



Place *Play Nano scientist* (with sink) next to *One by One* corner cabinet. Lift up *Play Nanoscientists* posts an inch or so (**the lifter is really handy for this**) and line up three sets of yellow plastic cleats in the channels (you'll probably need to do the front and back sides separately) .



# NanoLab setup

Then push the posts together and snug- a soft clamp (that doesn't scratch the powder-coated posts) can be helpful:



Repeat for *What do you wear in a Nano lab?* dress-up area.



## NanoLab setup

There are three 6' long pieces of post that go horizontally between the two sides. Two are plain, one has plastic strips attached to it. Plain bars go between the posts for the two Entry areas. Slide fingers in place slot at each end, and tighten fittings.



Bar at entrance to NanoLab:

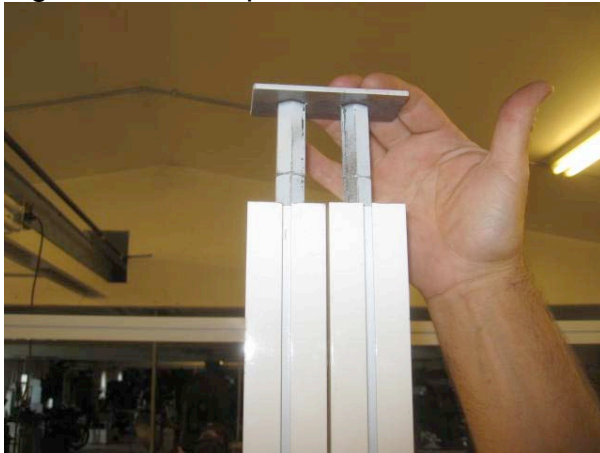


The third bar goes between the corner cabinet posts; it has plastic strips attached to it. Remove the cover (it is velcroed in place) to get access to star screws, and tighten. Then replace cover.

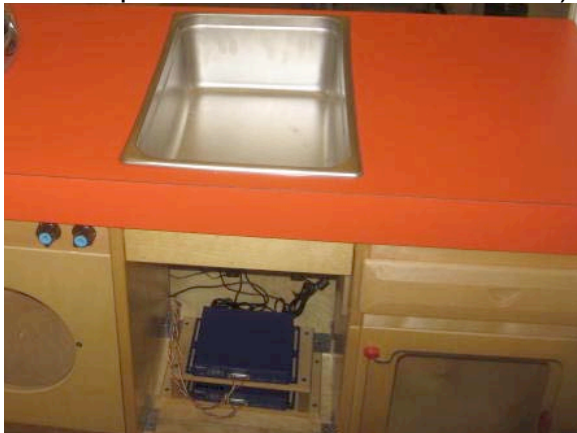


## NanoLab setup

Put the four top fittings in place to secure corner cabinet posts and Entry cabinet posts together at the top.



Electricity for *Play Nano scientist* cabinet: open front access panel under sink (unlock at top, and panel lifts out), and under *One at a Time* (unlock, and remove the two screws at the top-- 4mm or 5/32" Allen wrench).



Feed power cord from power strip under sink through grommets in Pretend Chip area and into *One at a Time* cabinet, and plug into power strip there. Replace the two access panels.

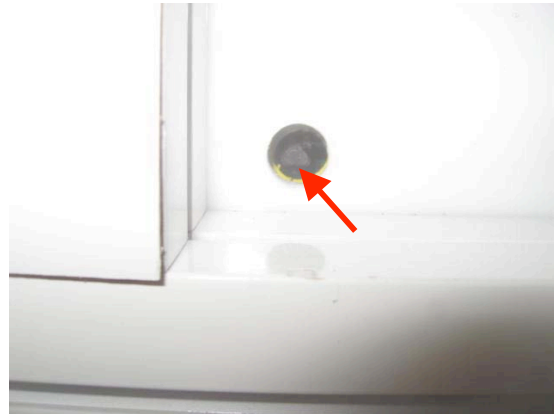
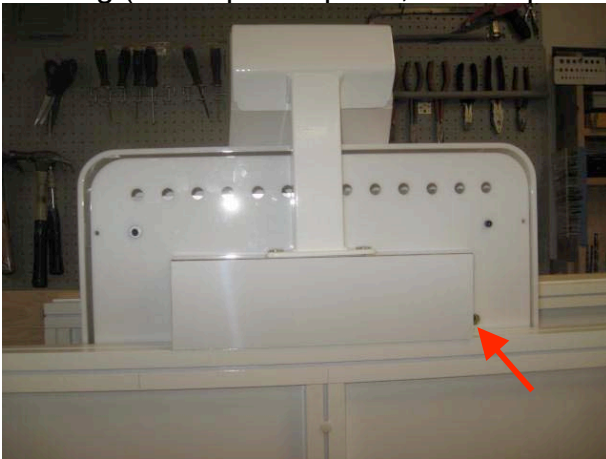


## NanoLab setup

POWER to NanoLab: bring extension cords to recessed male receptacles underneath *Lots of Atoms*, and *Atoms build on their Own*. The exhibits will all power up on their own when you turn on power to your breaker.



VOLUME: volume for video can be adjusted with access hole in the back of the TV housing (with a pair of pliers, or forceps from Entry *Play Nano scientist* area).



# NanoLab setup

Entry areas:

*Play Nano Scientist* pretend chip area should have pretend chips, tweezers, trays, and a trash can; there are a number of plastic tubs with extra parts, some may be stored inside the *Fact or Fiction* building cabinet.



Stock dressup area *What do you wear in a Nano Lab?* with labcoats, gloves, safety glasses and a trash can.



There is a list of consumable parts & their sources with the technical manual. There is also a USB thumb drive with the plastic tubs (attached to a 4-5" piece of red plastic) that has this file.

## Reading Area: setup

### Reading Area:

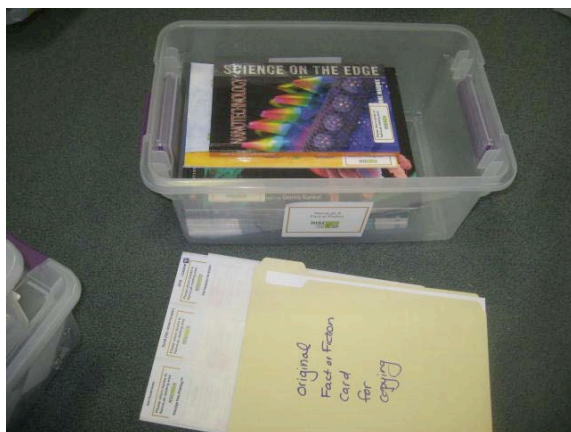
#### Locate components:

Two couches, in shipping crate with *Fact or Fiction* display cabinet

Rug 6' round, red/orange rug, in large plastic bag, in shipping crate with *Fact or Fiction* display cabinet

Bookshelf unit, in shipping crate with wall panels

Plastic tub with books (should be with a number of other tubs with spare labcoats, etc. in the crates with the Play NanoScientist and Dressup Area





# NanoLab takedown

## NanoLab takedown

Unplug your two extension cords from underneath *Lots of Atoms*, and *Atoms Build on Their Own*.

Remove the short 8" pieces of cover over electrical fittings on the corner cabinets. Squeeze the cover and you can tilt it out of channel.



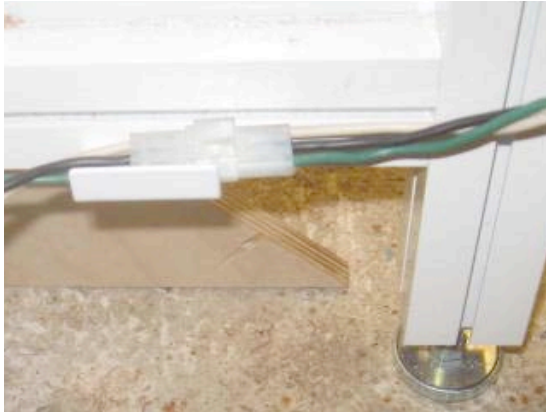
You will need to also pull up some of the long section underneath the corner cabinet, in order to get the molex connector and wires out of the gap in the cover:



There will be five covers to remove: connections that go to either side of the narrow bridge panels, and one on the right side of the large bridge panel (with TV). you do not need to remove the right hand cover under *Lots of Atoms* (to the left of the bridge panel with TV) as it doesn't have a power cord.

## NanoLab takedown

DISCONNECT molex connectors- **pull apart gently- do NOT grab wires, but hold onto connectors.**



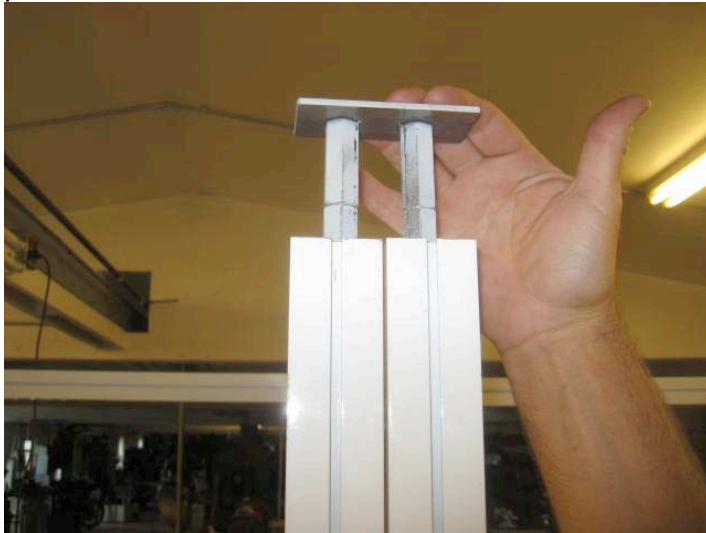
Replace plastic covers after you've taken the bridge panels off (or tape them to the appropriate countertops).

Open front access panel under sink (unlock at top, and panel lifts out), and under *One by One* (unlock, and remove the two screws at the top-- 4mm or 5/32" Allen wrench). Unplug cord from power strip under chip cabinet, that is plugged into the power strip under *One at a Time*. Replace access covers.

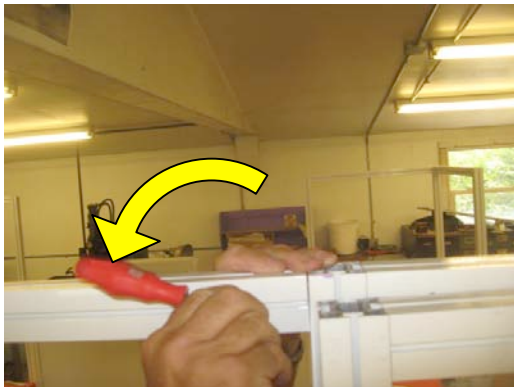


# NanoLab takedown

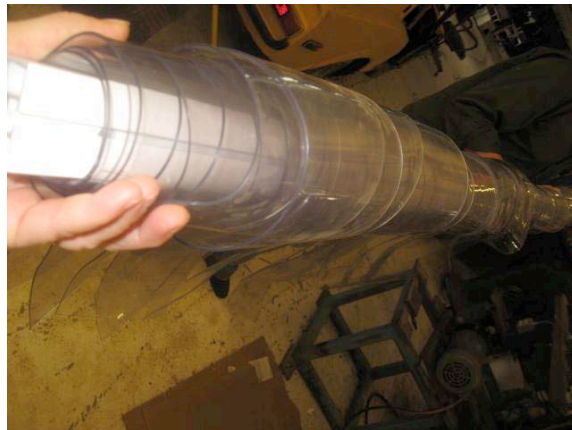
Lift out fittings that hold Pretend area posts to corner cabinet posts, and pack with setup parts tub.



Remove three horizontal 6' bars that span the cabinets—use Octonorm tool and loosen star screws by turning counterclockwise (remove cover from strip wall, which is velcroed in place, to get to star screw, then put it back in place).



Roll up plastic strips around their bar.

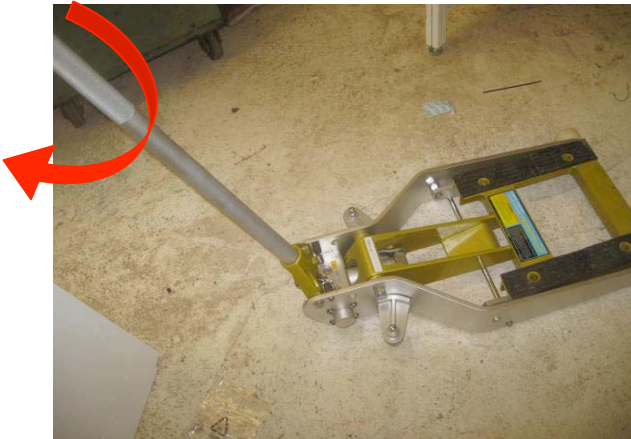


# NanoLab takedown

LIFTER INSTRUCTIONS: To lower, turn the top handle counterclockwise (as viewed from the top) about  $\frac{1}{2}$  turn, and it will lower itself down.



To raise something, turn handle clockwise  $\sim 1/2$  turn until it stops, then pump handle up and down.



# NanoLab takedown

Lift UP on Pretend area cabinet where it adjoins the corner cabinets, to get it off yellow plastic cleats on corner cabinet post (at least 1/2" or so). It is helpful to use the lifting tool again (you'll probably need to do the front and back sides separately, and may need to go back and forth).



The two cabinets may rise up together; in that case you can reach up and push down on the corner cabinet post:



# NanoLab takedown

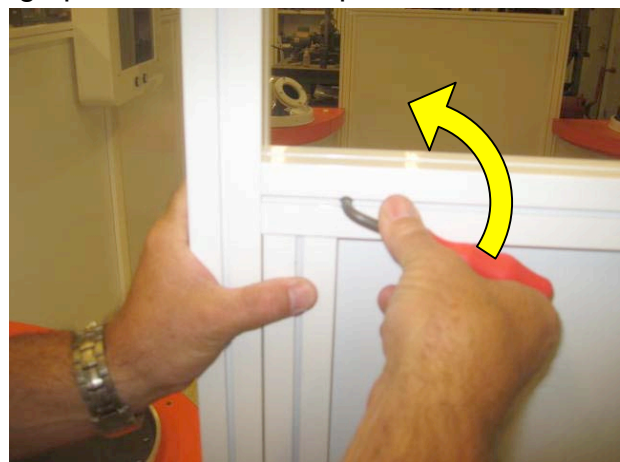
Push electric cord from *Play Nano Scientist* through grommet hole and into its cabinet.



To remove the three bridge panels, it helps to use the lifter to support the panel.



A second person can go around the outside and use the Octanorm tool to turn the star screws to loosen the fingers that hold the bridge panel to the corner posts:



# NanoLab takedown

Hold onto panel as you do this:



PACKUP PARTS;

Put fittings that hold two posts together, and tools and key, back in setup tub (which is packed in *Fact or Fiction* building cabinet.)



Tidy up labcoats and pretend chips, etc. before loading rolling crates. Tape drawers closed for shipping:



# NanoLab takedown

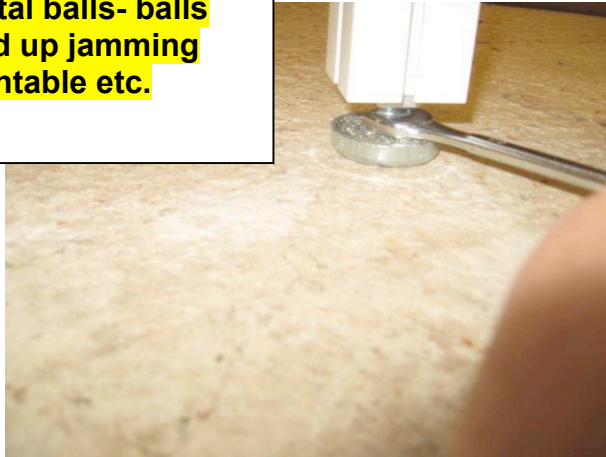
Put samples for *Seeing Tiny Things* inside glove for shipping.



**LEVELING FEET: they all need to be adjusted to their lowest level so they fit properly in the rolling crates;** that way the top board will grab and secure the top of each wall in place for shipping. You can do this with the ½" wrench.



**DO NOT TILT the three corner cabinets with the metal balls- balls will end up jamming the turntable etc.**



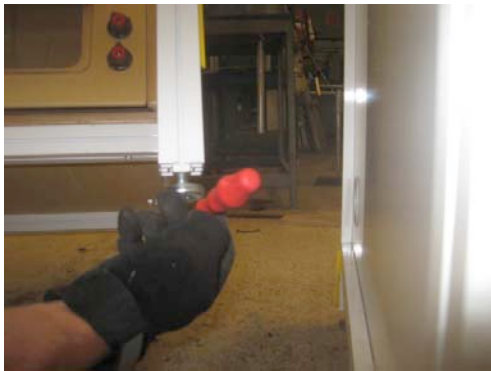


# NanoLab takedown

You can tilt the other cabinets, and it is a lot faster if you use two people: one can tilt the cabinets while a second person runs the leveling feet up: a T30 star drive (the Octanorm tool or a straight T30 in a screwdriver-style handle) works very nicely as there is a T30 recess in the bottom of the leveling foot.



Only *Seeing Tiny Things* corner cabinet can be tilted.



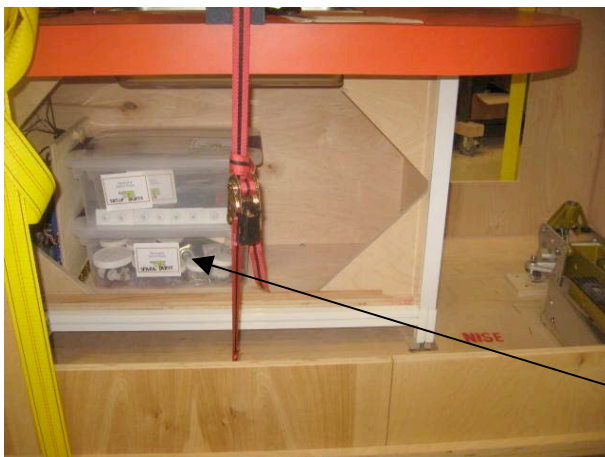
# NanoLab takedown

When you're all done, please pack up tools in small shoebox, and setup parts in larger tub; place tools inside bigger box, and store inside Building table cabinet.



Don't forget the keys!

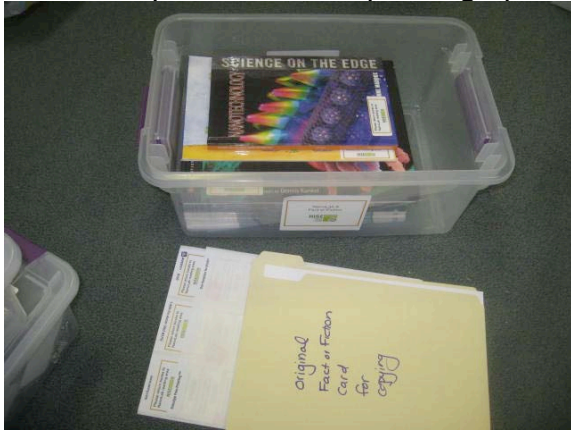
**Leave a cabinet key out, taped to cabinet or in sink, as you lock the access door!**



Bottom tub stays here, with extra hardware etc.

