



# PEOPLE, MATERIALS, AND PROCESS

The nuts & bolts for making  
Cardboard City a reality.



Recommended Citation: Bequette, M., Geake, L., Goeke, M., Lukowski, S., Callahan Schreiber, R., & Schmit, B. (2023). Cardboard Collaborative: A guide to creating more inclusive museum makerspaces. Science Museum of Minnesota.



You can access all the Cardboard Collaborative materials at [smm.org/cardboard-collaborative](https://smm.org/cardboard-collaborative). This material is based upon collaborative work supported by the National Science Foundation under Grant #1906884, Building More Inclusive Makerspaces to Support Informal Engineering Learning Experiences. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

# COMMUNITY INFORMED DESIGN

Cardboard City was developed across ten years of research and design iteration work and involved ongoing collaboration with community organization partners from across the Twin Cities. As our original goal was to understand how makerspaces can be designed to invite and engage many families, with particular attention to BIPOC families, seeking and being led by community voices was critical. Of course, our practices for doing this work have shifted over the ten years as we learn more, but by examining documentation from across the development of Cardboard City, we saw five consistent patterns to how we invited, listened, and acted based on community voice, which we now call Community Informed Design. Here, we will provide an overview of Community Informed Design.

## What does Community Informed Design look like?

Community Informed Design is a type of community engagement that falls between collaboration (where external partners give input on design) and co-creation (where external partners lead design). Recognizing that design work takes considerable time and effort, and diversity-focused change work requires emotional labor, Community Informed Design emphasizes community voice in the naming of direction for design while placing the responsibility of work on a collective of museum staff. Community Informed Design is characterized by five features, detailed below.

**Naming our Values and Assumptions:** Museums need to be transparent about what their needs and boundaries are when initiating work so that community organizations and individuals can honestly assess if the partnership is of interest.

**Emergent Planning:** Too clear of plans at the beginning of work can create resistance to change when community voices signal the need for a different direction. Naming high-level plans is important for establishing partnership, but let specifics — for example, theme, specific learning goals, length of program, primary audience, etc. — be open for direction from community voices.

**Flexible and Distributed Staffing:** Within an organization, distributing responsibility and contribution across staff can reduce burnout (i.e. a small number of staff will not be tasked with pushing against many systems) and identify productive solutions earlier (i.e. staff in different roles have different expertise about making things work within existing systems). Our internal project team included staff from visitor services, finance, development/fundraising, research, access and equity, and museum experience design.

**Organization-to-Organization Relationships:** Similar to potential burnout with internal staff, potential burnout — or simply life changes — with external partners is also a risk. Creating enduring organization-to-organization relationships supports partnership across transitions.

**Layered Data:** Finally, relying on a single or small number of people to be your source of information or ideas can create a tokenizing effect. While doing deeper design work is more effective with a constrained number of community organizations and individual partners, augmenting their insights with broader data efforts helps relieve any sense that someone has to “speak for” an entire community.

# STAFFING AND FACILITATION

What you need to know about staffing:

1. Be flexible
2. Work as a team
3. Celebrate staff or volunteers as makers

*“[Cardboard City] thrived on creative chaotic energy while still being a place that largely was controlled and relatively easy to maintain. I had great conversations with guests here and was delighted to see so many families either work together or give one another space to build that they needed.”*

*-Science Museum of Minnesota Visitor Experience Facilitator on working in Cardboard City*

## Why Your Plan for Staffing and Facilitation Matters

The Cardboard City gallery is an ‘all hands on deck’ experience! Your team, across the museum, is needed for a cardboard-focused makerspace to work.

Staff activate a makerspace: They can make and inspire, provide support for visitors, and ensure that the space is clean and comfortable. However, makerspaces are also labor intensive and can lead to burnout. Planning your staffing and facilitation strategy carefully makes you more likely to create an experience that works for visitors and staff.

What this looks like in practice:

- championing staff as makers,
- planning for visitor interactions,
- and cleaning or maintaining the makerspace.

To engage staff and support a positive visitor experience, one Cardboard City facilitator at the Science Museum of Minnesota recommended a 20 Minute Model. That means that within each hour in the cardboard gallery, facilitators spend about 20 minutes making on their own, 20 minutes checking in with visitors directly, and 20 minutes cleaning. That said, a 20 Minute Model isn’t always feasible. A rush of children on a field trip or a busy weekend might affect front-line workers’ ability to do much more than try to keep the space tidy. Others emphasized the importance of a team approach, Cardboard City required lots of stocking, cleaning, and organizing. Our team at the Science Museum of Minnesota emphasized being flexible. Sometimes the mess of cardboard making can feel overwhelming; call in team members to assist! This was only possible because the entirety of the staff was onboard.

