Science Museum of Minnesota®

ACTIVITY GUIDES AND INSPIRATION

SMM's history of cardboard making and straightforward guides to inspire a cardboard exhibition of any size.

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You can access all the Cardboard Collaborative materials at 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.

HOW DID WE GET HERE?

History of Cardboard Making at SMM

Cardboard has inspired SMM staff and visitors to explore, make, and play for many years. Activities on the museum floor, at summer camps, and out in the community have included cardboard as a material and tool to spark STEM learning.

In 2013, we began conversations and work with local families of color to understand the hands-on making they valued and did. Themes of food (cooking and gardening), art, reuse/thrift (sewing/clothing, fixing, low-cost materials), and music were prominent. Cardboard was specifically named by families as a readily available and low-cost material, and the museum decided to pursue cardboard making as one of the activities for further experience development. For detailed documentation of this earlier work, see the Making Connections Practitioner Guide, which complements our current thinking shared in this Cardboard Collaborative Guide.

Through grant-funded (*Making Connections: Exploring Culturally-Relevant Maker Experiences through an Iterative, Cross-Institutional Approach* [DRL-1323584] and *Cardboard: Building More Inclusive Makerspaces to Support Informal Engineering Learning Experiences* [DRL-1906884]) and everyday work, the museum has pursued this interest in cardboard making, working with BIPOC families for more than a decade and across four distinct design iterations.

What Did This Look Like?

In 2015, as part of *Making Connections*, the first “Cardboard Day” was held, when the museum gathered cardboard recycling donations, purchased large amounts of masking tape and scissors, and used an open rental space in the museum for the single-day event. The event was messy, experimental, and exciting. The families who had been working with museum staff were invited in specifically to test the space, along with museum visitors. Even during the single day it was open, we saw visitors who were inspired by other visitors’ creativity , sometimes adding to their creations. This single-day event sparked the potential of a large-scale joint build.

The cardboard makerspace was scaled up to a three-month exhibition-makerspace in 2016, hosted in a special exhibition space and accompanied by expanded tool options. We added benches, tables, and centralized storage for tools. We noticed that visitors were, again, inspired by each other and able to construct bigger builds together than they could do alone. We began to experiment with themes and challenges and watched how visitors responded. We also paid attention to how this space suited staff. The nature of the makerspace — free-flowing creation and construction — breeds mess and disorganization, which presents a unique challenge for staff.

A third iteration, *Cardboard Engineering*, opened in 2018, adding to the 2016 design by including artists-in-residence to demonstrate the potential of cardboard as a maker material and additional graphics at the entrance of the exhibition-makerspace with techniques for cardboard manipulation. We improved our staff training and support. We troubleshooted about how to organize tools and materials so that visitors could all receive access to them and weighed important decisions about how to share and display (and when to recycle) visitor creations.

In the summers of 2021 and 2022, our fourth and fifth iterations of the exhibition-makerspace opened with significant adjustments from the previous designs, supported by the NSF *Cardboard* funding, and responsive to previous challenges in our makerspace designs. A theme, *Cardboard City*, and areas with activity prompts and example creations, were developed to allow families who were less familiar with making to have on-ramps into the space. We presented all text in four languages, better reflecting the language diversity of the Twin Cities, as well as implementing graphical icons for simple instructions. We created workstations equipped with tools and cardboard materials to support family group making. Formal display spaces allowed for short- and long-term display of visitor and staff creations. Community organizations partnered with us to co-host spring family events in the exhibition space, and family research participants recorded video data to help us understand how they use the space.

We've also been experimenting with pop-up cardboard events associated with the exhibition-makerspace. Figuring out how to take a sizable exhibition on the road, how to make the event work in a park or a parking lot, has been a challenge that we continue to wrestle with. In 2022, we partnered with three other museums to share cardboard ideas with them; all of our different needs and dreams helped us all to push the boundaries of what is possible.

Cardboard continues to be compelling to us because of its ubiquity and potential. Most visitors come in with some familiarity with how cardboard behaves. They are inspired by the things others have made, they get ideas from the prompts throughout the space, and we want them to be empowered to make something bigger, or cooler, or more ingenious, than they might do on their own. We also want them to go home and continue to make, and maybe with new ideas inspired by their time at the museum.