# NanoLab takedown

There are plastic tubs for packing up the books and extra parts:



There is a plastic bag for the rug for the reading area:



SEE PACKING INSTRUCTIONS for loading cabinets, panels, and parts.

# NanoLab and Fact or Fiction: tools

12mm socket on thumbwheel ratchet, for changing gloves

1/2" wrench, for leveling feet

T30 torx right angle tool, for Octanorm white truss hardware

Metric allen wrench set

Inch allen wrench set

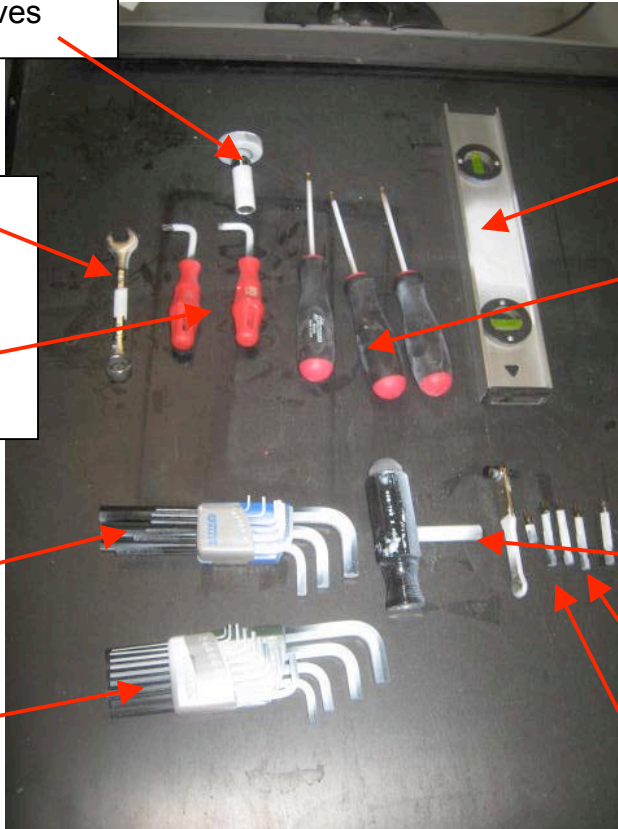
Level

4mm allen wrenches, for 1/4-20 bolts

90-degree screwdriver, and small ratcheting screwdriver, with T30 bits-- for leveling feet.

Extra T30 torx bits

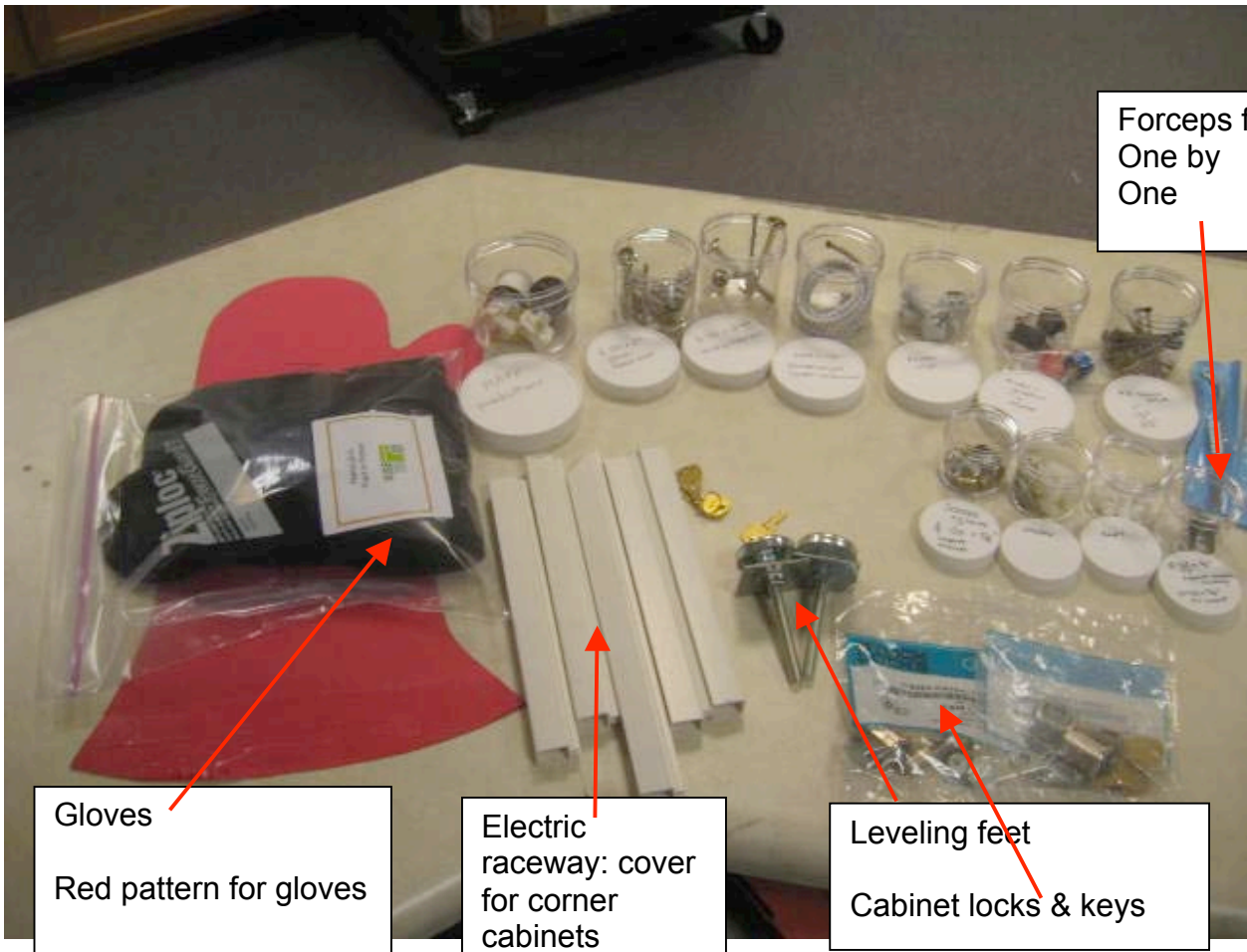
Square drive bits L(#2) for cabinet



# NanoLab & Fact or Fiction spare parts



Tub with spare hardware and such you might need for setup etc. is inside the *Fact or Fiction* building cabinet.



Gloves  
Red pattern for gloves

Electric raceway: cover for corner cabinets

Leveling feet  
Cabinet locks & keys

Forceps for One by One

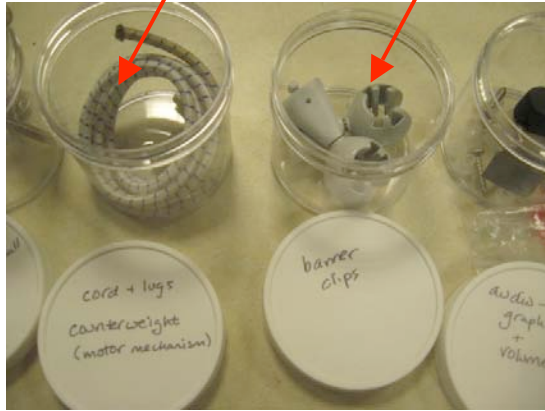
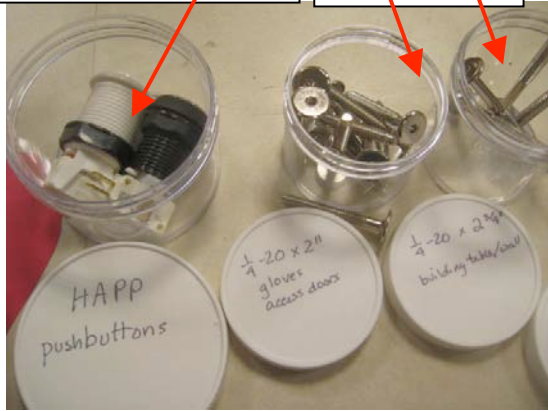
# NanoLab & Fact or Fiction spare parts

HAPP pushbuttons

1/4-20 bolts:  
2" and 2 3/4"  
long

Stretch cord-  
counterweight for  
motor mechanism

Banner  
clips



Domes: 1/4-20 x  
5/8" bolts,  
inserts, and  
locknuts

Molex 3-pin  
connectors

Audio: screws for  
graphic panels,  
potentiometer, and  
knob

#8 wood screws  
(#2 square  
drive): 1", 1 1/2",  
2 1/2" long



Caps (to cover star  
screws in metal  
bars that are  
permanently  
assembled

8-32 x 3/4" button head socket cap  
screws for TV cover, electric  
raceway brackets  
  
10-32 x 3/4" socket head screws for  
TV mount

# NISE Sciencenter Exhibits NanoLab & Nanotechnology: Fact or Fiction Parts lists & Specs

revised 9-19-09

\* = consumable

| NanoLab                                |   |   |   |                         |
|--|---|---|---|-------------------------|
| consumable                             | Description   | Est. Cost<br>without<br>shipping Part #   |   | Vendor                  |
| <b>Fabrication walls &amp; framing</b> |   |   |   |                         |
| X                                      | laminate - bright white   | n/a   | #949 Bright White Gloss                         | Formica                 |
| X                                      | laminate - orange   | n/a   | (orange) "bittersweet"                          | Pionite                 |
| X                                      | framing -Extrusion 40mm square  | 22 & 1 & 5 & 2  | m1000 (color; tiger drylac ral 09/10126)        | Octanorm                |
| X                                      | framing -adjustable feet with square bottom plate for M1000 extrusion   | 6 (6-17 order, in 3 F-F walls; changed 3 on 9-17, will change other 3 so all Z980.37) | m1016.37  | Octanorm                |
| X                                      | framing- adjustable feet (post goes in middle of extrusion)   | 24 inserted & 12 & 6 (3 for spares)   | Z980.37   | Octanorm                |
| X                                      | tension lock- slot punching, requires keyhole aperture (M1000)  | 60 (Mar 30) inserted by Octanorm  | Z951/13.00                                      | Octanorm                |
| X                                      | tension lock; fits in center of M1000 extrusion; T30 torx to turn   | 118 & 26 & 24 & 24 (all but last 24 inserted by Octanorm)                             | Z961/8.00                                       | Octanorm                |
| X                                      | tension lock 45degree right, for corner cabinets  | 4   | Z963/R.37                                       | Octanorm                |
| X                                      | tension lock 45degree left, for corner cabinets   | 4   | Z963/L.37                                       | Octanorm                |
| X                                      | white plastic caps to fill in holes for tension locks that are never taken apart in setup/takedown  |   | maybe McMaster 8720K34 1/2" dia polystyrene rod | custom by Rumsey-Loomis |
| X                                      | connecting clamp (two bars together, adjustable angle); corner cabinets   | 8   | E263.00   | Octanorm                |
| X                                      | 2.5mm hex key, probably for E263.00 connecting clamps   | 2   | E118.90   | Octanorm                |
| X                                      | tension lock 45degree Left (3-part); probably for angled bar Fact/Fiction hinged display cabinets   | 1   | Z 963/L.37                                      | Octanorm                |
| X                                      | tension lock 45degree Right (3-part); probably for angled bar Fact/Fiction hinged display cabinets  | 1   | Z 963/R.37                                      |                         |
| ZZ                                     | aluminum beam- rectangular 25mm x 5000mm  | 5   | Z300.01, powder coated                          | Octanorm                |
| ZZ                                     | M4x4 set screw cup point  | 24  |   | Octanorm                |
|  | Dibond white panels 0118" thick (bridge panels, lower walls on other cabinets); caulked in place to reduce vibration with DAP Seal 'n peel clear removable weatherstrip caulk |   |   | Curbell plastics        |
| X                                      | banner mounts-- "fabric clips"  | 16 & 60   | M1448.35  | Octanorm                |
| x                                      | white delrin rod 3/8" for banner pockets  |   | 8572K53   | McMaster-Carr           |

|                              |  |              |                                   |  |
|------------------------------|--|--------------|-----------------------------------|--|
| X                            | plastic wireway white ( <i>for wires along bottom of panels in NanoLab</i> )   | 4            | E460.30                           | Octanorm   |
| X                            | "threaded plate" -- springloaded teenuts-slide into extrusion, for screws for brackets for corner cabinet tops, some for electric raceway          | 24 & 15 & 25 | M1078.37                          | Octanorm   |
|                              | brackets that support corner countertops: 1/8" thick 1 1/2" aluminum angle, cut to ~2" long  |              |                                   | Lowe's   |
| X                            | M4 x 8mm phillips flat head screws for securing brackets to octanorm, that support corner countertops (into "threaded plates" M1078.37 in channel) |              | 96477A120                         | McMaster-Carr  |
| X                            | white metal brackets for supporting electrical raceway   |              |                                   | custom by Sciencenter (Accufab)  |
| X                            | white brackets: held in place with 8-32 x 3/4" button head socket head cap screws into tapped holes in octanorm                                    |              |                                   | custom by Sciencenter (Accufab)  |
| X                            | 1/8" thick x 1 1/2" wide steel for top plates with couplers to make fittings for tops of adjoining posts   |              | 8910K119                          | McMaster-Carr  |
| X                            | M4 x 40mm button head socket cap screws- for holding short pieces of Octanorm at bottom of Fact or Fiction building cabinet, used to attach wall.  |              | 92095A200                         | McMaster-Carr  |
| X                            | coupling nuts used to make fittings at top of adjoining posts; 3/8-16 x 1 3/4" long, 5/8" wide   |              | 90264A460                         | McMaster-Carr  |
| X                            | 3/8-16 x 5/8" long button head socket head cap screws in top plates into coupling nuts.  |              | 92949A621                         | McMaster-Carr  |
| X                            | fully threaded studs 3/8-16 x 2" long, to secure two coupling nuts together  |              | 91565A632                         | McMaster-Carr  |
|                              | T-shaped spline for adjoining posts- from plastic scraps in-house, custom made (yellow is HDPE, 1/2" thick)  |              |                                   | custom by Sciencenter  |
|                              | 10-24 x 3/4" pointed set screws, to hold spline in place in adjoining posts  |              |                                   |  |
| <b>overall</b>               |  |              |                                   |  |
| X                            | Curtain wall: clear plastic strips for entry to NanoLab's four corner exhibits; 6" wide, 0.060"  |              | 1894A14                           | www.mcmaster-carr.com/   |
| X                            | surge protectors; Tripp-lite TLM606HJ 6 outlets, 6' cord, 1120 joules  |              | 7693K93                           | www.mcmaster-carr.com/   |
| <b>Video and Audio Units</b> |  |              |                                   |  |
|                              | <b>video monitor:</b> 17" Monitor PRO LCD Monitor CGA /VGA, with glass overlay.  |              | Happ 49-2603-36                   | <a href="http://www.happcontrols.com">www.happcontrols.com</a>                     |
|                              | 17" monitor shroud custom by SMM   | n/a          |                                   | SMM custom   |
| X                            | external audio speaker for video   | \$170/pair   | JBL Control 23-WH speaker (white) | Full Compass Systems   |
| X                            | white powder coated mount for speaker  |              | custom                            | OMSI custom  |
| X                            | audio amplifier for speaker  |              | 49-5140-100                       | <a href="http://www.happcontrols.com">www.happcontrols.com</a>                     |
| X                            | power supply 12V DC for amplifier  |              | 80-1153-00                        | <a href="http://www.happcontrols.com">www.happcontrols.com</a>                     |
|                              | <b>Audio English Espanol buttons:</b> Happ push buttons (white clear lid to insert label inside)   | 16@6.60      | \$106                             | Happ D54-0004-21<br><a href="http://www.happcontrols.com">www.happcontrols.com</a> |
| X                            | <b>Headphones</b> (2 sets for each audio station)  | 14@\$49.99   | \$700                             | AKG K77 Headphones<br><a href="http://www.amazon.com">www.amazon.com</a>           |



|                         |  |             |                                       |   |
|-------------------------|--|-------------|---------------------------------------|---|
|                         | springs for strain relief for headphones;<br>2 1/4" long, 3/4" OD, ~1/16" wire x 10<br>coils   |             |                                       |   |
| X                       | Audio Amp & 12V DC power supplies  |             |                                       | <a href="#">SMM</a>   |
| X                       | second surface printed plastic for audio<br>Units  |             |                                       | OMSI custom   |
| X                       | hole punch for English and Espanol<br>labels in HAPP buttons, 7/8" dia   | 3424A52     |                                       | Mcmaster  |
| X                       | knob for volume-- Not McMaster<br>pot for volume-- 10K (Allied Electronics<br>66395)   | 7587K391    |                                       | <a href="http://www.mcmaster.com">www.mcmaster.com</a>  |
|                         | Roku Media Player Bright Sign HD410 r<br>for video & audio units, and 5V DC<br>power supplies  | 7@ \$349.99 | 2449.93                               | Roku Bright Sign HD410<br>BrightSign Sales, <a href="http://www.brightsign.biz">www.brightsign.biz</a><br>Tim Chluda, 614-571-3525 mobile |
| <b>Interactive Area</b> |  |             |                                       |   |
|                         | 4 different patterns for "how do we see<br>things" AFM interactive   |             |                                       | custom by Sciencenter   |
| M                       | 1/8" clear borosilicate glass beads for<br>AFM samples, put in place with<br>superblue   | 8996K22     |                                       | <a href="http://www.mcmaster.com">www.mcmaster.com</a>  |
|                         | "NANOLAB" on white plastic for One by<br>One 1/2" thick UHMW   |             |                                       | custom NC machined  |
| X                       | Acrylic domes 1/4" x 16" DIA X 8" high<br>plus 1" flange, with 5 3/4" holes at<br>15degrees from bottom of domes   | (4 @ \$90)  | \$360                                 | Global Plastic Services, Calais, Maine<br>B & W kitchen supplies, 19" OC, 2 1/4" deep cake pans, spray<br>painted white                   |
| X                       | outer metal rings to hold domes-<br>originally cake pans   | 38225       | aluminum cake/pizza pan 18" x 2"      |   |
| X                       | neoprene rubber edge trim, 1/16"<br>opening, 7/32" inside depth-- to protect<br><i>cut edges of white metal ring</i>   | 8507K12     |                                       | Mcmaster  |
| X                       | turntables for rotating domes ~60<br>degrees (for left and right-handed)   | 18635A54    |                                       | Mcmaster  |
| X                       | white plastic 3-part assembly to hold<br>gloves in opening in domes  |             |                                       | custom by Sciencenter   |
| X                       | gloves- Ponte black knit   |             |                                       | 400008645959 JoAnn fabrics  |
| X                       | 1" ultra-high-ull neodymium disc magnet,<br>1/8" thick, 9.7 pull lbs, <i>underneath Lots<br/>of Atoms</i>  | 58605K43    |                                       | mcmaster  |
| X                       | motors: Leeson Electric Model C6T1<br>FC1G 3/4HP 3-phase 208-230 volts,<br>1725 RPM, totally enclosed fan cooled;<br>5/8" shaft  | (3 @ 190)   | \$570                                 | 6135K33<br><a href="http://www.mcmaster.com">www.mcmaster.com</a>   |
| X                       | Automation Direct GST-10P5 1/2HP AC<br>Drive (Variable Frequency Drive (VFD))-<br>controller; converts 120V AC single<br>phase to 230V AC 3-phase power for<br>motor, as well as controlling speed, time<br>to ramp up and down, ... |             |                                       | <a href="http://www.automationdirect.com">www.automationdirect.com</a>  |
| X                       | Interactive white buttons: Happ<br>Pushbutton With<br>Horizontal Microswitch   | 4@ \$2.35   | \$9                                   | Happ 58-9111-L<br><a href="http://www.happcontrols.com">www.happcontrols.com</a>  |
| X                       | timer/relays   |             | Dayton 6A855, and 6X156 11 pin socket | <a href="#">Grainger</a>  |
| X                       | indoor steel enclosure for electronics<br>under 3 corner cabinets, 10" x 10" x 6"  |             | 75065K38                              | <a href="#">mcmaster</a>  |