Facilitation of cardboard experiences differs from other museum spaces, so training is strongly encouraged as a way to grow confidence in supporting visitors and increase team cohesion when supporting each other in creating meaningful and enjoyable experiences. We also liked to save time in the gallery to play with cardboard together as a staff before opening so people could connect with each other and learn more about the space and tools.

## Championing Staff as Makers

Staff who spend time making in the gallery have the chance to inspire visitors — maybe in sparking an idea or seeing a new way of working with the materials and tools. These are not formal demonstrations. Instead, staff “looking busy” with their own creations communicates to visitors that a skilled facilitator is nearby for support. Making in parallel with visitors gives staff something creative to do and creates another entry point to lure visitors into trying something new in the space.

Staff creations also help staff to develop a sense of ownership over the space. Through their own making, staff develop expertise in what cardboard can do. Example pieces set the tone for the immense possibilities of cardboard making. High-quality examples — those that may go beyond the tools available in the space — can be made by staff as well. For example, at the Science Museum of Minnesota, these pieces were designed using the Adobe Creative Suite, Blender, and Pepakura software and laser cut. Staff-made creations, whether made with special tools or parallel to visitors in the gallery, provided an additional jumping-off point for staff to share their skills and excitement for cardboard engineering with visitors.

## Interacting with Visitors

Staff play a key role in supporting visitors in Cardboard City, especially in introducing the concept of a “makerspace” and helping folks with various levels of comfort with making to get started in the space. For example, a facilitator might help a child choose something to make, direct a family to an open workstation, or give an adult tips for using a tool. Preparing staff for a variety of scenarios and deciding upon your organization’s approach to supporting visitors is key.

[picture here] Designated shelving allows for staff to retain their favorite pieces that also then serve as example pieces for visitors. Previously, it had been difficult for staff to see items that they or other visitors worked hard on remixed into something else by someone else. Cardboard City encourages visitors to contribute to something larger — such as the cityscape, theater display, or leaving behind vehicles for the Gravity Racer track — and staff help curate that collection over time.

## Cleaning and Maintaining the Makerspace

*“Find a cleaning system with your other team members. Cardboard can be too much for one person all at once, so please be mindful of whoever is running it and their needs.”*

*-Visitor Experience Facilitator, Science Museum of Minnesota*

Cleaning: there’s a lot of it! Staff members shared that cleaning felt more manageable when they could rotate cleaning with making and interacting with visitors in the gallery. It was also essential to communicate and work as a team. Managers of floor staff conducted 1:1 meetings with their Cardboard City staff to clean the space as they touched base. Staff from other departments also stopped by, especially on particularly high traffic days. Seeing everyone contribute to the space improved morale.

In the day-to-day operation of the space, groups leaving a workstation was a good sign that the area was ready to be “reset” compared to previous iterations without tables that required constant monitoring for areas of the floor that had become too messy. Workstations also helped to lift making activities off of the floor, which was more ergonomically comfortable. However, scraps still fell to the floor and needed cleaning. Overall, with a full gallery and just a few staff members in the space, staff shared to be aware of your colleagues in Cardboard City and help out where you can with maintaining the gallery.

## What Did This Look Like in Cardboard City?

At the Science Museum of Minnesota, Visitor Experience Facilitators support visitors on the museum floor. Typically, one to two facilitators were in the Cardboard City gallery at a time, a space that can easily hold 80+ visitors. This made the overall experience for visitors what one facilitator called a “self-engagement gallery”. Staff were not typically working one-on-one with visitors, but rather ensuring that conditions supported all visitors in trying something creative in the space, by rotating making with visitor support and cleaning. A six-month run of the Cardboard City gallery in 2022 was considerably harder on staff than a three-month run of the gallery in 2021. Consider the length and intensity of staff time and effort needed to run high-quality cardboard experiences over lengthy periods of time.