We don't feel like we're done with Cardboard: Plans are underway for new exhibition-makerspaces and every time we walk through the exhibition, we see things we want to tinker with. Our inspiration for that tinkering comes from visitors and what we notice them doing. It comes from community partners through formal and informal conversations; it comes from staff, who quickly become experts in the space.

CARDBOARD MAKERSPACE HISTORY

The cardboard makerspace at SMM has involved 4 distinct iterations. Each iteration involved significant refinement, learnings which have been translated into the design principles in this document.

Iterations of SMM's cardboard makerspace, 2015-2021

Iteration	Year	Photograph	Description	Design Points of Note
Cardboard Days	2015		Weekend event with open-ended makerspace and paired table top activities throughout museum	• Room filled with reused/recycled cardboard • Very experimental • Partnership with BIPOC families through Making Connections who were our early testers
Cardboard Gallery	2016		3 month makerspace exhibition emphasizing open-ended making	• Central location for cardboard and tools • Bench seating and a few tables available for making • Extended time allowed for bigger/thematic builds
Cardboard Engineering	2018		3 month makerspace exhibition emphasizing open-ended making	• Exemplar pieces via artist-in-residence • Joinery techniques graphic • Display area for creations
Cardboard City	2021		3 month makerspace exhibition emphasizing making within theme and activity zones	• New/fresh cardboard instead of recycled boxes • Activity prompts presented in zones • Workstations for making • Distributed locations for cardboard and tools

Photographs from Cardboard Iterations

2015 Cardboard Days

2016 Cardboard Gallery

2018 Cardboard Engineering

2021 Cardboard City

BALL RUN

Materials

Workstation:

- Colored masking tape
- Medical scissors
- Klever cutter
- “Pizza cutter” (perforating tool)
- Rulers
- Pencils

Additional materials:

- Large peg board
- Dowels
- Example pieces of ramps (folded flat cardboard), or pre-cut cardboard half cylinders
- Clothespins
- Balls

Prompts We Used

Some city dwellers use the public transit system to move around. Develop a fun route that moves them safely from top to bottom. Work with others to make the route longer or more complex.

Design a route that works

- Make a plan.
- Build your route.
- Test your route.
- Make improvements and try again.

Make and attach ramps

- Place the ramp template in the middle of your cardboard piece.
- Use the cutting wheel to score each side for easy folding.
- Attach two dowels to the wall to hold your ramp.
- Place the ramp on top of the dowels.
- Use clothespins to create a snug fit against the pegboard.

FACILITATOR NOTE:
While we have some suggested materials in this guide, creativity is encouraged. Facilitators and visitors should be encouraged to use any resources available across the different activities in the space.

Activity Prompts

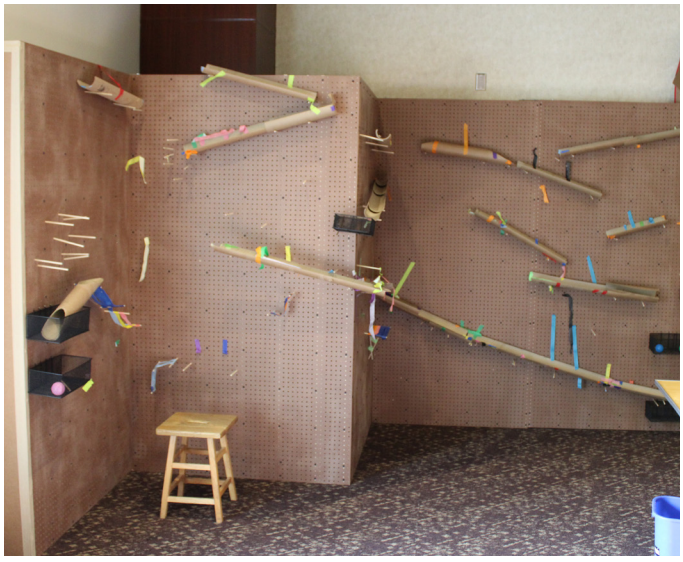
The Ball Run offered a range of activity prompts. Visitors might take on a creative construction mode of making to attach ramps using pre-fabricated pieces or examples left behind.

They might also tinker to build their own ramps, route, and improvements on their designs.

Examples

We found that examples were helpful for engaging visitors. When staff or visitors left their ramps attached to the peg board, other visitors could come up and run a ball down the ramp as an entry point into the activity.

It made it more clear that making new routes and testing them was an activity available in the space.