|    |   |  |  |
|----|---|--|--|
|    | electrical connections inside three corner cabinets with electrical boxes, and TV- Buchanan crimps with splice cap  |  |  |
| XX | 3-pin molex ("Socket and pin") connectors, and 0.093" pins- <i>for making electrical connections between cabinets and bridge walls</i>                                  | 69295K83 (plug) and 69295K63 (receptacle); 69295K22 (pins) and K32 (sockets) | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| X  | Timing belt 1/2" wide trapezoidal, 34.5" 3/8 pitch  | 6484K155   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | timing belt pulleys (front and back) trapezoidal tooth, 1/2" belt, 40 tooth, 2 5/8" OD; front pulley modified and bored out for stepped shaft                           | 6495K212   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | bushing for back pulley (motor side) JA 5/8" bore   | 6086K112   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | Carbon steel rod 1 7/8" 12L14-- used to make custom shaft and custom cam  | 90075K44   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
|    | front --custom stepped shaft 1 1/8" OD at bottom, 5/8" OD at top; larger in middle to fit into pulley   |  | <a href="http://Rumsey-Loomis">Rumsey-Loomis</a>                               |
|    | custom double offset-cam with 5/8" ID bore (attaches to top of custom stepped shaft with three set screws)  |  | <a href="http://Rumsey-Loomis">Rumsey-Loomis</a>                               |
| XX | 1 1/8" ID x 2 1/2" OD bearings for lower part of custom stepped shaft (2/shaft at bottom, in custom housing, to keep shaft vertical)                                    | 2780T47  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | 1 1/8" ID x 1 7/8" OD two-piece aluminum shaft collar clamped to lower part of custom stepped shaft (between two bearings, to keep assembly in place in custom housing) | 6436K143xx   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
|    | custom 2-part aluminum housing for containing bearing-shaftcollar-bearing on lower (1 1/8") part of stepped shaft   |  | <a href="http://Rumsey-Loomis">Rumsey-Loomis</a>                               |
| XX | aluminum from 3" x 3" x 12" block (top and bottom section on each housing)  | 9008K621   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
|    | aluminum mount plate 8 x 8 x 1/4"   | 89155K22   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | 1 1/8" ID x 2 1/2" OD bearing nestled into counterweight block; middle of double offset cam goes into this bearing  | 2780T47  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | 5/8" ID x 1 3/8" OD bearing pressed into moving white disk, top of double offset cam goes into this bearing   | 60355K602  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
|    | 12mm thick white Sintra (expanded PVC sheet) for big disk   |  |  |
| XX | 3" PVC rod in center of white disk for bearing support  | 8745K633   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
|    | drumheads (14" drumheads, with metal outer rim and plastic skin)  |  | <a href="http://hickey's music store- Ithaca">hickey's music store- Ithaca</a> |
|    | sheet rubber glued on top of drumhead   |  |  |
|    | sheet metal glued to underside of drum  |  |  |
|    | 1/16" thick   |  |  |
| X  | stretch cord for counterweight block, 3/16" outdoor   | 8858T85  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |
| XX | black delrin for clamping/tensioning stretch cord, 1/2" delrin  | 8576K15  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                         |

|                      |  |                                |  |   |
|----------------------|--|--------------------------------|--|---|
|                      | spade lugs for ends of stretch cord (3/16" hole for cord, 7/16" across, 3/16" screw hole)          |                                |  |   |
| X                    | knobs for One by One   |                                | 1373T53  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>  |
| X                    | lighting (1) for AFM; 5 LED- strip with 35V DC I(350mA) supply; made for under cabinet in kitchens |                                | item #283278, Utilitech model 29112 1-59 light white undercabinet/rope light | Lowe's  |
| X                    | steel ball bearings; low carbon steel ball, 1/8" diameter, grade 1000                              | 80 bags                        | 96455K49   | mcmaster  |
|                      | magnetic ball bearings   |                                |  |   |
| X                    | Gooseneck forceps for One by one   | 5@\$8.5                        | \$43 VWR # 82027-444   | VWR International, <a href="http://www.vwr.com">www.vwr.com</a>   |
| X                    | OFFI Tiki stools orange  | 4@\$59.99                      | \$240  | <a href="http://www.amazon.com">www.amazon.com</a> or <a href="http://www.designpublic.com/shop/offi/2125">http://www.designpublic.com/shop/offi/2125</a> |
|                      | plastic blocks for moving Lots of Atoms (made for use in applying graphics)                        |                                | example: beacon graphics Rigid Squeegee Z1008                                |   |
| <b>Graphics</b>      |  |                                |  |   |
|                      | banners  |                                |  | printed by Cayuga Press, <a href="http://www.cayugapress.org">www.cayugapress.org</a> , 1-888-cayuga1   |
| <b>Dress Up Area</b> |  |                                |  |   |
|                      | children's lab coats   | (4 @ 24.00 + \$5 embroidery)   | \$116 #407033M & #407033XL   | 1-800-labwear and children's lab coat, <a href="http://www.labwear.com">www.labwear.com</a>   |
|                      | adult lab coats  | (4 @ \$18.50 + \$9 embroidery) | \$110 #4012S and #4012L  | 1-800-labwear men's basic lab coat, <a href="http://www.labwear.com">www.labwear.com</a>  |
|                      | children's safety glasses  | (4 @ \$3.95)                   | \$16 Carolina cat #646713  | Carolina Biological supply, <a href="http://www.carolina.com/">www.carolina.com/</a>  |
|                      | adult safety glasses   | (4 @ 12.00)                    | \$48 LSS #25802C   | Lab Safety Supply (LSS), <a href="http://www.labsafety.com">www.labsafety.com</a>   |
|                      | plexiglas mirror   |                                | \$30   |   |
| *                    | nitrile gloves Small   | \$31 per box                   | VWR GLOVE NITRILE PF SM PK100, \$186 vWR# 40101-344                          | VWR International, <a href="http://www.vwr.com">www.vwr.com</a>   |
| *                    | nitrile gloves Large   | 14.24 per box                  | \$71 VWR GLOVE NITRILE PF L PK100  | VWR International, <a href="http://www.vwr.com">www.vwr.com</a>   |
| *                    | purple nitrile gloves SAFESKIN (1 box)   |                                | \$19 VWR # 82026-428   |   |
| *                    | badges   | (\$20 @ \$2)                   | \$40   | print and laminate from graphic file: <i>NanoLab_badges_07_22_08.pdf</i>  |
| *                    | badge clips  |                                | \$20   |   |
|                      | trash can: 18 Quarter Rectangular container 14" x8" x 12.75"                                       | \$13.79                        | \$14 85124   | United States Plastic Corp, <a href="http://www.usplastic.com">www.usplastic.com</a>  |
| *                    | sticky mats (optional if host desires)   | (60 sheets @ \$91.72)          | \$92 VWR cat #89041-740  | VWR International, <a href="http://www.vwr.com">www.vwr.com</a>   |
| <b>Play Area</b>     |  |                                |  |   |
|                      | cubby shelves for lab coats "Tote Shelf 2' x 32" with Totes or Baskets"                            |                                | \$375 F685   | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a>  |
|                      | chip oven "Playworks microwave"  |                                | \$176 C401   | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a>  |
|                      | "Playworks Drawer Unit" for above microwave oven   |                                | \$86 C403  | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a>  |
|                      | chip washer "Playworks Clothes Washer",  |                                | \$207 C412   | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a>  |
|                      | "deep tote" box for shelves - clear for cubby shelves  | 6@12                           | \$72 F890  | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a>  |
|                      | "shallow tote" box for shelves - clear for cubby shelves   | 5@7                            | \$35 F880  | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a>  |
| X                    | "sink"-- stainless steel full pan 6" deep; 12 1/2" x 21" x 6" deep                                 | \$21                           | B&W 73102  | B&W kitchen supply  |
| *                    | yellow plastic tweezers  | 10@sets of3 @ \$10.22          | \$102  | Findingking on <a href="http://www.amazon.com">www.amazon.com</a>   |
|                      | small round containers: 4oz HDPE squat container with LDPE lid                                     | 3@\$ .30                       | \$1 81121  | United States Plastic Corp, <a href="http://www.usplastic.com">www.usplastic.com</a>  |
| *                    | trays for pretend chips: White HDPE Photo developing Tray 5"x7" Print, 8 3/4" x 6 7/8" x 1.5"      | 20@\$4.22                      | \$72 52050   | United States Plastic Corp, <a href="http://www.usplastic.com">www.usplastic.com</a>  |

|   |  |           |      |        |  |
|---|--|-----------|------|--------|--|
|   | magnifiers: dual plastic magnifier 3x and 6x | 30@\$1.65 | 49.5 | 602276 | Carolina Biological supply, <a href="http://www.carolina.com/">www.carolina.com/</a> |
| X | *<br>pretend chips                           |           |      |        | print and laminate from graphic file: <i>NanoLab_waferprintfile.pdf</i>              |

### Reading Area

|   |  |  |            |  |  |
|---|--|--|------------|--|--|
| X | self standing bookshelf for reading area |  | \$205 F775 |  | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a> |
| X | "32 library display bookshelf            |  | \$700 J650 |  | Community Playthings, <a href="http://www.communityplaythings.com">www.communityplaythings.com</a> |

|   |     |  |  |  |  |
|---|-----|--|--|--|--|
| X | rug |  | Target Home 066-01-0515, ID029489-<br>\$99 0515-JG |  | Target Home 6' round "red multi shag" area rug |
|---|-----|--|--|--|--|

### Suggested Reading Area Books

|  |   |         |         |  |  |
|--|---|---------|---------|--|--|
|  | Sciencenter Ithaca, NY (C. McCarthy, R. Ostman, E. Maletz, & S. Hale),<br><i>How Small is Nano?</i><br>Sciencenter, Ithaca, NY, 2008,<br>lulu.com 24 pages. | \$22.80 | \$68.40 |  | <a href="http://www.lulu.com">www.lulu.com</a> or <a href="http://amazon.com">amazon.com</a> |
|  | Sciencenter Ithaca, NY, (R. Ostman, C. McCarthy, E. Maletz, & S. Hale),<br><i>Is That Robot Real?</i> , Sciencenter, Ithaca, NY, 2008, 44 pages, lulu.com   | \$26.80 | \$80.40 |  | <a href="http://www.lulu.com">www.lulu.com</a> or <a href="http://amazon.com">amazon.com</a> |
|  | David Jefferis, <i>Micro Machines: Ultra-Small World of Nanotechnology</i>  | \$25.20 | \$25.20 |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Dianne Maddox, <i>Nanotechnology: Science on the Edge</i>   | \$23.70 | \$23.70 |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Rebecca L. Johnson, <i>Cool Science: Nanotechnology</i>   | \$26.60 | \$26.60 |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Corona Brezina, <i>Careers in Nanotechnology</i>  | \$27.95 | \$27.95 |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Robert E. Wells, <i>What's Smaller than a Pygmy Shrew</i>   | \$15.95 | \$15.95 |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Charles and Ray Eames (1998)<br><i>Power of Ten: A Flipbook</i> , W H Freeman & Co., 154 pages.   | \$11.00 | \$11.00 |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Frank B. Edwards (1992) <i>Close Up: Microscopic Photographs of Everyday Stuff</i> , Firefly Books, 48 pages  |         |         |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Stephen Kramer and Dennis Kunkel (Photographer) (2003) <i>Hidden Worlds : Looking Through a Scientist's Microscope</i> , Houghton Mifflin Co., 57 pages.    |         |         |  | <a href="http://amazon.com">amazon.com</a>   |
|  | Shelley Rotner (Illustrator) and Richard F. Olivo (1997) <i>Close, Closer, Closest</i> , Atheneum, 40 pages   |         |         |  | <a href="http://amazon.com">amazon.com</a>   |

|   |            |
|---|------------|
| Howard Tomb and Dennis Kunkel<br>(1993) <i>Microaliens: Dazzling Journeys With an Electron Microscope</i> , Farrar Straus & Giroux. | amazon.com |
| Peter Ziebel (1993) <i>Look Closer!</i><br>Clarion Books, 32 pages.   | amazon.com |

## Fact & Fiction

| consumable               | Description   | Est. Cost  | Part #             | Vendor  |
|--------------------------|---|------------|--------------------|---|
| X                        | card display holders "Gaylord "Label Holder Slot Block Acrylic 1/2H x 3W x 1 1/2"D Pkg 12"            | \$58.50    | Gaylord #WW-61-135 | Gaylord <a href="http://www.gaylordmart.com">www.gaylordmart.com</a>  |
| <b>Construction Area</b> |   |            |                    |   |
| X                        | robot building toys "DragonBonz"  | 2@\$37     | \$74               | Curious Toys from <a href="http://www.Amazon.com">www.Amazon.com</a>  |
| X                        | robot building toys "ExoBonz Deluxe"  | 4@\$37     | \$148              | Curious Toys from <a href="http://www.Amazon.com">www.Amazon.com</a>  |
| X                        | robot building toys "SeaBonz"   | 2@\$37     | \$74               | Curious Toys from <a href="http://www.Amazon.com">www.Amazon.com</a>  |
| X                        | bin for toy parts: stainless steel full pan 6" deep; 12 1/2" x 21" x 6" deep                          | \$21       | B&W 73102          | B&W kitchen supply  |
| X                        | Fact/Fict pen cup: condiment jar with lid (spray painted black on underside)                          | \$2        | B&W 79000          | B&W kitchen supply, condiment jar with lid  |
| X                        | Fact/Fict card tray: Winco SP7904 1/9 size pan 4" (poly), spray painted black on underside            | \$4        | B&W #87444         | B&W kitchen supply , pan 4" deep plastic  |
| X                        | supply of pencils   | \$5        |                    |   |
| X                        | OFFI Tiki stools orange   | 2@\$59.99  |                    | <a href="http://www.amazon.com">www.amazon.com</a> or <a href="http://www.designpublic.com/shop/offi/2125">http://www.designpublic.com/shop/offi/2125</a> |
| <b>Graphics</b>          |   |            |                    |   |
|                          | banners   |            | n/a                | printed by Cayuga Press, <a href="http://www.cayugapress.org">www.cayugapress.org</a> , 1-888-cayuga1   |
| <b>Audio Unit</b>        |   |            |                    |   |
| X                        | Roku Media Player Bright Sign HD410 r for video & audio units   | 1@\$349.99 | 349.99             | Roku Bright Sign HD410<br>BrightSign Sales, <a href="http://www.brightsign.biz">www.brightsign.biz</a><br>Tim Chluda, 614-571-3525 mobile                 |
| X                        | Audio English Espanol <b>push buttons:</b> Happ push buttons (white clear lid to insert label inside) | 2@\$6.60   | \$13               | Happ D54-0004-21<br><a href="http://www.happcontrols.com">www.happcontrols.com</a>  |
| X                        | <b>Headphones</b> (2 sets for each audio station)   | 2@\$49.99  | \$100              | AKG K77 Headphones<br><a href="http://www.amazon.com">www.amazon.com</a>  |
| X                        | Audio Amp   |            |                    | <a href="http://www.smm.com">SMM</a>  |
| X                        | second surface printed plastes for for audio Units  |            |                    | OMSI custom   |
| <b>HARDWARE</b>          |   |            |                    |   |
| X                        | Cam Lock--Polished Nickel Finish<br>Keyed to C415A, 3/4" Dia Hole, 7/8"                               |            | 1770A812           | <a href="http://www.mcmaster.com">www.mcmaster.com</a>  |

|   |  |   |  |   |
|---|--|---|--|---|
| X | Cam Lock--Polished Nickel Finish<br>Keyed to C415A, 3/4" Dia Hole, 5/8"<br>nickel-plated 1/4-20 bolts x 50mm long,<br>large head, uses 4mm or 5/32" allen<br>wrench)-- for glove holders, access<br>panels under four corner cabinets,<br>headphone stanchions |   | 1770A555   | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
| X | nickel-plated 1/4-20 bolts, 5/8" long, fully<br>threaded, large head-- to hold outer ring<br>on four stations  |   | 264.76.750   | <a href="http://www.hafele.com">www.hafele.com</a>                                    |
| X | #6 x 5/8" ss oval head screws- through<br>metal brackets into underside of corner<br>countertops   |   | 264.76.730, modified   | <a href="http://www.hafele.com">www.hafele.com</a>                                    |
| X | #8 uni-drive screws, stainless-- secure<br>graphics to tabletop  |   | 90315A426  | <a href="http://mcmaster-carr.com">mcmaster-carr</a>                                  |
| X | shoulder washers- white nylon- secure<br>graphics to tabletop  |   | 93686A440  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
| X | 8-32 x 3/4" button head socket cap<br>screws- stainless- to secure front panel<br>for TV and metal brackets that support<br>electric cord cover; uses 3/32" allen<br>wrench (TV uses same shoulder<br>washers as for graphics)                                 |   | 91145A148  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
| X | 10-32 x 3/4" socket cap screws- black<br>oxide--for mounting TV frame: coupling<br>nuts to back cover for TV shroud, and<br>coupling nuts to mounting brackets on<br>TV frame inside- 5/32" hex)   |   | 92949A197  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
| X | 1/4-20 x 1/2" Button head socket head<br>cap screws, stainless, with washers- for<br>mounting clear curtain strips to<br>horizontal bar; and 1" dia fender<br>washers  |   | 91251A345  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
| X | 1/4-20 inserts (wood/plastic) for<br>mounting outer metal ring over domes<br>(4)   |   | 92949A537  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
| X | 1/4-20 locknuts, for mounting white<br>plastic rings for gloves for domes  |   | 92105A675  | <a href="http://www.mcmaster.com">www.mcmaster.com</a>                                |
|   | white plastic ring to protect edges of<br>holes for cables-- 3" OD on cover.   | Serv-a-lite CG-212WH,<br>upc 39008-43627 from<br>Bishop's (in bins); same<br>thing online CG-212WH<br>at Electronicplus.com<br>for instance | GE model "furniture cover in black<br>#76293004, at Home depot for 2 1/2"<br>hole???? white seems not to be<br>available. McMaster sells white "desk<br>grommets" 2 3/4" ID hole in desk, 3"<br>flange 93775K32??? | any hardware store<br><br>Steve thought Lowe's.. Didn't find any this big, nor white? |
| X | #8 x 1" long yellow zinc plated, flat<br>head, square drive (#2) wood screws--<br>for securing four domes to wooden rings<br>inside, outer race of turntable to wooden<br>ring, & inner race of turntable to<br>countertop)                                    |   |  | McFeeley's 0810-FMY   |
| X | #8 x 1 1/2" long yellow zinc plated, flat<br>head, square drive (#2) wood screws --<br>for securing countertop with sink to<br>cabinets underneath   |   |  | McFeeley's 0814-FMY   |
| X | #8 x 2 1/2" long yellow zinc plated, flat<br>head, square drive (#2) wood screws--<br>for securing corner tabletops to base<br>cabinet from underside  |   |  | McFeeley's 0820-FMY   |