Here is what we heard from facilitators in the space:

### **What was a favorite visitor moment you observed:**

*“I loved when the adult visitors became invested in building their own creations. Adults, especially parents, often seem to have trouble letting go of the idea that the museum is a children’s space. It was nice interacting with adults who wanted to get the weight distribution just right on their car or wanted a particular color of tape for their art piece.”*

### **Another favorite moment:**

*“I loved seeing families work together and bridge huge age gaps. I loved seeing grandparents and grandchildren both have their hands on the same project. I especially liked to see the way in which they interacted. It seemed very equal. Usually when I see children and adults work together on a project, I see the adults guiding and instructing the children. In cardboard, it seemed that the lack of instructions allowed children and adults to work on an equal plane.”*

### **How could we continue to improve the experience:**

*“I think having the car area be more in the middle and not in the way back. A lot of people who are intimidated by the space don’t often even see the cars and just turn around and leave. Also, making it clear anything the kids make they can take home.”*

### **Overall we heard simply from our facilitators about the visitor experience:**

*“PEOPLE LOVE IT!”*



# SELECTING A THEME

## Why themes are useful

We —and others who have designed cardboard-focused programs and makerspaces — have found a unifying theme to be beneficial for visitor engagement. First, a theme operates as a light prompt in even very open-ended making. If a visitor misses all signage regarding the designed activities, the theme provides a visual starting point for them. Second, themes allow the same base activity to be lightly reimagined based on an alternative theme to support visitor’s repeat visitation and the needs of specific programs. For example, we reimagined the open-ended skylines activity in the Cardboard City as creating a new city on Mars. Finally, a theme can support the design of new activities. With Cardboard City, the city concept generated many divergent activity ideas, of which we settled on and implemented five specific activities. When reimagining the experience as a space exploration program, the new theme prompted the creation of a rocket-making activity.

## Building on a city theme

While Cardboard City adopted a city theme, we do not know for certain that this theme would be superior to other approaches. We ourselves had adapted the core activities to reflect a space exploration theme, with similar engagement results. We believe that strong themes should be relatable in some way to many visitors. When unsure, front-end evaluation — particularly with underserved visitors — can be used to assess current and potential visitor receptiveness to specific themes.

We communicated the theme to visitors both explicitly through our written labels and implicitly through the visual design of the space. The exhibition title and introduction panels all emphasized the idea of building a city together, and each activity’s written prompt included a narrative connection to the city. Visual elements such as laser cut cardboard “skylines” decorated the walls and example pieces at activity stations showed what final products may look like.



# WHAT'S IN A WORKSTATION?

## Why workstations?

Workstations are ultimately about ergonomics: Can I work for a period of time in this place? Do I have to hold my body in an odd position or can I move comfortably? Do I have the tools I need here, or will I need to move frequently? Can I find the tools and materials I need quickly? Can I easily locate a space for my group to work together? A strong workstation has nearly everything a maker needs to complete their task in an easily identifiable and accessible location.

## Workstations in Cardboard City

In Cardboard City, our workstations involved a standard-height table, wooden benches, a wooden organizer divided into five compartments, six tool types (safety boxcutter, roller for perforation, medical scissors, hole punch, pencil, and ruler), and a stationary colored tape dispenser. Cardboard was available at separate stations throughout the gallery. The 6-foot-long tables were positioned away from walls, allowing all sides to be used for making. Maintained walkways between tables allowed for wheelchair and stroller accessibility. Further, 6-foot-long and single-person wooden benches were placed along the sides of the tables for adults to sit on (and younger children to kneel to reach the table). We separated tools by type in the organizer and placed the organizer and tape dispenser at opposite ends of the table. While the distance between ends means that rarely could a maker reach both the tools and tape from the same exact position, we generally observed single-family groups using an entire workstation together and collaboratively passing materials and tools from opposite ends of the table.

## Specialized tools

Workstations near particular activities should include the specialized tools or supports that are useful for that space. For example, in our wearables area, workstations included a wooden mannequin head that visitors could build hats on. At workstations near the cars activity, we pasted copies of the assembly instructions onto the table surface. For supports that are more general, such as basic joinery techniques, we positioned them near the workstations for the open-ended city skylines activity.



# MATERIALS MANAGEMENT

Here, we are sharing considerations to plan for material life cycles and the actual material list that we used in Cardboard City.

## What is material management?

Cardboard City required a lot of consumables — the cardboard and tape, but also copious amounts of tools. The gallery required frequent stocking and restocking. As you plan activities for a cardboard-focused makerspace, you also have to keep in mind how you will manage supplies — collecting, storing, and disposing them.

## WHAT IT LOOKED LIKE IN PRACTICE

In general, when planning ahead for the material needs of Cardboard City, consider where you can gather supplies, if you have the space to store supplies, and how you will handle materials at the end of their lifecycle — through recycling or other disposal.

## Material Life Cycles



### Gather

The first step is to source all the materials. You may choose to fabricate, order from suppliers, or seek sponsorships to gather materials.