CARDBOARD CITYSCAPES

Materials

Workstation:

- Colored masking tape
- Medical scissors
- Klever cutter
- “Pizza cutter” (perforating tool)
- Rulers
- Pencils

Additional Materials:

- Negatives of laser-cut wheels
- Irregular cardboard pieces

Prompts We Used

Creating a homey, welcoming city
What makes a community a good place to call home? Is it houses, apartments, shops, and schools, or something else? Build your idea and add it to the growing city.

Building an equitable, accessible city
How can communities provide positive spaces for those who call it home?

Making a lively, friendly city
A city needs places where everyone can go for fun and enjoyable experiences. Make a park, a pool, a shop, or other fun place. Build your idea and add it to the growing city.

Create a structure that can fit in the palms of your hands.

What kind of building would you want next to your school, home, etc.?

FACILITATOR NOTE:
When facilitating the space, we found that supplying 2’ x 4’ flat cardboard worked best. Irregular pieces add creativity and present new affordances for visitors.

Contribute to Something Larger

The growing cityscape highlights the Contribute to Something Larger Design Principle – visitors have the option to leave their creation behind to contribute to the city!

GRAVITY RACER

Materials

Workstation:

- Colored masking tape
- Medical scissors
- Klever cutter
- “Pizza cutter” (perforating tool)
- Rulers
- Pencils

Additional Materials:

- Cardboard wheels
- Bee tubes for axles
- Cardboard axle ends
- Racer body templates
- Ramp with different surfaces

Prompts We Used

Gravity Racer - build for speed
This city is known for rough roads and steep slopes. Build a vehicle that can safely reach the bottom on any road condition.

Vehicles big and small
What different vehicles do you see in your community? Each one has a purpose. What does your vehicle do?

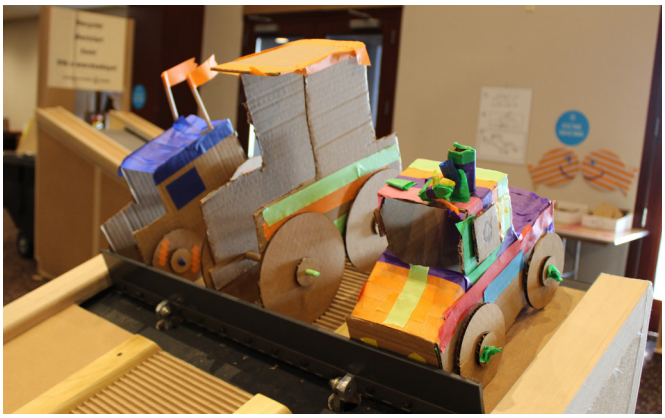
Mechanics needed!
Our garage has many vehicles that need a bit of work. Test one at the ramp to see what can be fixed.

Garage racers
Try out what has already been made. What did others do to make sure their racer made it down the ramp?

FACILITATOR NOTE:
We found that templates and directions helped visitors get started without hindering creativity. We saw turtle cars, boats, and even a cookie cart all from the same directions!

Icon Based Instructions

Gravity Racer was the most used activity in the space! We provided icon-based instructions (see next page). We saw visitors make many creative vehicles. Multiple access points (through instructions and play with example cars left behind) allowed families to participate with less barriers.



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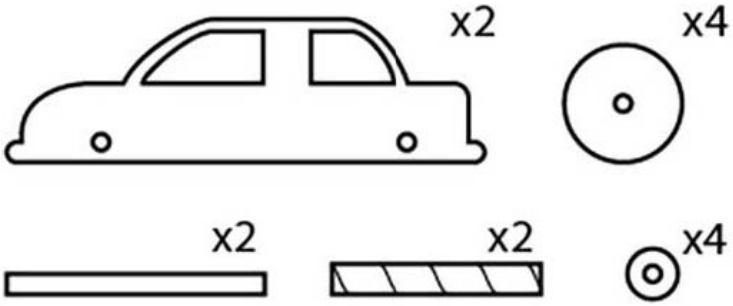