**TOOLS**

|   |  |   |  |                |
|---|--|---|--|----------------|
| x | torx head wrench (T30) w/handle  | 4 | E14.90   | Octanorm       |
| x | 4mm allen wrench with handle, gold color   |   | 7996A86  | McMaster       |
|   | 12mm deep socket for 1/4" drive, for changing gloves                                 |   |  | Home Depot     |
|   | 1 1/2" round thumbwheel ratchet-- 1/4" socket; for changing gloves                   |   | 94022-2VGA   | Harbor Freight |
| x | T-handle screwdriver, for use with T30 bits  |   | Husky 408-799  | Home Depot     |
| x | ratcheting offset screwdriver set (reversible); used with T30 bits for leveling feet |   | General No 8075<br>7396A25 (1 15/16") & 7013A29 (insert bit) | Home Depot     |
| x | T30 torx bits  |   |  | McMaster       |
|   | 12" level  |   |  |                |

**PACKING**

|  |  |  |           |                      |
|--|--|--|-----------|----------------------|
|  | ratcheting tie-down straps; 2" wide x 27' long                         |  |           | Lowes and Home Depot |
|  | cart-king caster, swivel, 3 1/2" x 1 5/16" rubber wheel, 200# capacity |  | 2370T11   | McMaster             |
|  | grade 8 hex head cap screw, yellow-plated, 1/4-20 x 1 3/4"             |  | 91257A548 | McMaster             |
|  | 1/4-20 locknut   |  | 93298A110 | McMaster             |

NanoLab & Fact or  
Fiction  
Common Components  
List

|                      | Description                                       | Part number             | Vendor        | Notes  |
|----------------------|---|-------------------------|---------------|--|
| <b>Tables/Kiosks</b> |   |                         |               |  |
| <b>Framing</b>       |   |                         |               |  |
|                      | Extrusion   | m1000                   | Octanorm      | (color; tiger drylac ral 09/10126)                                 |
|                      | Caps  | m1015                   | Octanorm      | (color; tiger drylac ral 09/10126)                                 |
|                      | Feet  | m1016                   | Octanorm      |  |
|                      | "L" Brackets                                      |                         | TBD by site   | Secure various panels to framing                                   |
|                      | #8-32 x 1/2" button head star drive machine screw | 90910A194               | McMaster-Carr | securing "L" bracket to frame                                      |
| <b>Insert Panels</b> |   |                         |               |  |
|                      | Acrylic Sheet                                     | w2447 white             | TBD by site   | .125" thick. Do we need to do anything to keep this from rattling? |
| <b>Cabinet</b>       |   |                         |               |  |
|                      | Laminate  | #949 Bright White Gloss | Formica       |  |
|                      | Plywood   | 3/4" plywood            | TBD by site   |  |
|                      | Cam Lock  | 1770A812                | McMaster-Carr | Polished Nickel Finish Keyed to C415A, 3/4" Dia Hole, 7/8"         |
|                      | Hinge   | 1569a435                | McMaster-Carr | 1 1/2" x 4' piano hinge w/holes, bright nickel                     |
| <b>Table Top</b>     |   |                         |               |  |
|                      | Laminate  | Bittersweet             | Pionite       |  |
|                      | Plywood   | 3/4" ply                | TBD by site   |  |
|                      | Headphone Stanchion                               |                         | TBD by site   | weldment, powdercoated   |
|                      | #10-24 x 1" Button socket cap screw, stainless    | 93686A440               | McMaster-Carr | Bolt Headphone Stanchion to table top.                             |
|                      | #8-32 x 1/2" button head star drive machine screw | 90910A194               | McMaster-Carr | securing "L" bracket to frame                                      |
| <b>Graphics</b>      |   |                         |               |  |



|  |                                   |                         |               |                                       |
|--|-----------------------------------|-------------------------|---------------|---------------------------------------|
|  | Plywood                           | 1/2"                    | TBD by site   | Substrate for vertical graphics       |
|  | Laminate                          | #949 Bright White Gloss | Formica       | P-lam for above                       |
|  | Acrylic                           |                         | TBD by site   | .25" for second surface graphics      |
|  | #8 uni-drive screws,<br>stainless | 93686A440               | McMaster-Carr | Secure graphic to table top/substrate |
|  | Shoulder washers                  | 91145A148               | McMaster-Carr | Secure graphic to table top/substrate |

| <b>Side Monitor</b> |  |           |               |  |
|---------------------|--|-----------|---------------|--|
|                     | Brackets   |           | TBD by site   | weldment (reference drawing 3/7), powdercoated |
|                     | Frame  |           | TBD by site   | weldment (reference drawing 4/7), powdercoated |
|                     | Shroud   |           | SMM           |  |
|                     | #8-32 x 3/4" Button<br>head hex socket cap<br>screw, stainless | 92949A197 | McMaster-Carr | Secure shroud to frame                         |
|                     | #8-32 x 1/2" Flat head<br>machine screw                        |           | TBD by site   | Secure monitor to frame                        |

| <b>Multimedia</b> |                     |             |             |   |
|-------------------|---------------------|-------------|-------------|---|
|                   | Media Player        | HD410       | Roku        | Single player will play slideshow and Audio Description.        |
|                   | Headphone           | AKG K-77    | TBD by site | ADN has a show currently with these headphones.                 |
|                   | Audio Amp           |             | SMM         | Get final count to Mark by 6/4                                  |
|                   | Audio Desc. Buttons | D54-0004-21 | Happ        | small, round, white   |
|                   | 17" Monitor         | 49-2603-30  | Happ        | 17" Vision PRO LCD Monitor CGA /VGA. Should have glass overlay. |
|                   | "Next" Button       | 71-0004-T1  | Happ        | low profile, triangle, white                                    |
|                   | 32" Monitor         | FWD32LX2F/B | Sony        |   |
|                   | Fan                 | 4WT49       | Grainger    | Fan,Axial,55 CFM,115 V Not necessary in all tables.             |

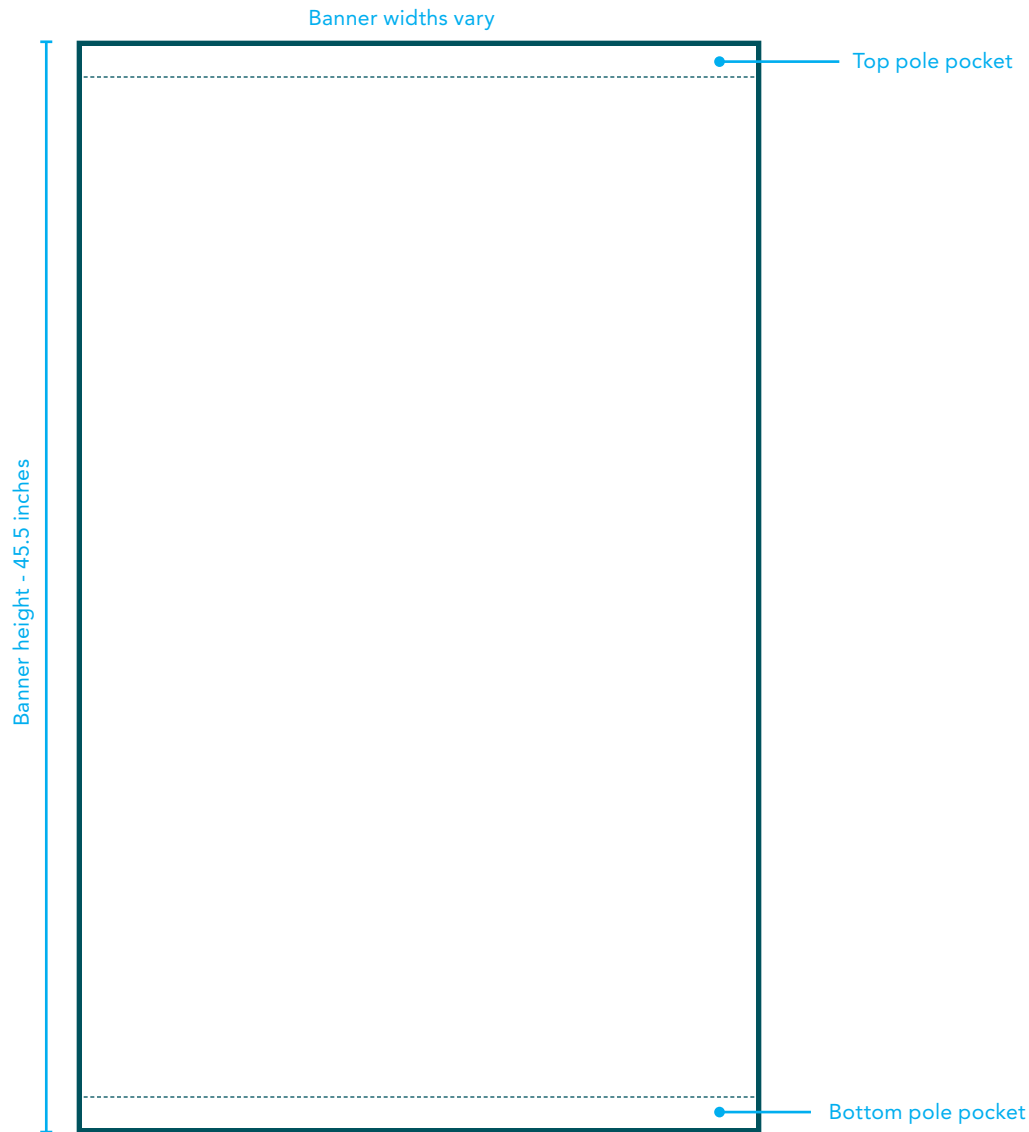
## Major electronic components for C

- Preliminary 1/30/2008 -

| Component     | Sub Component    | Item                         | Model Number | Vender          | Cost     | Notes   |
|---------------|------------------|------------------------------|--------------|-----------------|----------|---|
| Self Assembly | Miscellaneous    | Green Round Stop             | 77-0004-23   | HAPP Controls   | \$7.35   |   |
| Self Assembly | Miscellaneous    | Red Round Stop               | 77-0004-20   | HAPP Controls   | \$7.35   |   |
| Self Assembly | Audio Descriptio | AKG K-55 Head                | ANG K-55     | Full Compass    | \$34.05  |   |
| Self Assembly | Audio Descriptio | OMSI Built Audio Amp         |              |                 |          |   |
| Self Assembly | Audio Descriptio | Roku Brightsign              | HD600        | Roku Labs       | \$499.00 | Provides description audio and applications video<br>Item used to be \$299, now goes for \$499. Availability has been a problem and it may be advisable to consider an option for future applications |
| Self Assembly | Audio Descriptio | White Round En               | 57-0004-21   | HAPP Controls   | \$7.60   |   |
| Self Assembly | Audio Descriptio | Volume Control Teardrop Knob |              |                 |          |   |
| Self Assembly | Audio Descriptio | Volume Control Pot           |              |                 |          |   |
| Self Assembly | Applications Dis | 17" Open Frame               | 49-2603-00   | HAPP Controls   | \$306.00 |   |
| Self Assembly | Applications Dis | Green Triangular             | 71-0004-T3   | HAPP Controls   | \$7.55   |   |
|               |                  |                              |              |                 |          |   |
| Quantum Dots  | Miscellaneous    | OMSI Built Controller        |              |                 |          |   |
| Quantum Dots  | Miscellaneous    | OMSI Built LED Assembly      |              |                 |          |   |
| Quantum Dots  | Audio Descriptio | AKG K-55 Head                | ANG K-55     | Full Compass    | \$34.05  |   |
| Quantum Dots  | Audio Descriptio | Roku Brightsign              | HD600        | Roku Labs       | \$499.00 | Provides description audio and applications video<br>Item used to be \$299, now goes for \$499. Availability has been a problem and it may be advisable to consider an option for future applications |
| Quantum Dots  | Audio Descriptio | White Round En               | 57-0004-21   | HAPP Controls   | \$7.60   |   |
| Quantum Dots  | Audio Descriptio | OMSI Built Audio Amp         |              |                 |          |   |
| Quantum Dots  | Audio Descriptio | 12 VDC Wall Wa               | 323300       | Jameco Electron | \$29.69  |   |
| Quantum Dots  | Audio Descriptio | Volume Control Teardrop Knob |              |                 |          |   |
| Quantum Dots  | Audio Descriptio | Volume Control Pot           |              |                 |          |   |
| Quantum Dots  | Applications Dis | 17" Open Frame               | 49-2603-00   | HAPP Controls   | \$306.00 |   |
| Quantum Dots  | Applications Dis | Green Triangular             | 71-0004-T3   | HAPP Controls   | \$7.55   |   |

|               |                  |  |               |                 |          |   |  |
|---------------|------------------|--|---------------|-----------------|----------|---|--|
|               |                  |  |               |                 |          |   |  |
| Intro Video   |                  | Hyundai 32" LCD  | E320D         | New Egg         | \$529.00 | Black/Silver 32" 16:9 8ms LCD HDTV - This is a consumer grade moniotr, a commerical grade may be advisable. Some model not likely to be available later in project.                                   |  |
| Intro Video   |                  | Roku Brightsign  | HD600         | Roku Labs       | \$499.00 | Provides description audio and applications video<br>Item used to be \$299, now goes for \$499. Availability has been a problem and it may be advisable to consider an option for future applications |  |
| Intro Video   |                  | Amplified Speaker                                      | Audix PH3S    | Full Compass    | \$179.00 |   |  |
| Intro Video   |                  | Green Medium F   | 57-0004-63    | HAPP Controls   | \$7.55   |   |  |
|               |                  |  |               |                 |          |   |  |
| Billion Beads | Audio Descriptio | AKG K-55 Head  | ANG K-55      | Full Compass    | \$34.05  |   |  |
| Billion Beads | Audio Descriptio | White Round En   | 57-0004-21    | HAPP Controls   | \$7.60   |   |  |
| Billion Beads | Audio Descriptio | Volume Control   | Teardrop Knob |                 |          |   |  |
| Billion Beads | Audio Descriptio | Volume Control   | Pot           |                 |          |   |  |
| Billion Beads | Audio Descriptio | OMSI Built Audio                                       | Amp           |                 |          |   |  |
| Billion Beads | Audio Descriptio | 12 VDC Wall Wa   | 323300        | Jameco Electron | \$29.69  |   |  |
| Billion Beads | Audio Descriptio | VMusic2 MP3 Pl   | 895-VMUSIC2   | Mouser Electron | \$41.05  | Not likely to continue to be available 6-12 months from now based on past history.  |  |
| Billion Beads | Audio Descriptio | PIC to read buttons, volume pot and control MP3 player |               |                 |          |   |  |
| Billion Beads | Applications Dis | Axion 10.4" LCD  | AXN-9105M     | Amazon.com      | \$149.99 | Comsumer grade product was difficult to mount and install. It may be advisable to consider an option for future applications.   |  |