### Storage

Given the resource-intensive nature of makerspaces, a place to store the materials is needed — whether for a gallery or pop-up events. The picture shows a portion of the storage area used at the Science Museum of Minnesota in 2021.



Within the gallery space we also used storage to reduce any resource-hoarding that might otherwise occur. Each workstation housed a tray with several tools. Stations for visitors to gather cardboard supplies within the gallery were distributed across the space.

### Disposal

Ideally the cardboard in the space not used by visitors — off cuts from projects or even entire projects left behind that cannot be kept in the gallery — can be recycled. However, not all makerspaces will have access to robust recycling programs in their communities, and increasing recycling can come with added costs. Consider the material waste and what your site can feasibly do with it when taking on a cardboard-focused makerspace.



Prepping materials for recycling may also be important — for example, cardboard covered in masking tape may not be accepted in recycling facilities. In addition, as more and more visitors come through the space, more cardboard waste is produced. One way to reduce some of the cleaning needed, and include some encouragement around recycling, is to create a Recycling Center.



In Cardboard City, the Recycling Center contained graphics overhead and a conveyor belt. Visitors that wanted to recycle any remaining cardboard (or even their whole creation) could spin the wheel on the conveyor belt to move the cardboard into a waiting recycling receptacle. Reducing waste, as well as making recycling and cleaning fun, serves as a benefit for both staff and visitors.



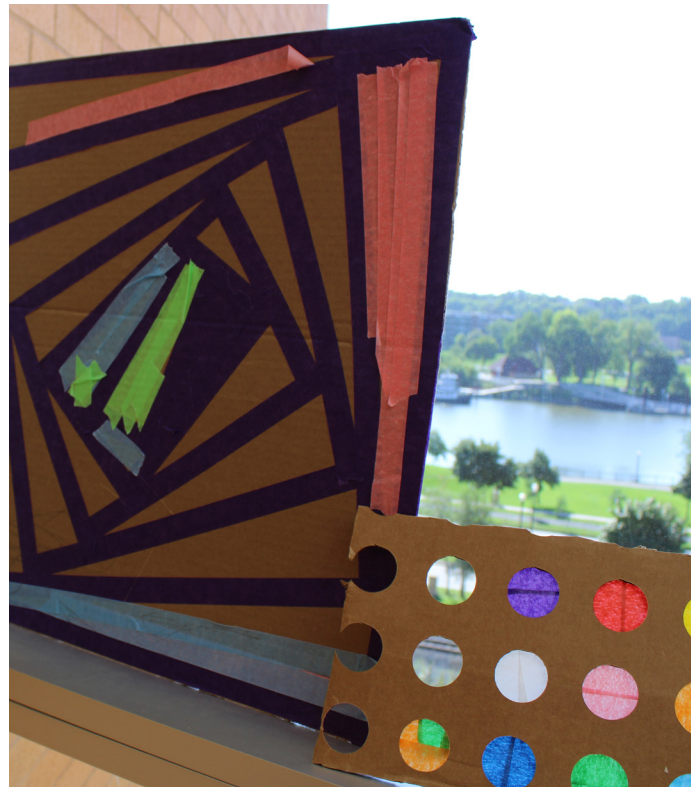
# WHAT TO INCLUDE IN A CARDBOARD CITY

## Fabrication of Cardboard City

At the Science Museum of Minnesota, we have a large exhibit production shop with full-time exhibit fabricators and exhibit maintenance technicians. We created all of the exhibit infrastructure and interactives for Cardboard City with a team of 2-3 full time fabricators for about 2 months, and an additional 4 staff members focused solely on the cardboard sculptures for about a month. We recognize that many institutions do not have this type of team in place. Fortunately, the complexity of a cardboard maker gallery can be scaled up or down to match the capacity of any institution. A successful gallery should focus on the material itself, and offer visitors approachable interactives with comfortable accommodations for making.