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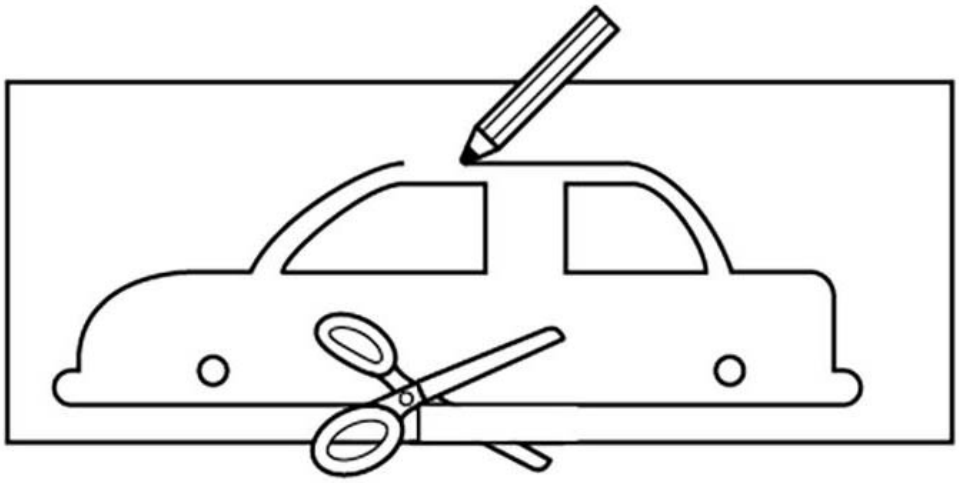

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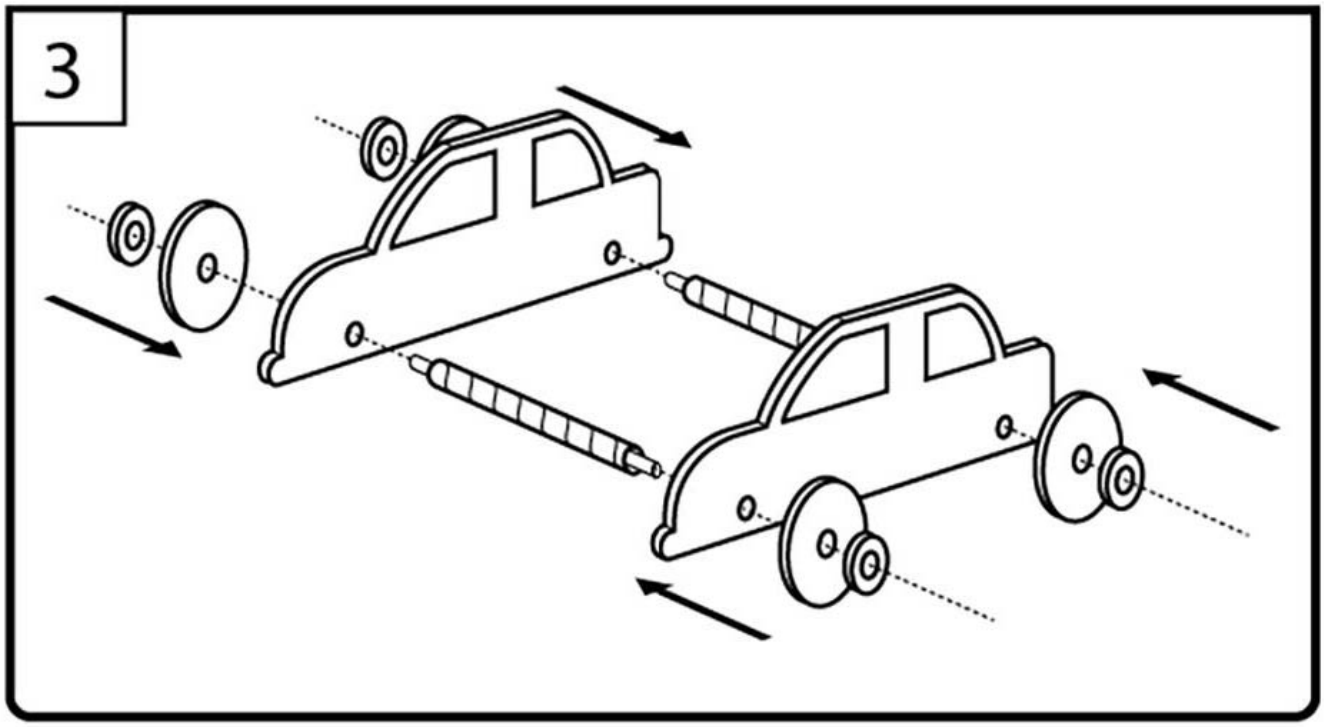

SHADOW PUPPET THEATER

Materials

Workstation:

- Colored masking tape
- Medical scissors
- Klever cutter
- “Pizza cutter” (perforating tool)
- Rulers
- Pencils

Additional Materials:

- Craft sticks
- Wooden skewers
- Light source
- Puppet stage with spaces for craft sticks and skewers

Examples

Example pieces — both those created by the museum and left by other visitors — let families start by playing with the shadow theater before deciding what new puppet to make.