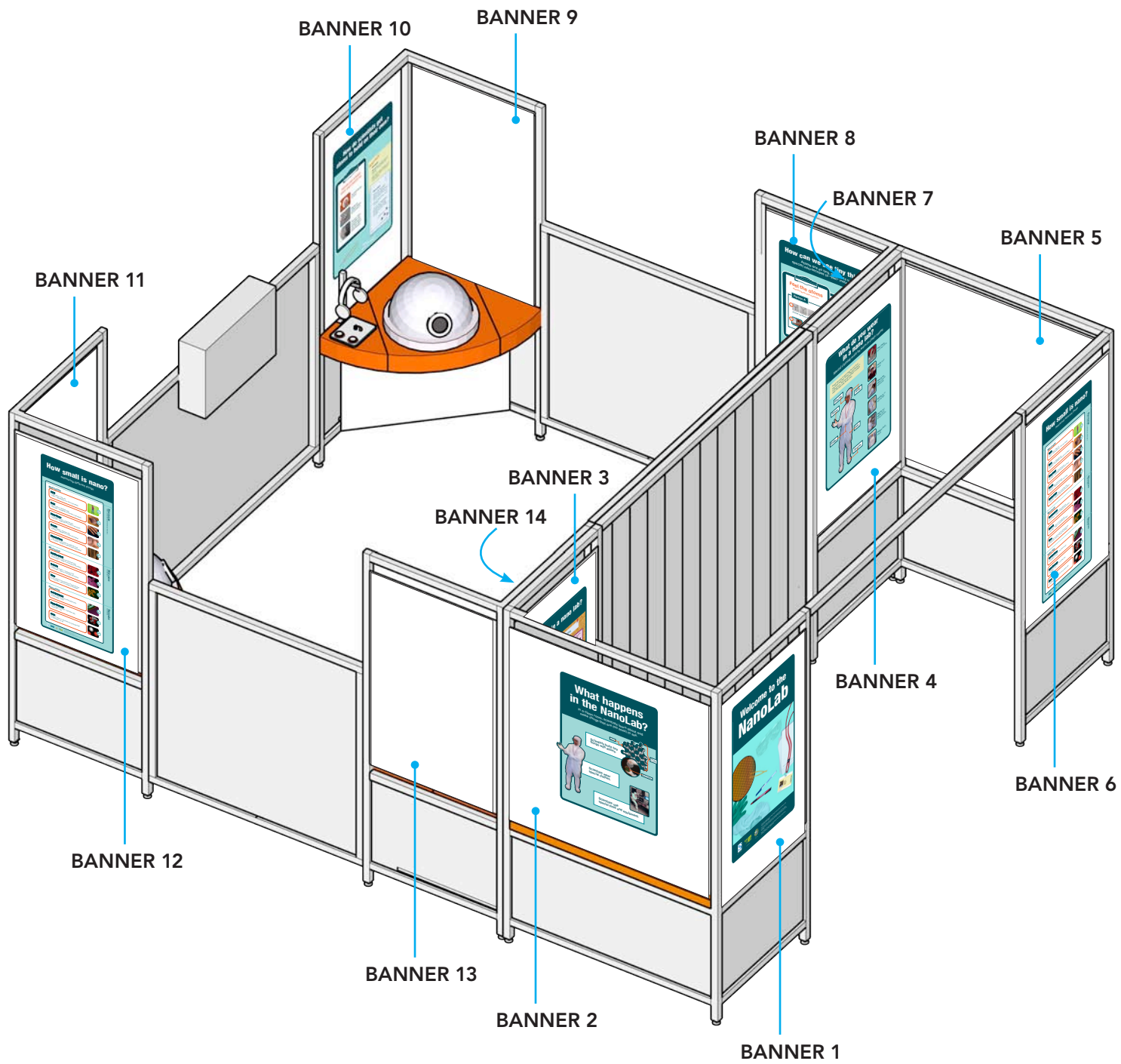
# NANOLAB BANNER NOTES

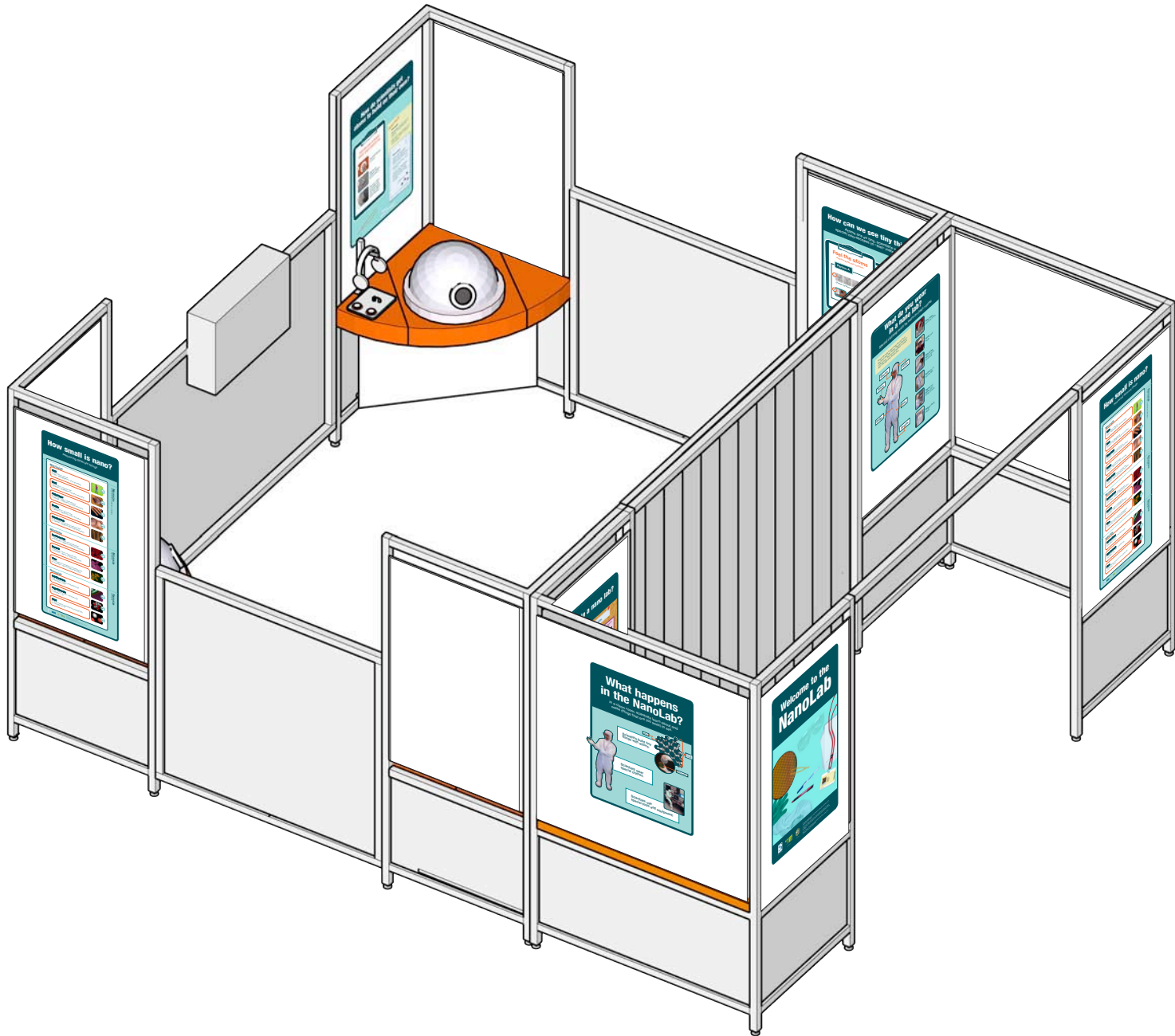


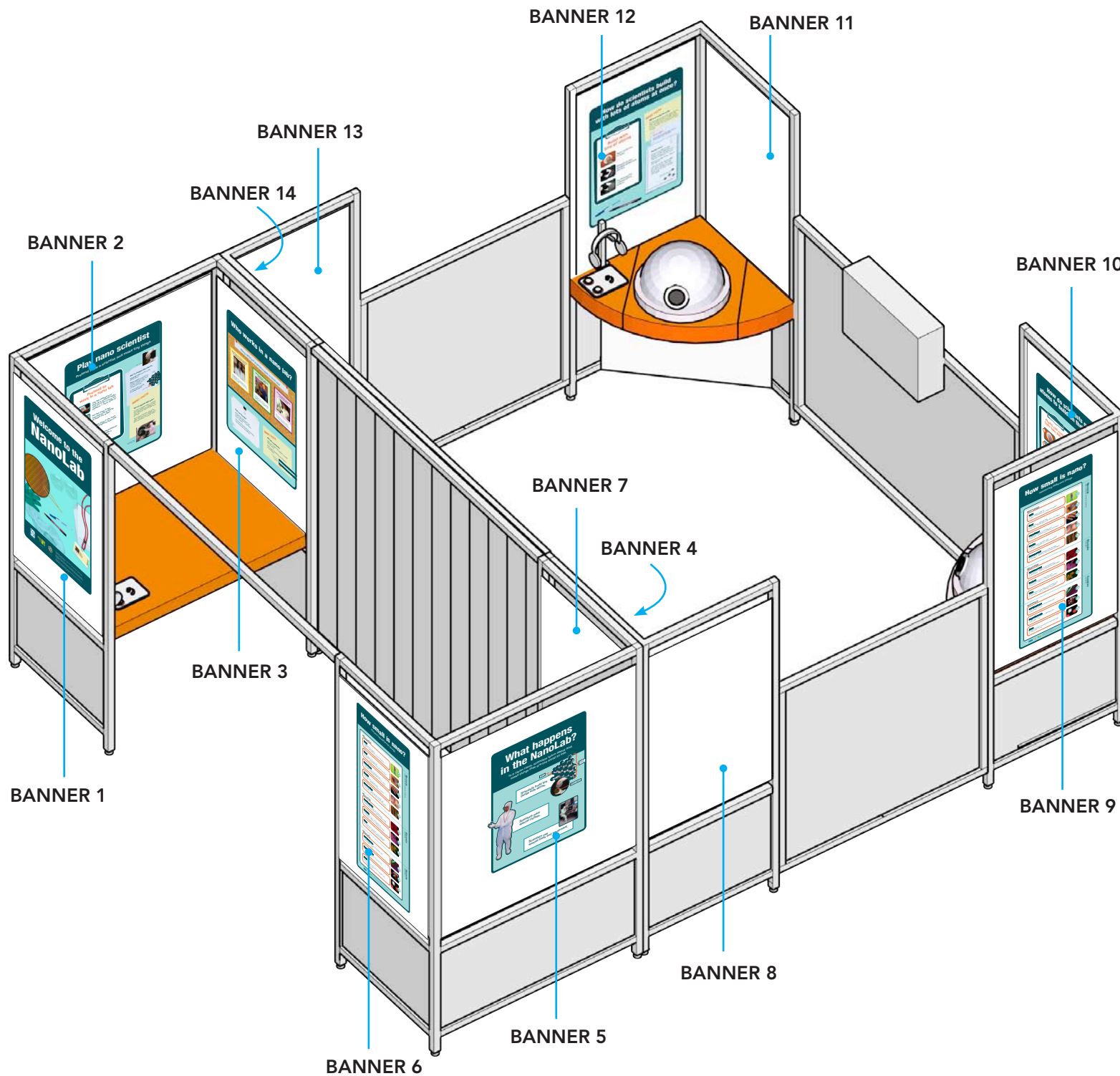
## BANNER LIST

- BANNER 1** - 28.5" x 45.5"
- BANNER 2** - 44.875" x 45.5"
- BANNER 3** - 28.5" x 45.5"
- BANNER 4** - 28.5" x 45.5"
- BANNER 5** - 44.875" x 45.5"
- BANNER 6** - 28.5" x 45.5"
- BANNER 7** - 28.5" x 45.5" (*blank*)
- BANNER 8** - 28.5" x 45.5"
- BANNER 9** - 28.5" x 45.5"
- BANNER 10** - 28.5" x 45.5"
- BANNER 11** - 28.5" x 45.5" (*blank*)
- BANNER 12** - 28.5" x 45.5"
- BANNER 13** - 28.5" x 45.5" (*blank*)
- BANNER 14** - 28.5" x 45.5"
- BANNER 21** - 28.5" x 45.5"
- BANNER 22** - 33" x 45.5"
- BANNER 23** - 33" x 45.5"
- BANNER 24** - 33" x 45.5"

18 Banners total

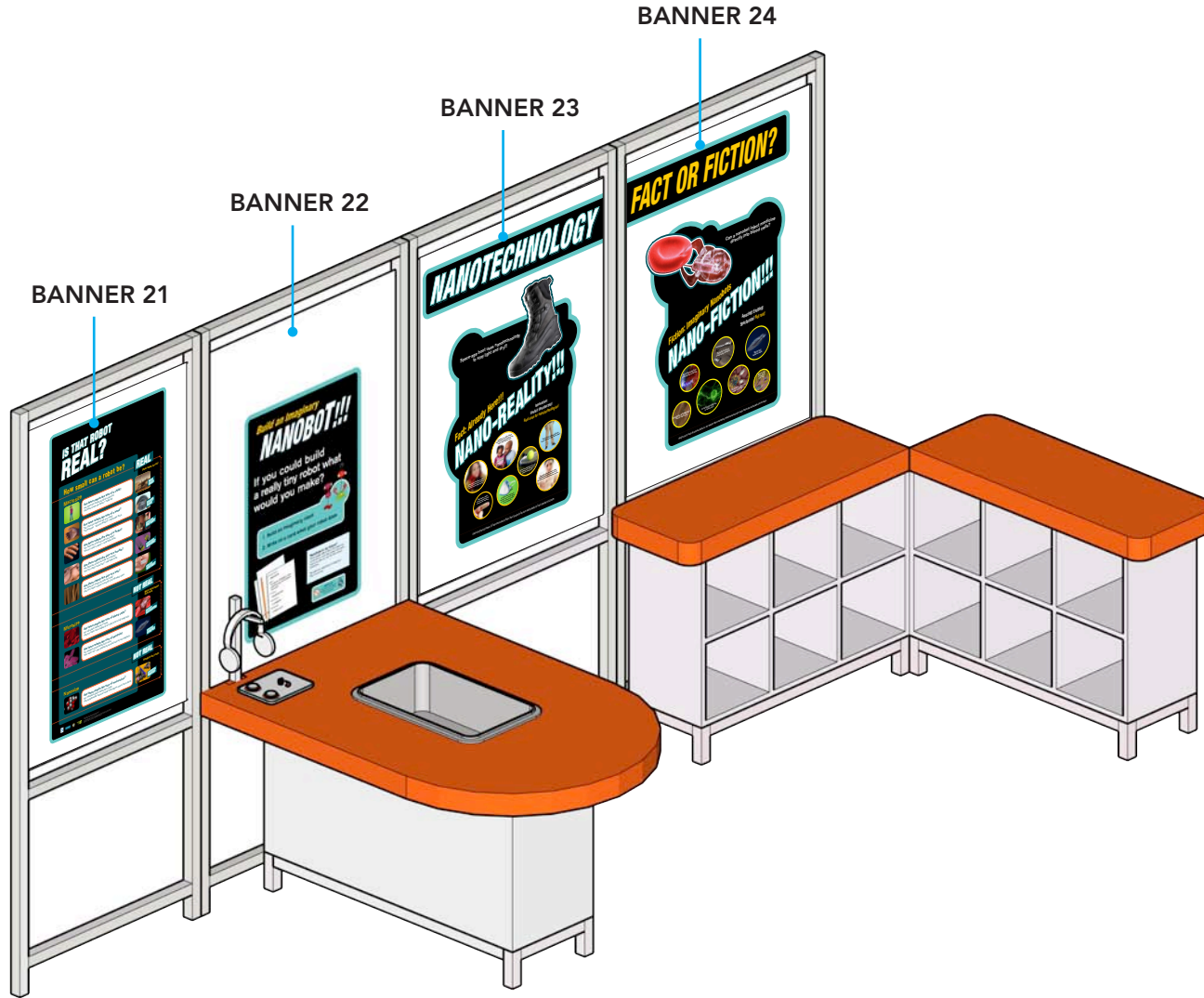












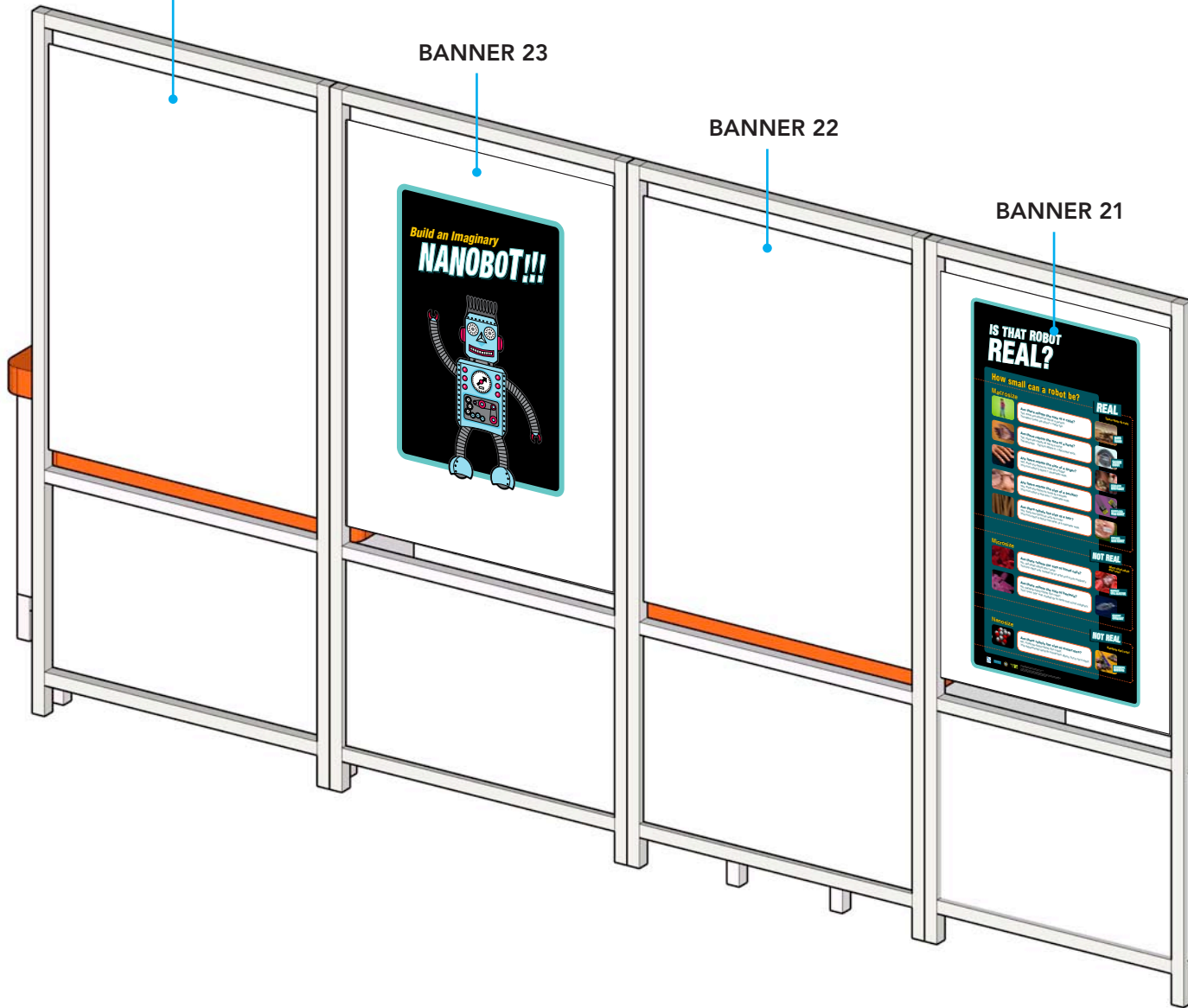


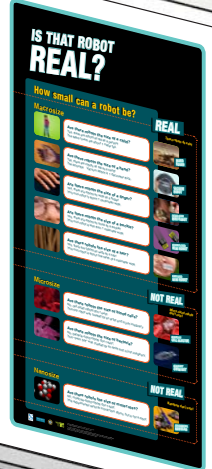
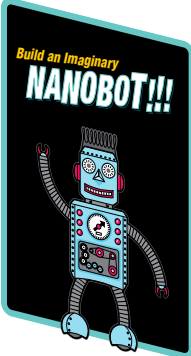
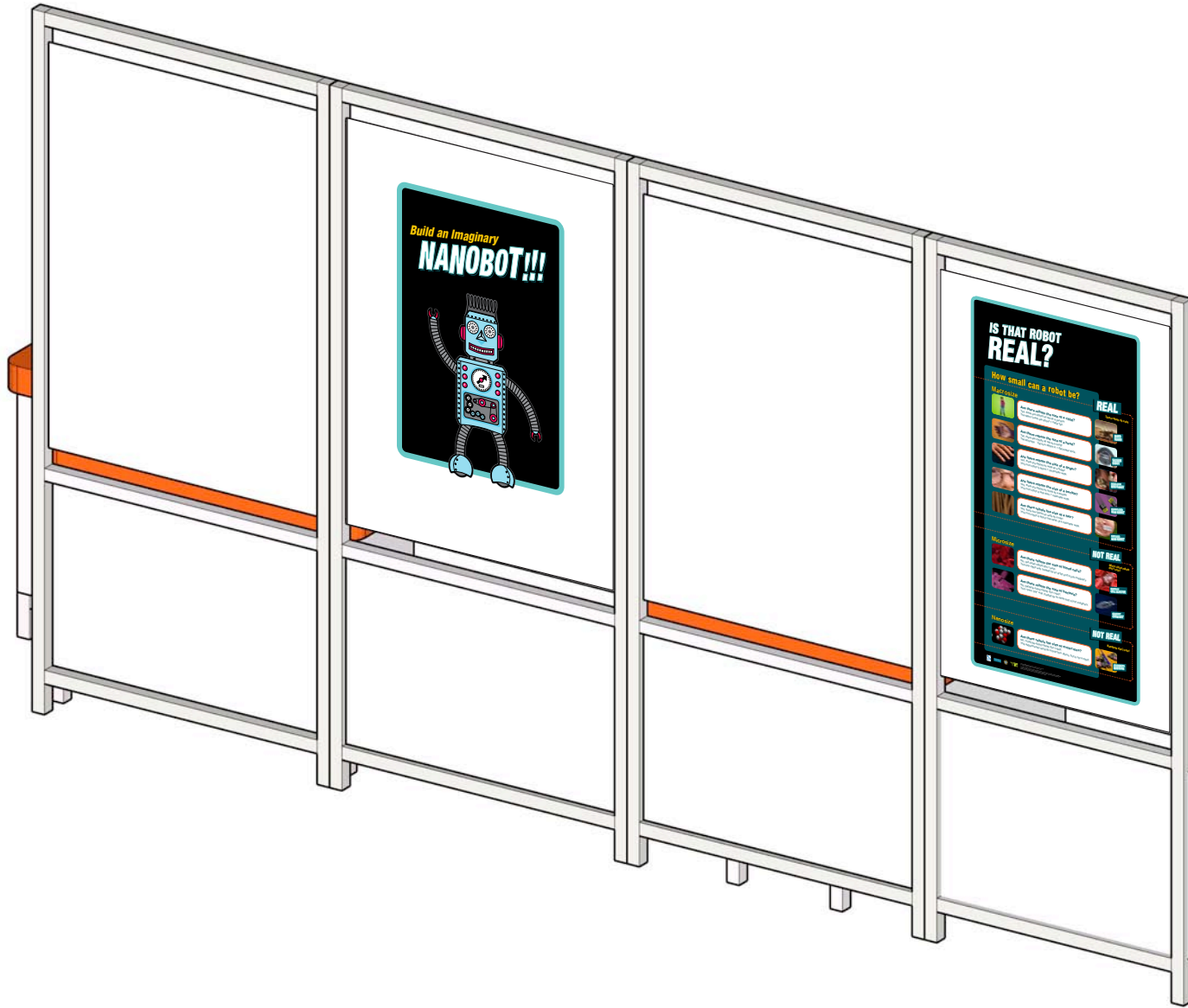
BANNER 24