### Cardboard

- 48" x 36" sheets heavier substrate (we used a more durable corrugate made with an A Flute or C Flute internal structure, with a #56 or #59 substrate), 420 sheets for car wheels (sent to a vendor with a laser cutter);
- 48" x 100" sheets for sculptures we will be cutting, 100 sheets;
- 48" x 100" lighter substrate, 280 sheets for car sides;
- 48" x 48" sheets lighter substrate, 2500 sheets for the gallery; we found that when we put large sheets on the floor people tended to build giant forts so we cut them down and tried to keep the largest size at 2'x4' in the exhibit
  
- Wheels: we laser cut them from heavier substrate and also contracted a vendor to make them
- Dowels (used primarily in Gravity Racer Activity): ¼" wide dowels cut down to be 6" long each
- Paper: copy paper and cardstock (used primarily in Stomp Rocket Activity)
- Tongue depressors (used primarily in Theater Activity)
- Yarn (used primarily in the Wearable Activity)
- Balls (used primarily in the Ball Run Activity)
- Ball run ramps (used primarily in the Ball Run Activity in 2022)



## Tape

The most commonly used joinery technique was taping. Colored tape offered visitors more choice, creativity, and the option to “decorate” creations. Tape was attached to the table on a large dowel with a C-clamp.

### Things we purchased direct from suppliers:

- Colored Masking Tape

### Things we fabricated:

- Tape Dispenser on Table

**Reflections on tape:** The variety in colors were appreciated, some visitors had fun taking the C-Clamps off the tables which was unintended and posed a hazard that facilitators needed to monitor.

## Tools

### Items we purchased direct from suppliers:

- Medical scissors
- Klever cutters
- Hole punch
- Rulers
- Carpenter pencils
- Tray for tools

### Items we fabricated:

- “Pizza cutters:” a perforation tool with a plastic perforator and handle



# SOURCING AND RESOURCES

We're sharing sponsorship and resource sourcing ideas for developing a Cardboard City exhibition.

## Why your sourcing plan is important

Makerspaces often are intensive both in the material and labor resources needed to create a fun and engaging experience. Creating a plan for sourcing external and internal resources early in project development helps ensure sufficient time to establish relationships and gather materials and tools.

## Identifying External Sources of Support

External support may activate the experience beyond what is possible on your own!

### Where are you getting the cardboard?

Cardboard galleries have two general options — source cardboard through recycling used cardboard or use “clean” cardboard.

*Used/recycled cardboard:* Requires lead time and space to store large amounts of cardboard. Consider what types of donated/used cardboard would be optimal for your visitor experience.

For example, in 2022 at Science Mill in Johnson City, TX, repurposing corrugate and cardboard allowed the museum to reuse much of the corrugate and cardboard that was coming into the museum for prototyping different experiential elements of their cardboard-focused events. Donations can also help. Iowa Children's Museum partnered with a local bank in 2022 to donate cardboard bank boxes for events.

*Clean cardboard or corrugated:* Requires lead time to identify a supplier and space to store ordered materials. These materials are an added expense, for which identifying external sponsors is helpful. In 2021, Science Museum of Minnesota transitioned to “clean” corrugate as the primary material in Cardboard City. Sponsorship from International Paper supported ongoing Cardboard Engineering initiatives alongside in-kind materials donations by the International Paper factories in Minnesota.

*The main message:* No matter how you source corrugate or cardboard in your space, plan on plenty of lead time to plan and organize your materials (see the Materials Management section for more information about the cardboard materials, tape, and tools used in the gallery) as well as managing the life cycles of materials in the space.

### What local partnerships may offer support?

As you plan for a making experience, consider your local ecosystem around making, engineering, design, and more. For example, local universities may have access to speciality tools, such as a laser cutter, for sourcing pre-cut materials.

Here is a more expansive list that you might consider:

- Solicit companies to provide volunteers to help engage visitors with cardboard. You could also ask them to donate to support supplies needed for engaging visitors with hands-on activities.
- Rent out your cardboard exhibition during non-peak or closed hours to groups or companies for employee–family gatherings.
- During outreach events, ask a sponsor for a grant that will support your staff and offer additional value to the community (example: providing meals and take-home materials at events). Volunteers from the company’s affinity groups can participate in events with wayfinding or activity tables.
- Envision what sort of local partnerships you can develop. For example, engineering and architecture firms may have a shared interest.
- Schedule a meeting with sponsors to involve them in how cardboard activities will look and be presented.

## Prioritizing Internal Resources

Maintaining a cardboard gallery requires dedicated space and staff time, and even smaller pop-up events have a footprint to consider. Regular cleaning and resupplying materials is necessary throughout the space.

Internally, consider roles for staff and volunteers. If you don’t have an active volunteer program or resources to supplement additional volunteers, you might solicit companies in your area with a shared interest, such as engineering or architectural firms to support the space or events with volunteers. You may consider training volunteers similar to staff.

Internal resources may also be needed to prepare materials, especially any examples you plan to seed in the space. When applicable, these can create meaningful professional development opportunities and ways for staff to become more deeply connected to the space.