Contribute to Something Larger

Many visitors used their own puppets and example pieces to create a story or “movie” with the shadow theater. Putting a creation into use is one way of contributing to something larger.

Prompts We Used

And then what happened?

You and your friends are strolling through the city when all of a sudden . . .
Who lives in this city? What happens here?
Create shadow puppets to help you share your story.

Make your city story

You and your family just moved into the city. One of the first things you notice is . . .
Create shadow puppets and share a story about life in the city.

Share a favorite story

Do you have a favorite bedtime story or fairy tale?
Make puppets to help you tell your story.

FACILITATOR NOTE:
Example pieces left at the theater ranged from laser cut fabricated pieces to a variety of visitor made creations. Visitors can make narrative play out of these pieces at the theater in addition to their own creation.

WEARABLES

Materials

Workstation:

- Colored masking tape
- medical scissors
- klever cutter
- “pizza cutter” (perforating tool)
- rulers
- pencils

Additional Materials:

- Yarn
- Shoe stays
- Mannequin bodies and heads
- Mirror for “catwalk”

Prompts We Used

Create something to wear, a tool to use, or a game to play. First imagine it, try drawing it, then make it!

Shoes for getting around

Design a functional yet stylish pair of shoes to wear in Cardboard City. Try them on. How do they fit? Check them out in the mirror. How do they look?

A hat that fits your mood

Make a hat for a special occasion or just for fun. Try it on and model it on the runway. How does it look? How does it fit? Does it stay on your head if you jump up and down?

FACILITATOR NOTE:
Making and wearing your own design is a great conversation starter and way to encourage others in the space!

Workstations

The workstations in the wearables section included additional items such as mannequin forms and a mirror for visitors to shape and test out their creations.

Examples

Staff made some amazing wearables to showcase on mannequins. They also made wearable creations like the airplane garment below that stayed in the space and was very popular!

STOMP ROCKET

Materials

Workstation:

- Colored masking tape
- medical scissors
- klever cutter
- “pizza cutter” (perforating tool)
- rulers
- pencils

Additional Materials:

- Variety of paper and cardstock
- Dowels to roll rocket body
- Stomp Rocket Launcher

Prompts Prompts We Used

Building a rocket

Rocket Body

- Roll a piece of paper around a dowel or PVC pipe and tape the edge
- Try different materials to find the best rocket body for you

Nose Cone

- Cover one opening of your rocket body
- Use to tape to secure it
- Check out different ways to make a nose cone

Fins

- Add fins to the open side of the rocket body
- How many fins?
- What shape or size fins?

Test out your rocket!

How far did it go?
Any changes you want to make?

Challenges:

Can you make your rocket:

- Go further than the last test?
- Change directions?
- Hit a target?

FACILITATOR NOTES:
Stomp rockets can introduce additional safety concerns. Use cones to block off the ‘launch zone’ if you can. Check for safety often, and use ‘cleared for takeoff’ to let visitors know when it’s safe to launch. Plastic rockets (purchased) or example rockets can be useful for engaging visitors that don’t want to build their own.

Rich Materials

We intentionally included a wider variety of materials — including paper and cardstock — because those materials afford rounded shapes easily compared to cardboard

Icon Based Instructions

Icon-based instructions walked visitors through creating specific shapes including the tubular body and cone-shaped nose for the rocket.

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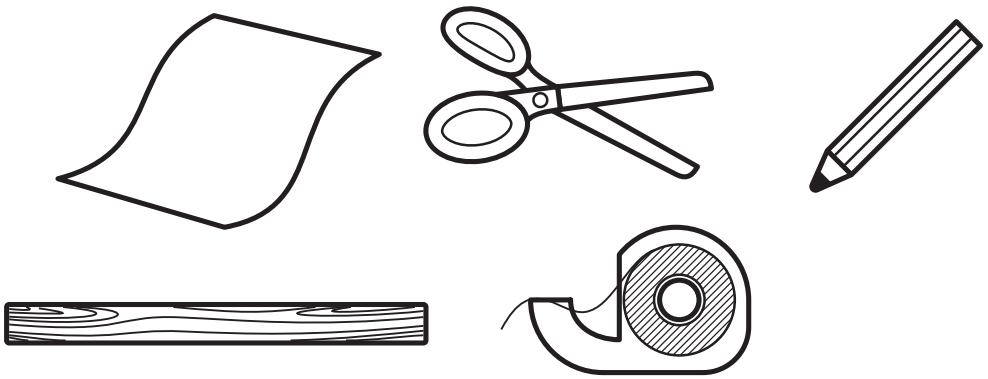