BANNER 23

BANNER 22

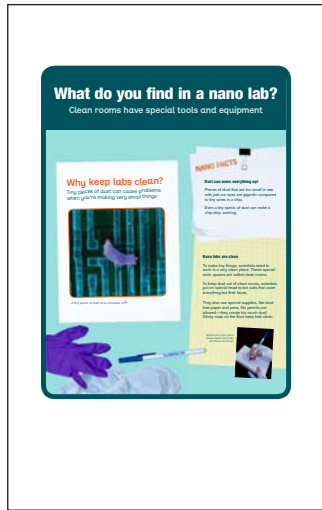
BANNER 21



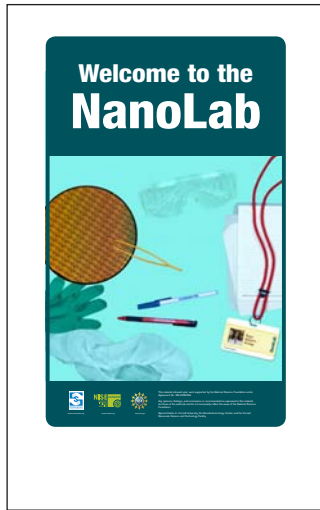


**BANNER 1 - 28.5" x 45.5"**

SIDE A



SIDE B

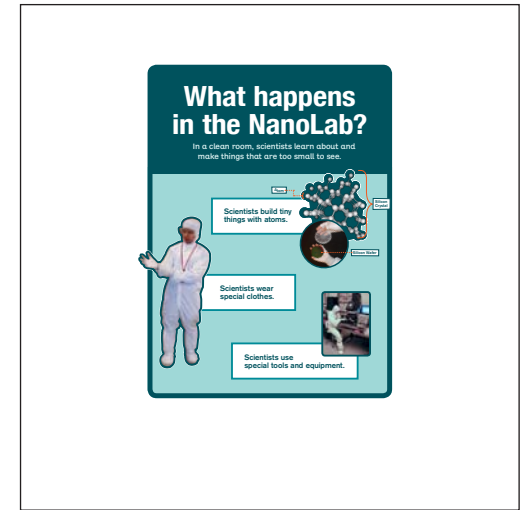


**BANNER 2 - 44.875" x 45.5"**

SIDE A

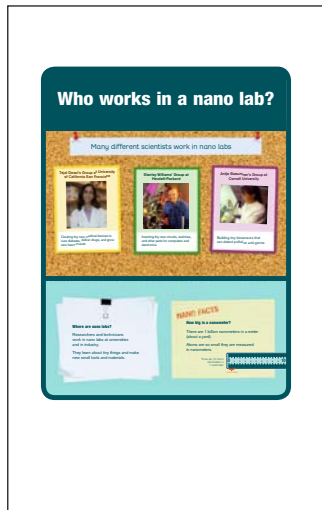


SIDE B



**BANNER 3 - 28.5" x 45.5"**

SIDE A

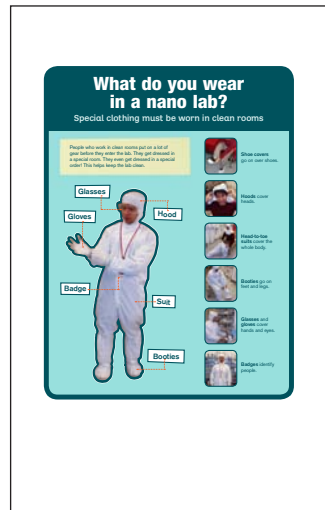


SIDE B



**BANNER 4 - 28.5" x 45.5"**

SIDE A



SIDE B



**BANNER 5 - 44.875" x 45.5"**

SIDE A

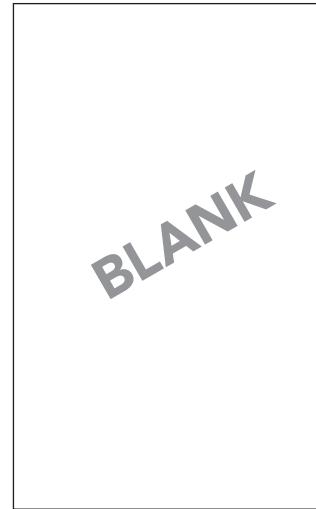


SIDE B

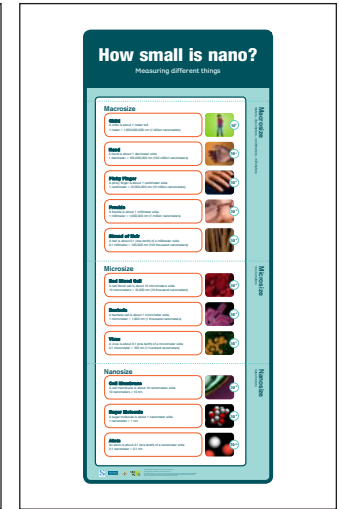


**BANNER 6 - 28.5" x 45.5"**

SIDE A



SIDE B



**BANNER 7 - 28.5" x 45.5"**

SIDE A



SIDE B



**BANNER 8 - 28.5" x 45.5"**

SIDE A



SIDE B



BANNER 9 - 28.5" x 45.5"

SIDE A

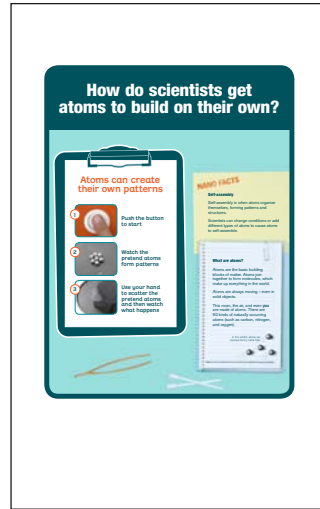


SIDE B



BANNER 10 - 28.5" x 45.5"

SIDE A



SIDE B



BANNER 11 - 28.5" x 45.5"

SIDE A

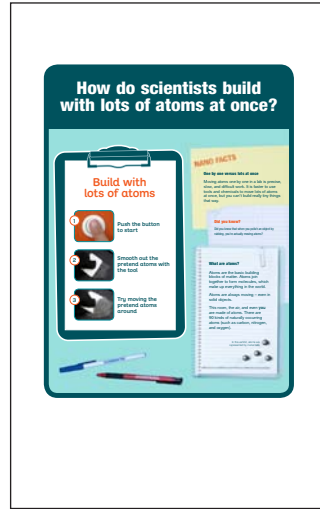


SIDE B

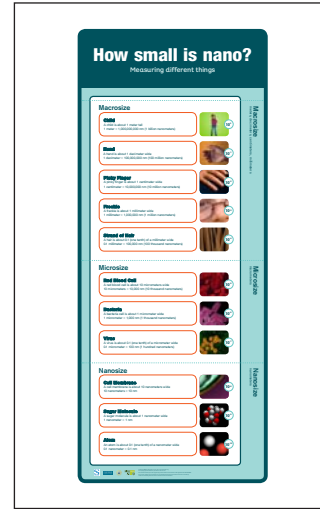


BANNER 12 - 28.5" x 45.5"

SIDE A

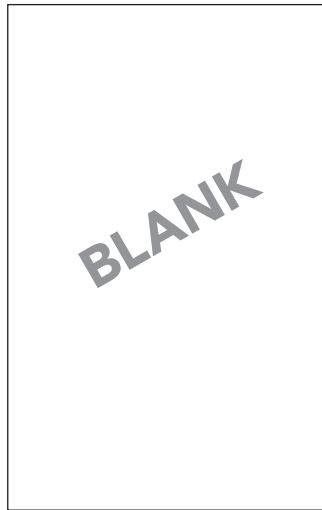


SIDE B



**BANNER 13 - 28.5" x 45.5"**

SIDE A

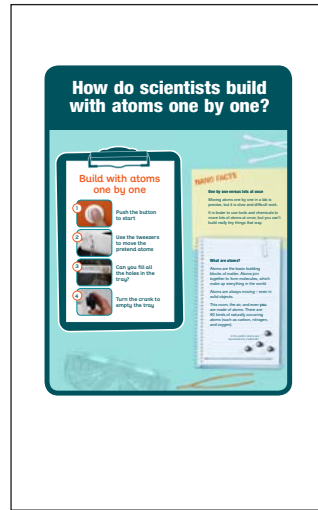


SIDE B



**BANNER 14 - 28.5" x 45.5"**

SIDE A



SIDE B





BANNER 21 - 28.5" x 45.5"

SIDE A

**IS THAT ROBOT REAL?**  
How small can a robot be? **REAL**

**Microsize**

- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**

**NOT REAL**

**Microsize**

- Are these robots the size of a robot? **NOT REAL**
- Are these robots the size of a robot? **NOT REAL**

**NOT REAL**

**Nanosize**

- Are these robots the size of a robot? **NOT REAL**

**NOT REAL**

SIDE B

**IS THAT ROBOT REAL?**  
How small can a robot be? **REAL**

**Microsize**

- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**
- Are these robots the size of a robot? **REAL**

**NOT REAL**

**Microsize**

- Are these robots the size of a robot? **NOT REAL**
- Are these robots the size of a robot? **NOT REAL**

**NOT REAL**

**Nanosize**

- Are these robots the size of a robot? **NOT REAL**

**NOT REAL**

BANNER 22 - 33" x 45.5"

SIDE A

**Build an Imaginary NANOBOT!!!**

If you could build a really tiny robot what would you make?

- Build an imaginary robot
- Write on a card what your robot does

**Build an Imaginary Nanobot!**

1. Draw a robot that is tiny (smaller than a cell).  
2. Write on a card what your robot does.  
3. Share your robot with a partner.

**Build an Imaginary Nanobot!**

1. Draw a robot that is tiny (smaller than a cell).  
2. Write on a card what your robot does.  
3. Share your robot with a partner.

SIDE B



BANNER 23 - 33" x 45.5"

SIDE A

**NANOTECHNOLOGY**

Space-age boot uses nanotechnology to stay light and dry!!

**Fact: Already Here!!!**  
**NANO-REALITY!!!**

Inventor: Mark DiNapoli!  
Real uses for nanotechnology!

**Amazing Cooling Spectacular! Not real!**

SIDE B

**Build an Imaginary NANOBOT!!!**

BANNER 24 - 33" x 45.5"

SIDE A

**FACT OR FICTION?**

Can a nanobot inject medicine directly into blood cells?

**Fiction: Imaginary Nanobots**  
**NANO-FICTION!!!**

**Amazing Cooling Spectacular! Not real!**

SIDE B



# NanoLab- changing gloves

## To change gloves:

You need to undo the four 1/4-20 screws on the front ring; they go into locknuts **inside** the dome.



One way to do this is with a long 12mm socket (with tools for exhibition); you normally need a 7/16" socket for 1/4-20 nuts, but here you need something a bit larger to account for the thickness of the glove fabric. There is a handy hand-held ratchet with 12mm socket shipped with the tools for the exhibition for this task. Reach inside the glove with this tool to get hold of the nut (check that the ratchet is set up to unscrew), and then with your other hand undo the screw on the outside (4mm or 5/32" allen wrench).



# NanoLab- changing gloves

Slide off the back ring and you can bring the gloves and top assembly out.

Look carefully and see if there is anything special about the white ring: for some of the exhibits the opening in the clear dome is close to the bottom and one side of the plastic ring is ground down to fit; if so, you need to keep track and remember that as you put a new glove in place.



Bottom of this ring is ground off here, for *Atoms Build on their Own*

Undo the four setscrews that hold the glove sandwiched in place between the outer ring and a piece of white PVC pipe.

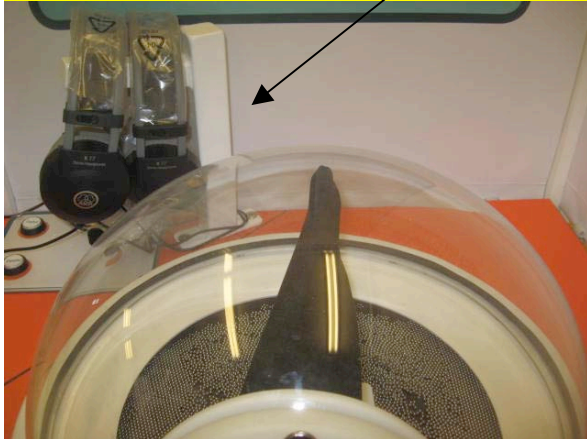


# NanoLab- changing gloves

Slide in a new glove- adjust length to about 12" long as measured from bottom of white ring.



Be sure to orient so thumb will be sticking up when you're done.



## NanoLab- changing gloves

Then slide inner piece of pipe back in, tighten set screws, and finally trim excess fabric.



Slide back in hole. Bring back ring in place, then reach and grab nuts and get them started on each screw. Tighten using 12mm socket again to hold onto the nut—**do not overtighten.**



# Nanolab: sewing gloves

Cut out two layers of fabric at once.



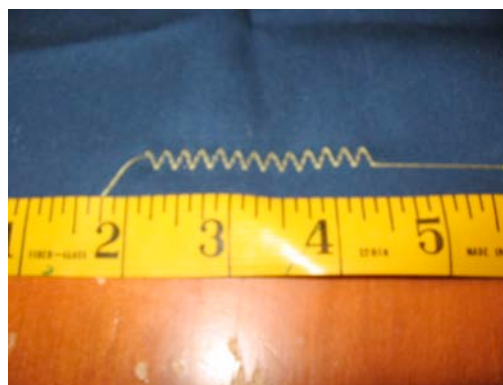
Pin.

Sew about 3/8" seam.

Snip inside corners particularly (notch between thumb and first finger, and at flare at cuff end), also around outside corners of hand.



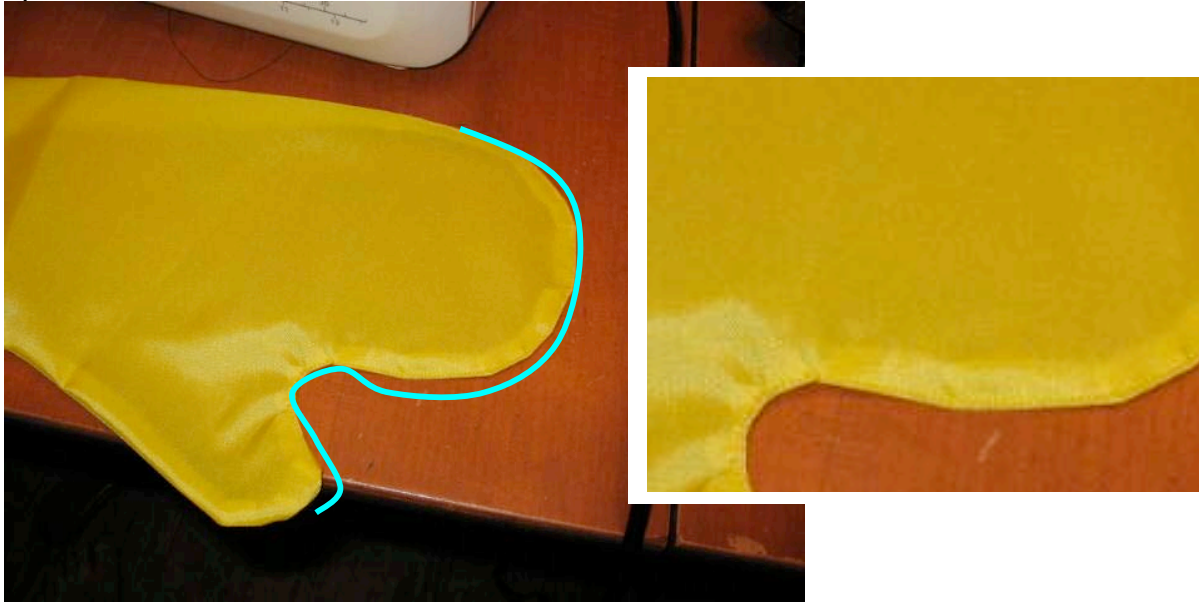
Finish edges-- 3 stitch zigzag—pull apart fabric at snips so it can be turned inside out later.



## Nanolab: sewing gloves

Turn right side out.

Reinforce by stitching just inside seam, along fingertips and down to notch and partway up thumb.

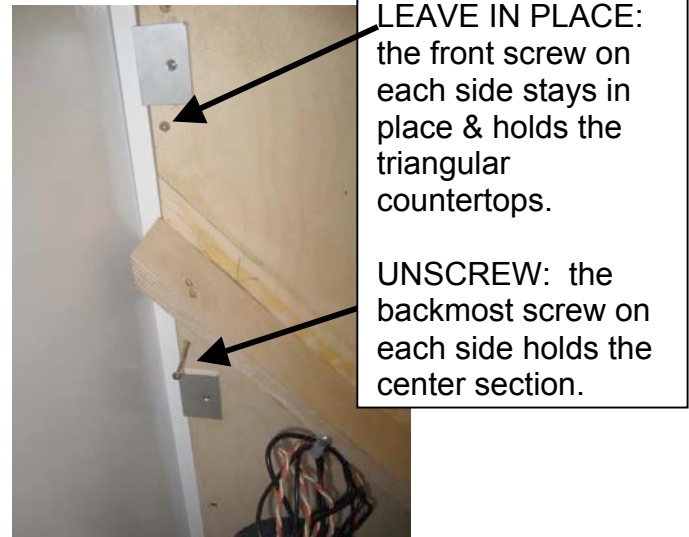
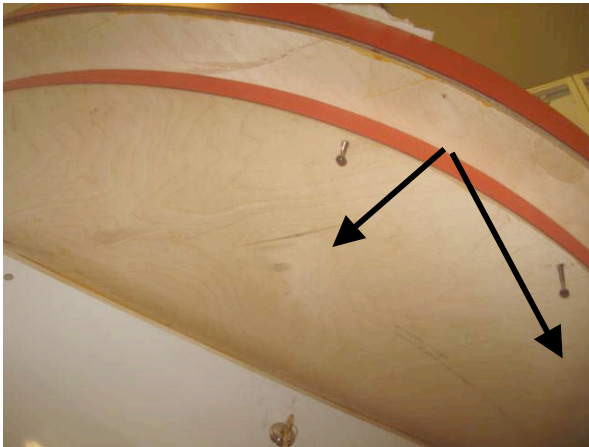


# NanoLab- dome & access to mechanisms

## ACCESS to the inside motor-driven mechanism

You can leave the dome assembled. Open up the front access door.

Undo the four square drive screws (#2 drive, included with tools) that go from the underside of the cabinet into the center section of the top of the table—two screws are at the front of the cabinet, and one is along each edge about  $\frac{1}{2}$  way to the back corner. Then lift the orange tabletop section off.



When you're ready to put it back together, you can wiggle the top a bit to get the shaft to line up in the bearing of the  $\frac{1}{2}$ " white Sintra disk. Screw back in place.

**See separate detailed documentation on the motor, mechanism, and electronics.**



# NanoLab- dome & access to mechanisms

## To get access inside the dome:

**KEEP TRACK of the ORIENTATION of the parts as you take it apart, in order to put it back together.**

If the opening in the dome is close to the bottom of the dome, you'll first need to remove the white plastic ring and glove; see instructions for changing gloves to remove white plastic ring (there's a nice tool for this job).

If you're taking apart One by One, you first need to remove the handle/threaded rods that go into the white bar inside: reach inside with one hand to hold the white bar, and you can unthread the post/knob.



To take off the white metal ring (a cake pan originally) undo the four screws that hold the outer white metal ring in place; 4mm or 5/32" allen wrench for the 1/4-20 screws. You may need to pry up the metal rim to be able to lift it off.



# NanoLab- dome & access to mechanisms

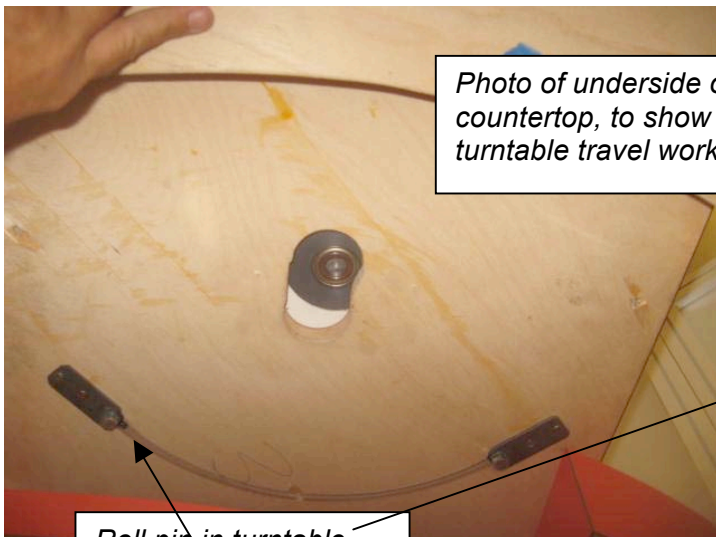
Then undo the square drive screws (there is a #2 bit, with setup parts) BY HAND that holds the clear acrylic dome and white plastic shroud in place on a wooden ring., and lift them off **Mark the orientation first (if not already done)!**



You can see the wooden ring and turntable that the acrylic dome is mounted to:



The turntable allows visitors to turn the dome/glove/opening by about 60 degrees, to accommodate visitors that are left-handed as well as right-handed; there is a roll-pin mounted to the turntable that travels in a slot in the countertop; the length of the slot determines the travel of the turntable.



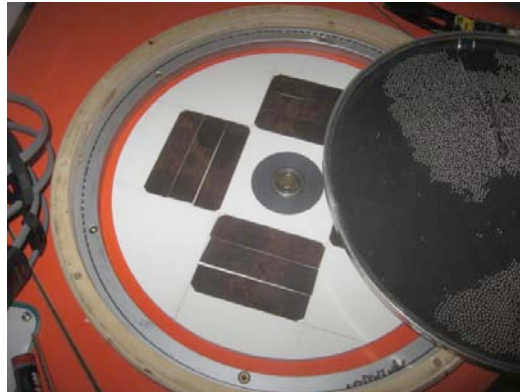
*Photo of underside of top part of countertop, to show how the turntable travel works.*

*Roll pin in turntable travels in slot*

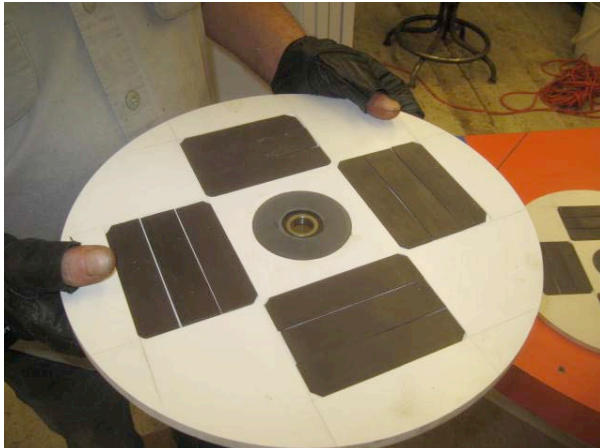


# NanoLab- dome & access to mechanisms

The flat surface with the round metal balls is a drum, with a layer of rubber glued on top and sheet metal glued on the bottom. You can lift it off- it is held in place by sheet magnets underneath. But either remove the balls first, or slide it to the side a bit, so you can get underneath and lift **VERY CAREFULLY to avoid tipping and spilling the metal balls (and you don't want metal balls to get loose and stuck between the white sintra and the turntable).**



Last, you can lift the white sintra disk off the shaft- however you really **do NOT** want to do this, as metal balls could fall down and into the space around the shaft.



## NanoLab- dome & access to mechanisms



Reassemble: be sure there are no 1/8" metal balls down between the white disk and the turntable. Then line up white plastic and dome, screw back in place BY HAND.

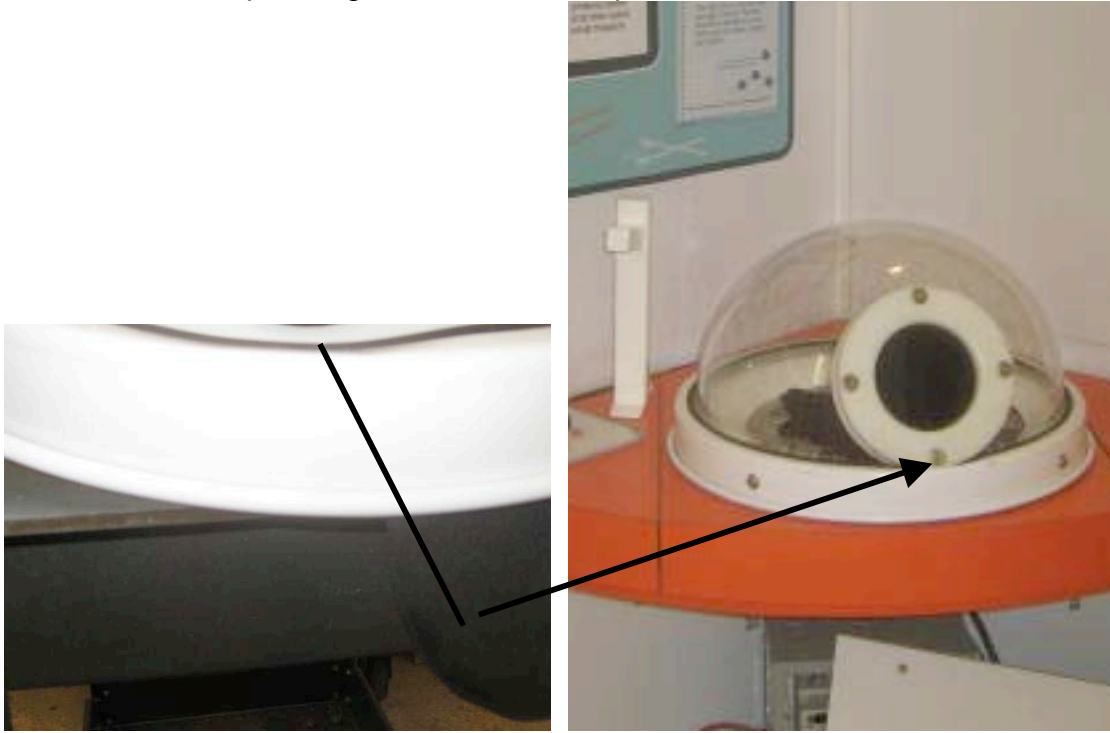


Line up the outer metal ring carefully so the holds match, and slide it down and screw cover in place. Be sure turntable moves freely- if it is binding loosen the four screws and use a prybar to lift it up slightly.



# NanoLab- dome & access to mechanisms

Note that for the domes with white rings down low, there is a dimple in outer metal ring so that the white plastic glove-holder fits in place:



# NanoLab- interactive exhibit motor mechanisms

Three interactives all have rubber-coated disks that gently move around, to simulate the motion of atoms at the Nano scale: One by One, Lots of Atoms, and Atoms Build their own (Self Assembly).

These all have the same motor/drive mechanism/electronics .

The following pages show how it works and is wired/programmed.

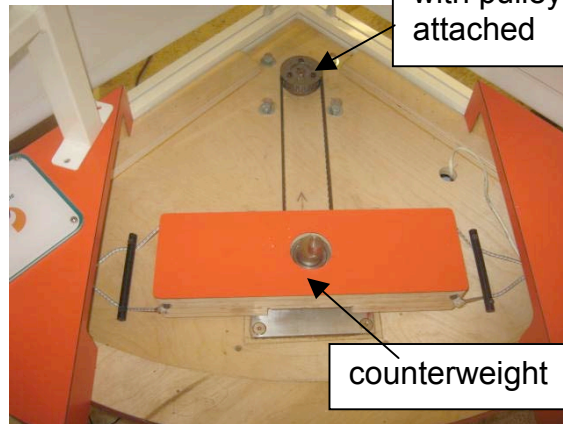


# NanoLab- interactive exhibit motor mechanisms

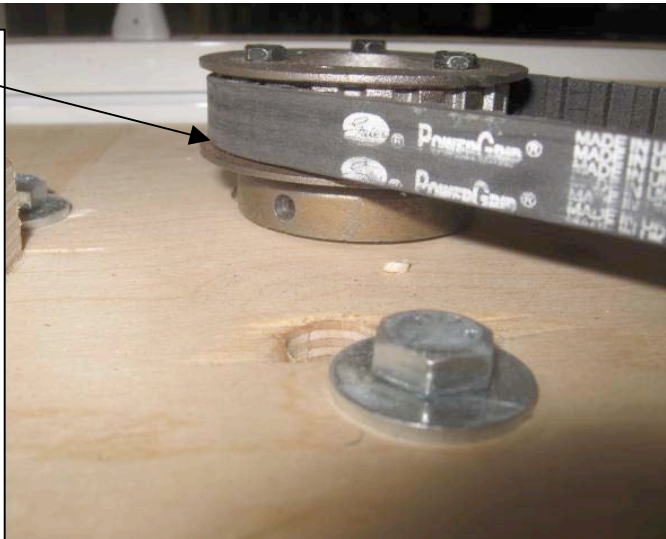
## MOTOR AND BACK PULLEY

The first set of photos shows the motor and mechanism that causes the drumheads inside the domes to vibrate and shake the metal ball bearings that visitors use as “atoms.”

The motor is mounted to the underside of the table base at the back of the cabinet, in order that visitors in wheelchairs can approach the cabinet. Its shaft is vertical, and turns a pulley and belt.



Pulley is screwed to a matching JA bushing (McMaster 6086K112); as the 3 screws are tightened this draws the slotted bushing onto motor shaft, and draws the bushing into the pulley via their tapered fit. To remove the pulley, you'd need to undo the 3 screws, and screw them in the other 3 holes to push the bushing out.

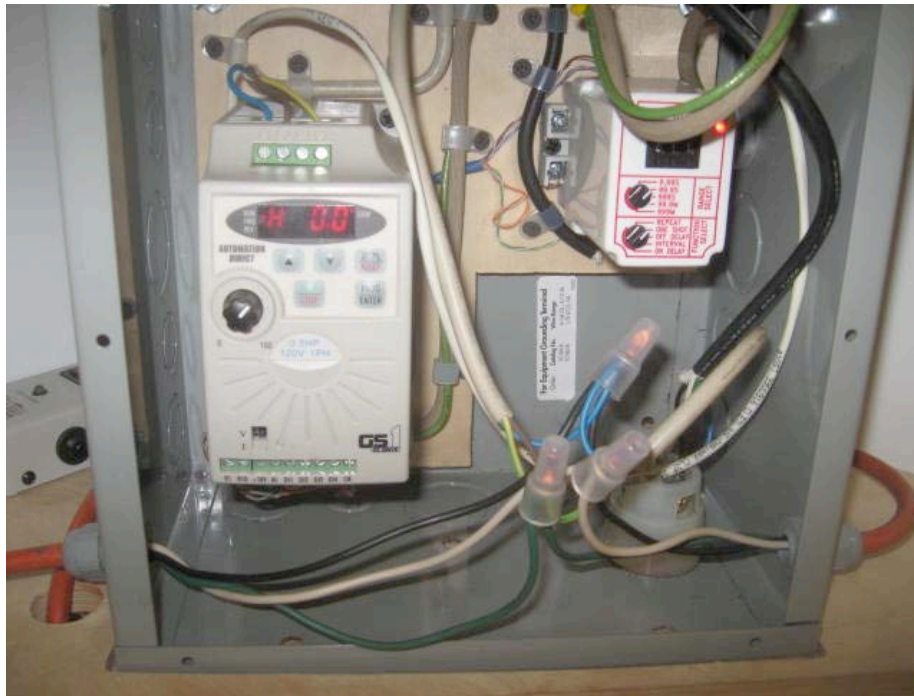


# NanoLab- interactive exhibit motor mechanisms

## MOTOR CONTROLLER & ELECTRONICS:

When a visitor presses the white HAPP button on the tabletop, a relay/timer unit is turned on, and the motor controller turns on power to the motor, and gradually builds up speed over about 15 seconds. The motor stays on until the timer/relay unit cycle ends (typically set for about 60 seconds) when it goes off automatically (slowing down over about 3 seconds).

The motor is a 3/4HP, 3-phase, 230 volt motor which runs smoothly and efficiently and quietly while not getting warm. It is run by the Automation Direct AC Drive GS1-10P5 controller unit in the electronics box in the underside of the cabinet; that unit also takes single-phase, 120V AC input power and creates the necessary 3-phase, 230V AC power that enables the motor to run. The motor is 3/4HP to get up to the desired 5/8" shaft; the controller is rated for 1/2HP, so the motor will not be run anywhere near its full power.



## Timer-relay settings:

600

99.9seconds range

oneshot

HAPP button microswitch is Normally Open (NO); when pressed by visitor it closes momentarily, which tells the AC Drive to turn on the motor and bring it up to speed over several seconds. The AC Drive also has an output which then closes; this is wired to two contacts on the timer and starts the timer running for about 60 seconds; during that time the "STOP" on the AC Drive is inhibited, allowing the motor to run. When the timer finishes its cycle, the stop is no longer inhibited, so the AC drive decelerates the motor to a stop.



# NanoLab- interactive exhibit motor mechanisms

## Automation Direct AC Drive controller settings:

Time for motor to come up to speed: 20 seconds (programmed; actually gets there in 3-4 seconds with no load).

Time for motor to slow down and stop: 5 seconds

Output to motor: 13 hertz (230 volts AC), which causes motor to turn at about 20% of its rated 1725rpm at 60hertz, or about 350-400 rpm

Digital Input 1 (DI1) is FWD RUN command; causes motor to run (forward) when actuated (momentarily pulled to common by HAPP microswitch)

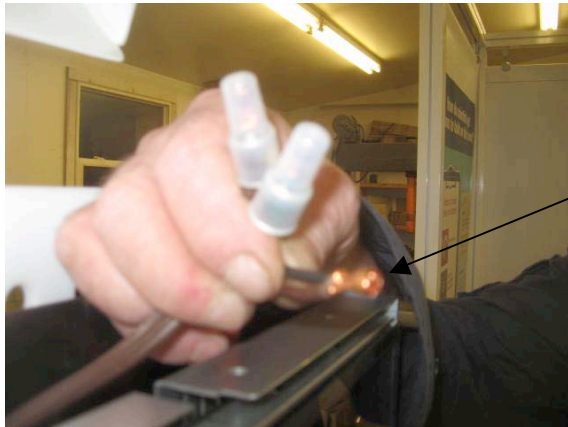
When DI1 is actuated, this also causes R1 and R10 to contact; that closes two contacts on the timer/relay and starts the timer/relay.

Digital Input 3 (DI3): STOP command; output from timer/relay leads keeps this pulled to common until the end of the timer cycle; when the timer no longer pulls this to common, the controller causes the motor to decelerate and stop.

Pressing run/stop button on front of AC Drive will stop the motor (cannot start the motor again until the timer has timed out).