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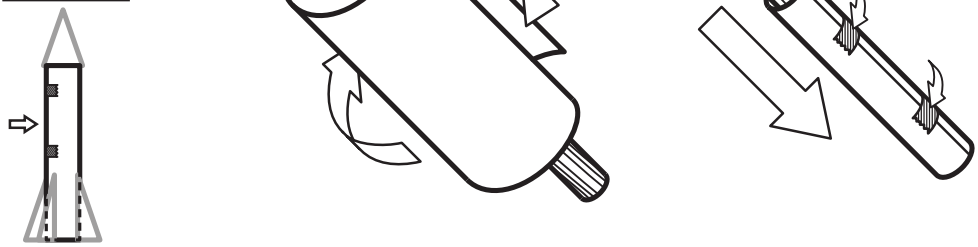

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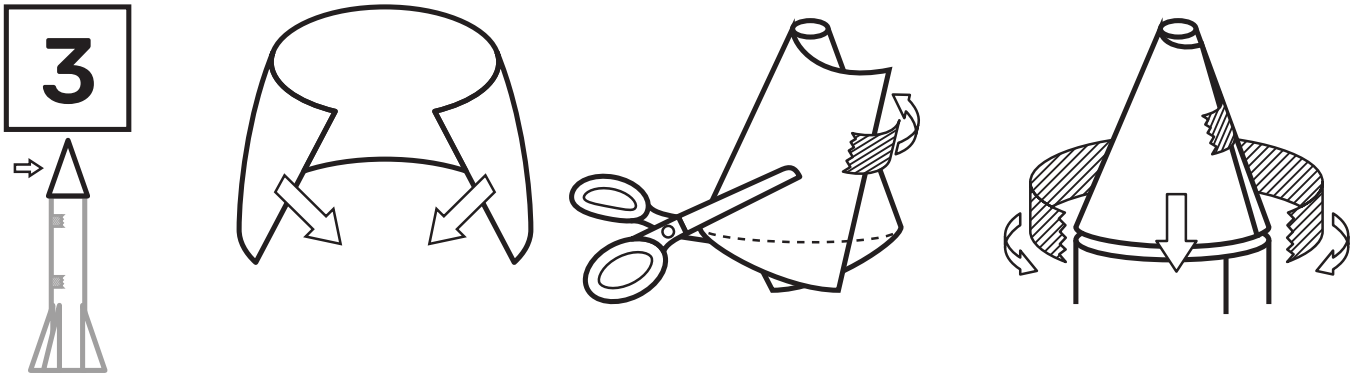

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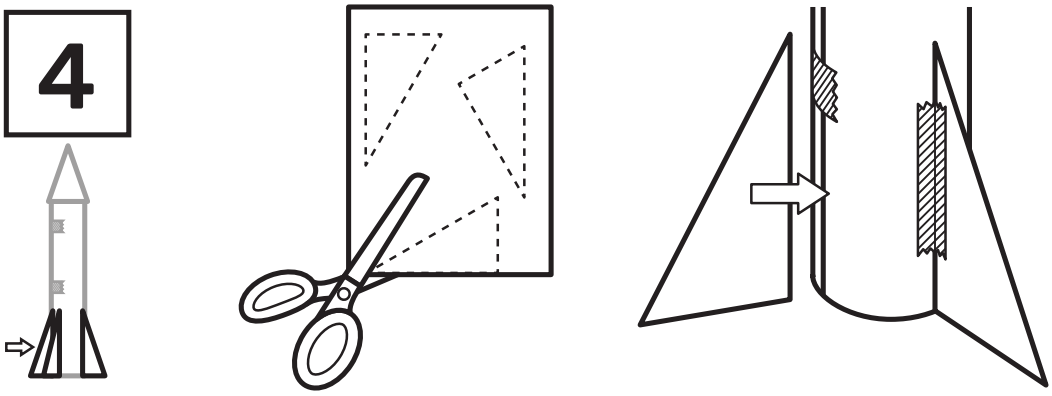