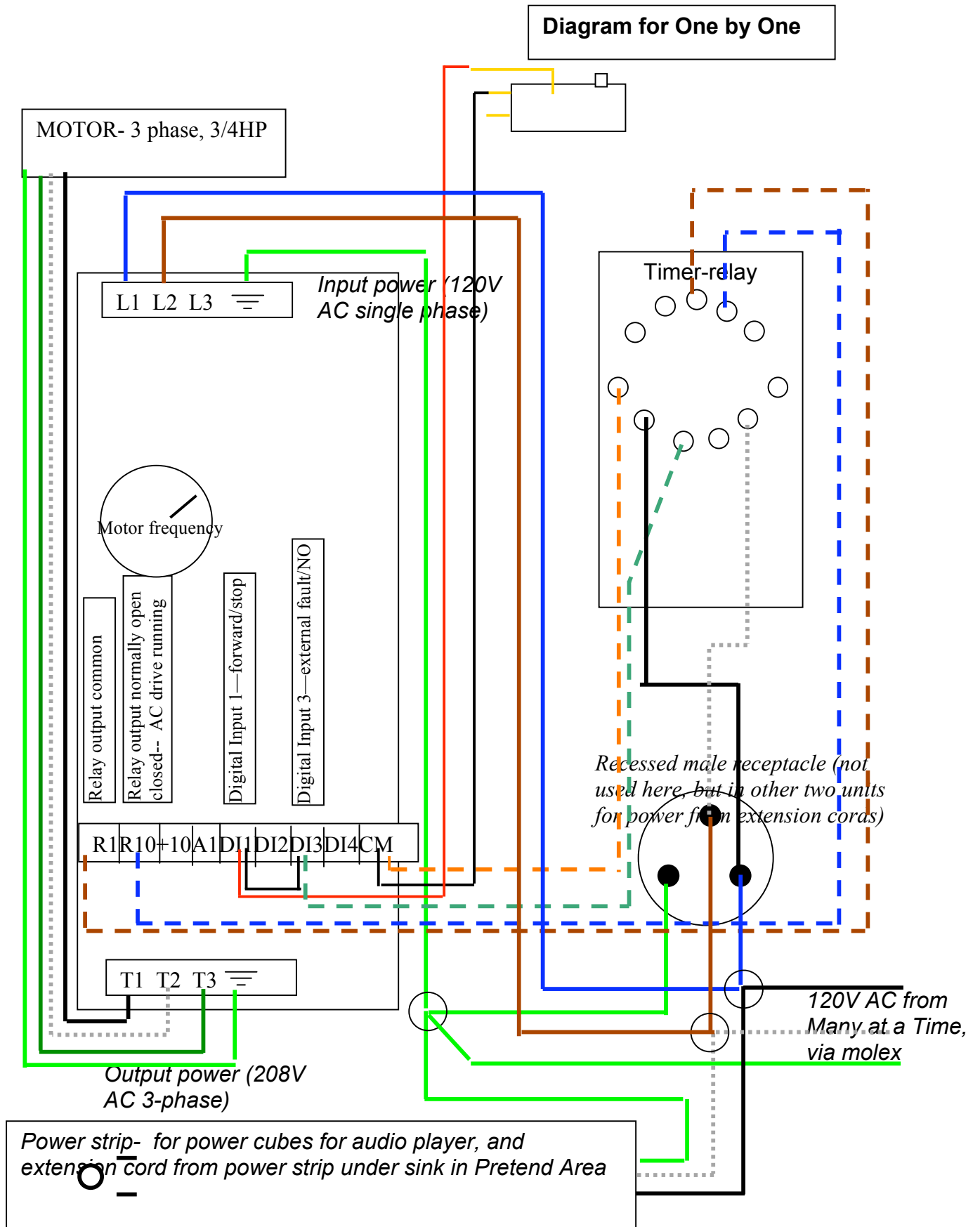
# NanoLab- interactive exhibit motor mechanisms

Electrical connections inside box are not wire nuts, but more reliable “Buchanan crimp” fittings that crimp firmly onto wires.—wires (stripped) go into copper cap, copper cap with wires goes inside plastic sleeve (with ring with teeth) and then crimp tool is used to squeeze copper cap onto wires; the cap/wires do not come out easily because of the ring with teeth inside the plastic sleeve. They cannot be unscrewed (unlike wire nuts)- for servicing, you must either cut wires or cut the cap off, and cut off the crimp (to avoid shortening the wires).



Copper cap  
squeezed on—  
plastic sleeve then  
slides on last.

# NanoLab- interactive exhibit motor mechanisms

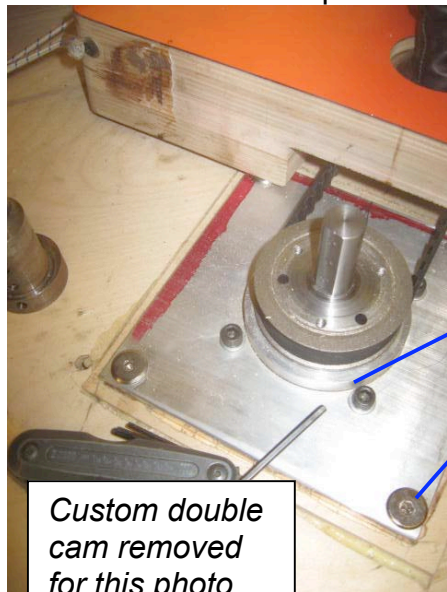


# NanoLab- interactive exhibit motor mechanisms

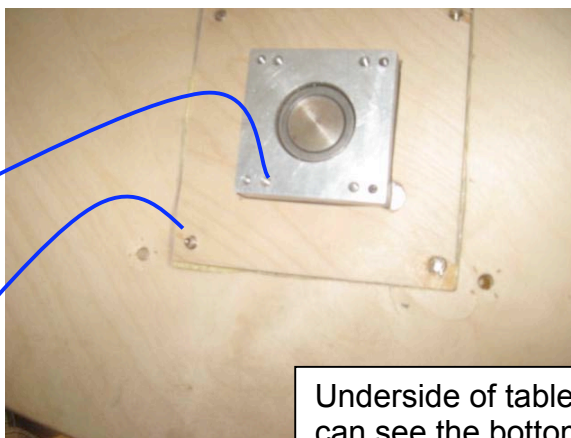
## FRONT PULLEY

As the motor turns, the pulley/belt attached to its shaft drives a front pulley. The front pulley has been machined out (it normally has a taper inside) and a stepped shaft pressed into the pulley that extends below the pulley (1 1/8" dia) and above it (5/8" dia), with a wider section pressed into the pulley (hand press with loctite).

Underneath the pulley the lower part of the 1 1/8" part of the shaft has a bearing, then shaft collar (to keep the shaft at the correct height), then second bearing- the two bearings spaced apart are there to keep the shaft aligned vertically. The two bearings and shaft collar are captured in a two-part aluminum housing built for this:



*Custom double cam removed for this photo so you can see the shaft*



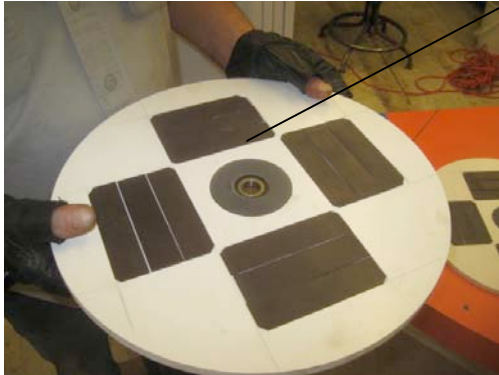
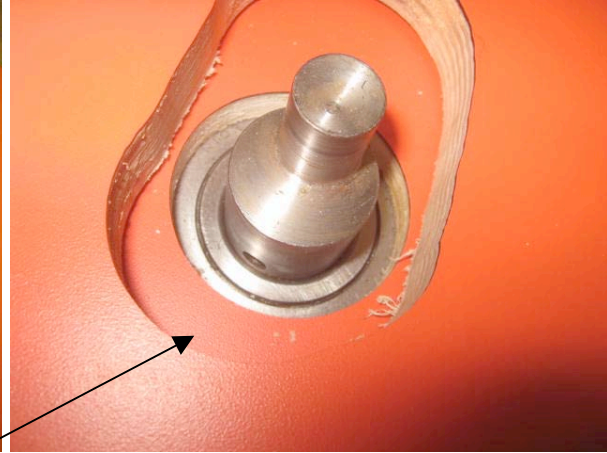
Underside of tabletop—you can see the bottom of the 1 1/8" shaft, in a 1 1/8" bearing captured in the aluminum housing.

There are two moving parts driven simultaneously by the front pulley- a white 1/2" thick Sintra disk with drumhead on top that visitors see, and a hidden orange block of wood (with metal inside it for extra weight) that is a counterweight that moves opposite to the white Sintra disk/drumhead assembly—having the counterweight makes the entire motion smooth, without a lot of vibration on the tabletop/cabinet.

# NanoLab- interactive exhibit motor mechanisms

## MOVING DRUMHEAD:

There is a 5/8" shaft sticking up through the tabletop—it is off-center from the front pulley, so it moves around like a cam with a travel of about 1/4". The white 12mm thick (just under 1/2") Sintra disk has PVC center section, with a center bearing that the shaft goes through, and thus moves around on the tabletop about 1/4". PVC is used in center of the white Sintra because Sintra is too soft to hold a press-fit bearing.



# NanoLab- interactive exhibit motor mechanisms

There is a drumhead that has a steel plate glued to its bottom; the steel is attracted to the magnet material on the top of the white sintra disk:



## MOVING COUNTERWEIGHT:

As the white sintra disk/drumhead moves, the counterweight moves in the opposite direction by about 1/8”:



Several pounds of metal is embedded in the plywood of the counterweight block

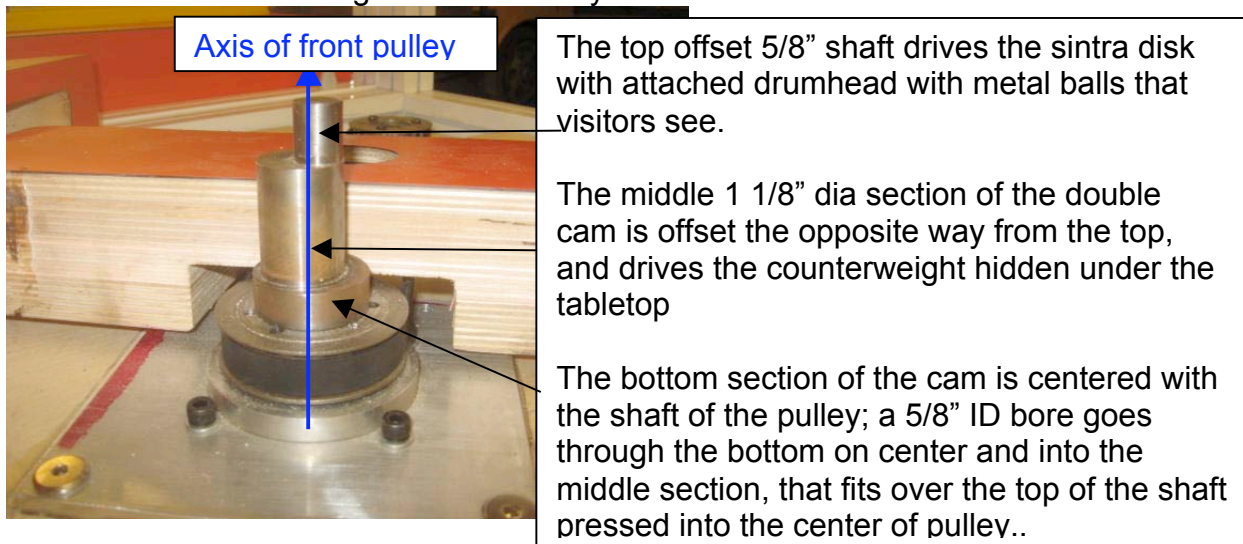
# NanoLab- interactive exhibit motor mechanisms

To keep the motion smooth at the end of the travel, the counterweight has bungee cord attached at each end (the tension in the cord can be adjusted and then held in place with the black bar screwed down):



## DOUBLE-CAM

A custom double-cam mechanism is attached to the shaft of the pulley. You can see it here with the counterweight out of the way:



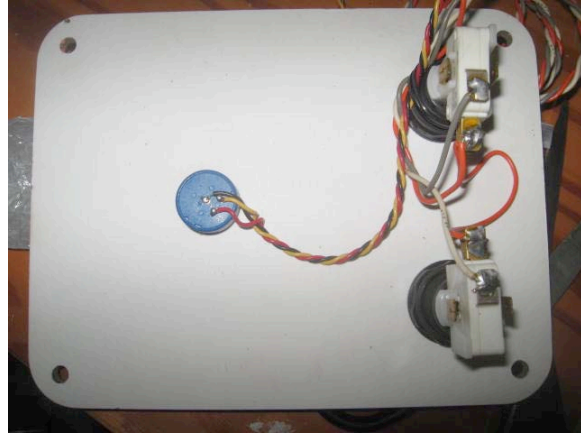
FYI, the double-offset cam is attached (with three set screws) to a stepped shaft that goes through the front pulley: the top part of the stepped shaft is 5/8", the bottom is 1 1/8" and pressed into the pulley and through it



# NanoLab- audio & headphones

## ACCESS to volume & pushbuttons:

Undo the four screws that hold the graphic card in place, and you can lift it up to get access to the two pushbuttons:



The volume knob is attached to a 1/4" shaft with a tiny set screw, which takes a 0.050" allen wrench. It turns a 10K potentiometer.

## ACCESS to the audio amplifiers & headphones

Undo the two screws that hold up the white metal stanchion (4mm or 5/32" allen wrench, included with Nanolab tools), and set the stanchion aside.

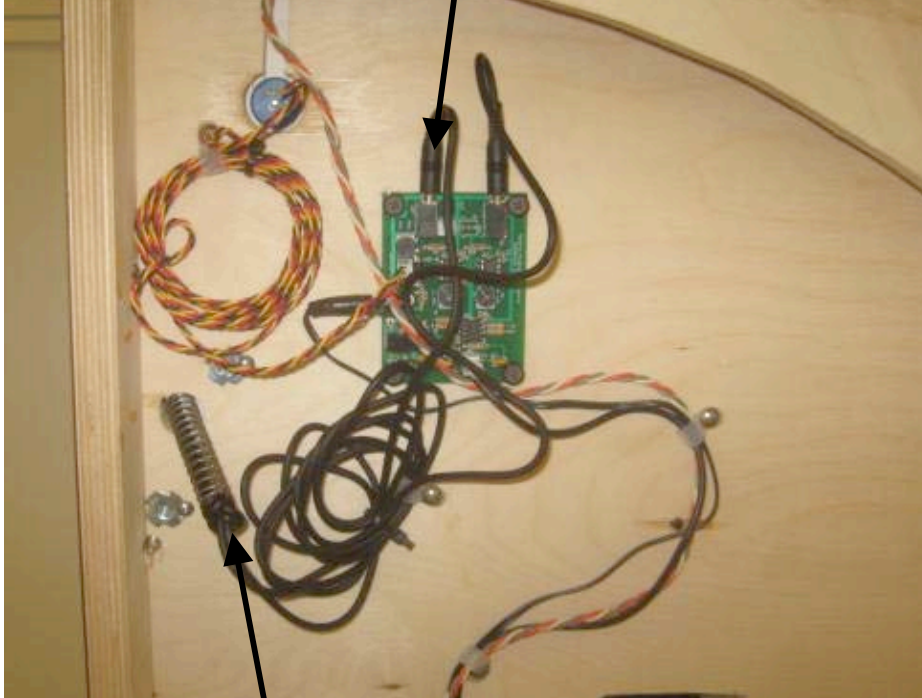


Access: see instructions that follow for the different cabinets.



# NanoLab- audio & headphones

Then unplug the headphone(s) from the jack on the audio amplifier board.

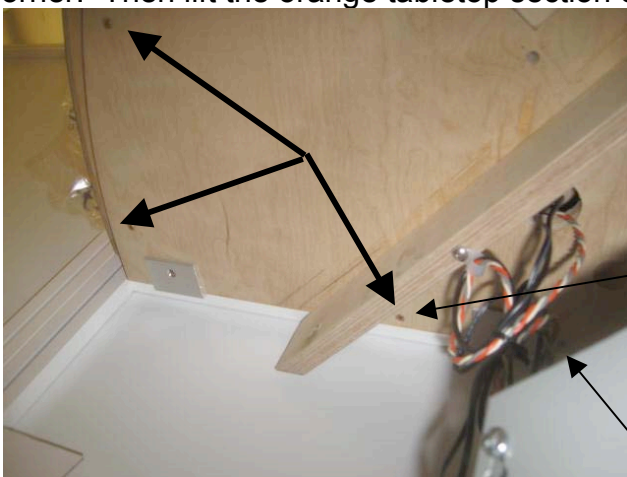


Undo the knot in the cable, and feed the cord out through the spring (which serves as strain relief) and hole in the countertop. Feed cord for new headphone(s) through hole and spring, redo the knot, and plug in.

Reassemble countertop, then stanchion.

## Access for the three exhibits with motor mechanisms:

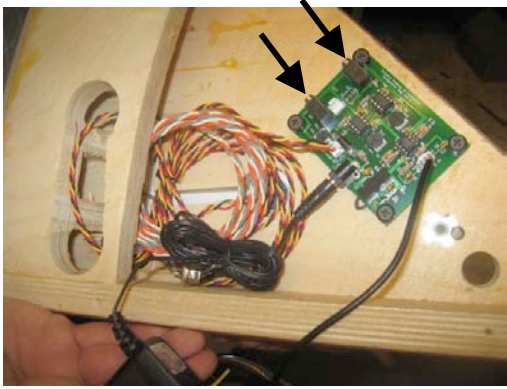
Undo the three square drive screws (#2 drive with tools for NanoLab) that go from the underside of the cabinet into the triangular section of the top of the table—two screws are at the front of the cabinet, and one is along the edge about ½ way to the back corner. Then lift the orange tabletop section off.



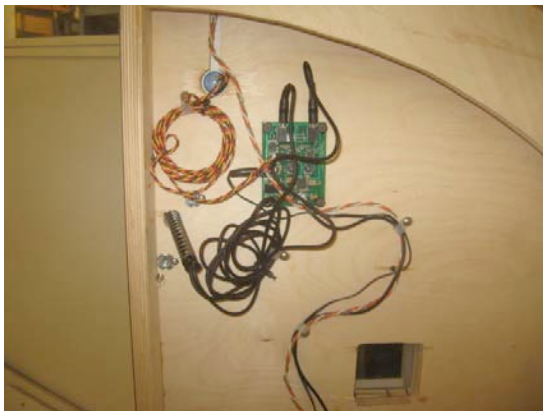
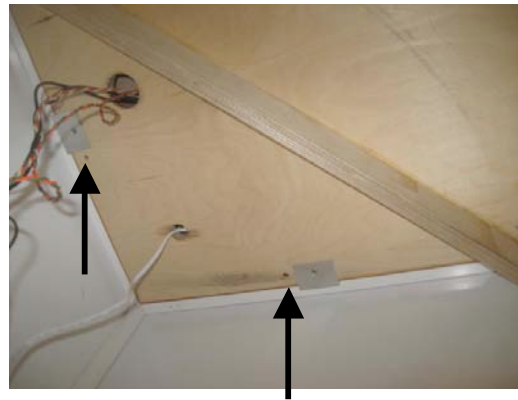
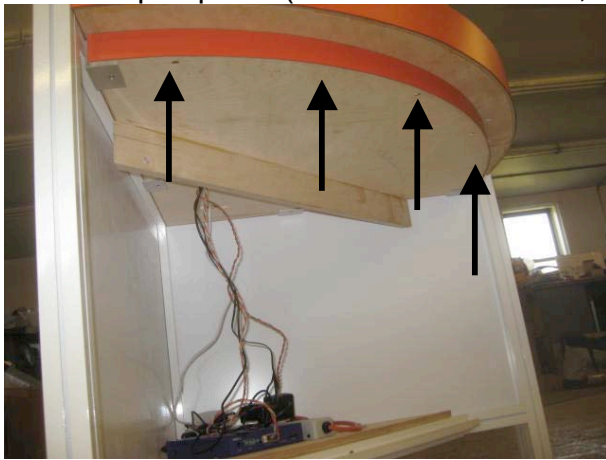
UNSCREW the front screw on the side

LEAVE IN PLACE: the backmost screw on the side that holds the center section.

# NanoLab- audio & headphones



Access for *Seeing Tiny Things* cabinet: undo the six screws that hold the entire countertop in place (four across the front, one along each side) and lift it up:



# NanoLab- audio & headphones

## Access for *Welcome to the Nano Lab* and *Play Nano Scientist*:

Open the center access door. Undo the four screws (#2 square drive again) that holds the tabletop down to the two cabinets.



Then you can carefully lift up the tabletop—someone else will need to hold it while you replace the headphones (or clamp it securely in place):



Access for *Fact or Fiction* Building table is from the inside of the cabinet; remove access panel & tilt board down.