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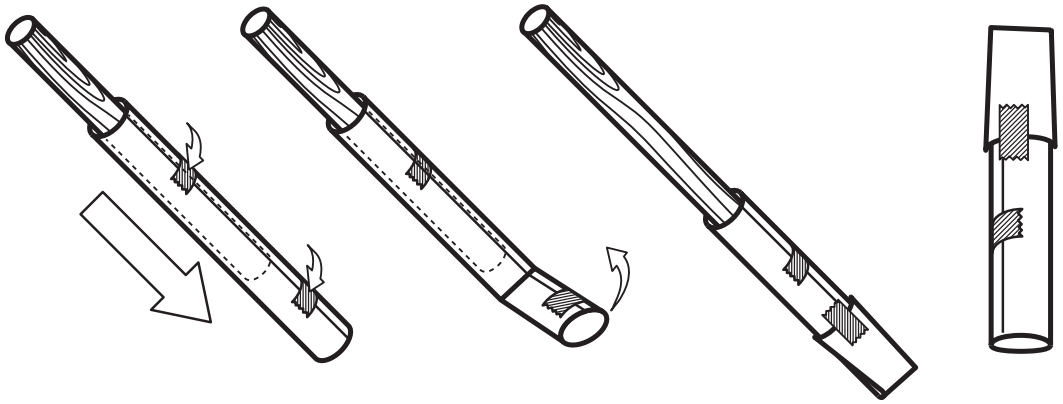

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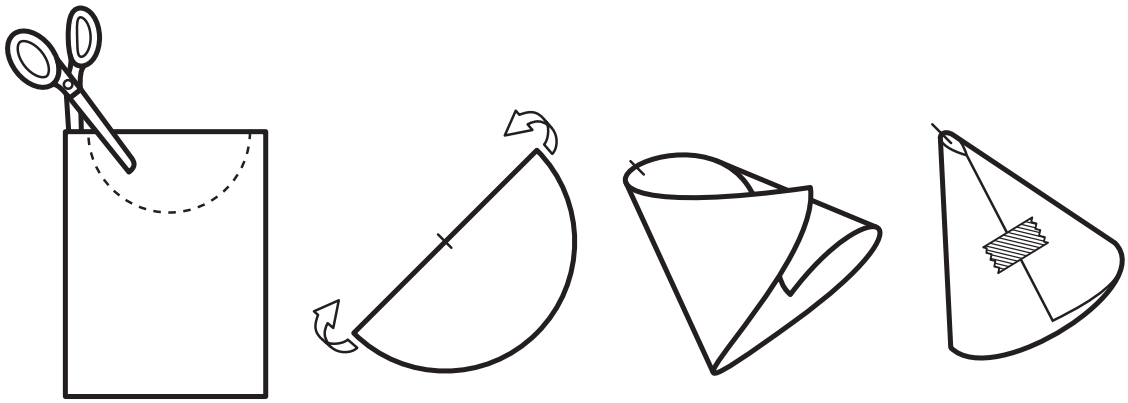

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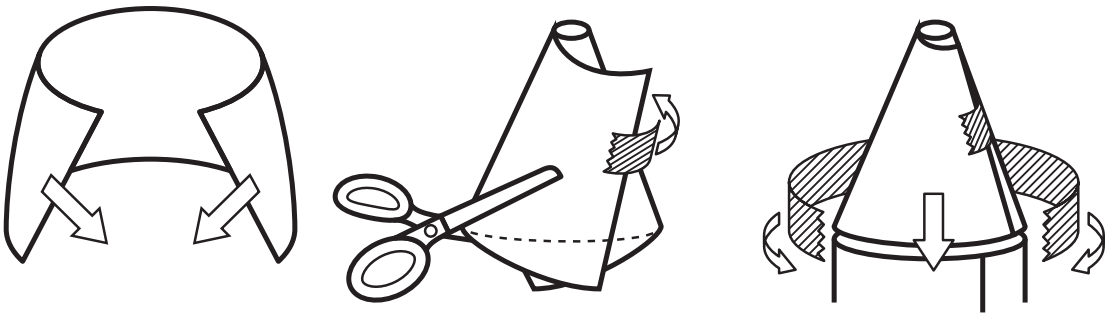


INSPIRATION FROM OUR PARTNERS

Partnerships in Learning

After learning about making with our community partners and exhibition, we sought out museum partners to share our knowledge and learn from them. Our partners came from different regions, audiences, communities, and missions. Each partner identified topics of interest, challenges they were having, and goals for our time as a group. We met with each group separately in up to 10 meetings in April 2022, sent sample workstations their way, and a $5000 stipend to use to support making at their museum. Since the initial meetings, we have met to learn what they found valuable from our time together and to support their making endeavors.

Science Mill

Johnson City, TX | 16 Full Time Employees | Focus on STEM Careers in Rural Texas

Challenges: No municipal recycling

- Monthly making
  - Since Memorial Day 2022, Science Mill has facilitated monthly making activities on the floor. May's was focused on cardboard while June's focused on circuitry (with cardboard components). Each month has shifted themes encouraging STEM Careers.
- Pucks and sustainability
  - The Science Mill created Pucks, a cardboard connector, with their cardboard waste and a laser cutter. The Pucks are extremely flexible and adaptable to building needs. They have also been excellent tools of communication and team building. The Pucks have helped the Science Mill repurpose most of their cardboard waste into useful materials
- Rural Reach
  - The Science Mill reaches Western Texas by sending STEM content their way and training educators. They have added making and cardboard programming, as well as sent Pucks, across the state!
- Infused across the museum
  - Cardboard has become part of the Science Mill. They invested in a laser cutter and have been using it to create signage, name badges, and so much more.
  - When large groups are scheduled, floor facilitators plan additional making activities because of the low facilitation and high engagement

The Science Mill infused making into their daily practices and revolutionized recycling in their spaces!

Lewisburg Children's Museum

Lewisburg, PA | 3 Full-Time Employees | Audience: <8 year olds and their families

Challenge: Getting adults engaged in open-ending making

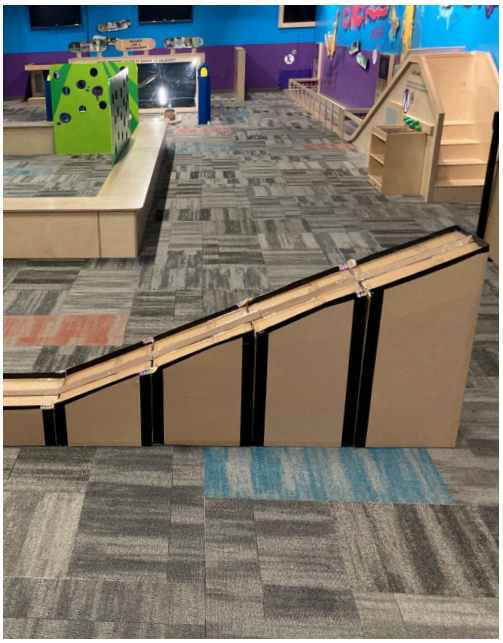
- MacGyver Camp
  - Lewisburg Children's Museum utilized the Making Design Principles to create a week-long making camp with daily challenges.
- Exhibition Space — Loose Parts
  - Their open-ended making space was not frequented by families and adults often and the team didn't know what to do.
  - LCM had plans to implement monthly themes and featured assembly-style activities to create starting points for folks who didn't identify as makers.

Makerspaces need people to restock, clean up, and sometimes facilitate. Implementing a makerspace requires staff buy in across the institution.

Iowa Children's Museum

Coralville, IA | 14 Full Time Employees | Audience: <10 year olds and their families

Challenge: Increase making in outreach



- Partnerships
  - The Iowa Children's Museum utilized their current partnerships to expand their making. They added making to their monthly activities with their local libraries.
  - Their current exhibit shop does not have a laser printer; they partnered with their local university to create cardboard pieces for assembly-style making.
- Adding to current events
  - Every month, the Iowa Children's Museum opens their doors for Family Free Night. Each month has a different theme and that is activated throughout the museum spaces. ICM utilized a cardboard theme for their Family Free Night in May 2022.
  - Move it, Dig it, Do it is the largest family event for the Iowa Children's Museum. It is a "truck zoo" where children can come see and sit in large vehicles and explore the careers associated with them. This year, they added the assembly-style car-building activity and had a foldable ramp for testing the cars. They were able to iterate off of our exhibit's model.

With an already established making program, ICM expanded offerings and extended partnerships!