DESIGN SQUAD™

EVENT GUIDE

SPARK KIDS' INTEREST IN ENGINEERING

DESIGN SQUAD: INSPIRING A NEW GENERATION OF ENGINEERS

Resources to help you host your event:

- 5 engineering challenges
- A planning checklist
- Tips for working with kids and volunteers

PBS®

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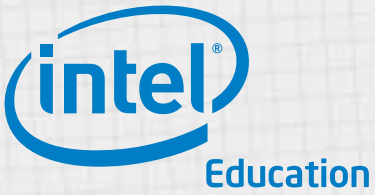

Dear Engineers and Educators,

Intel welcomes you to the new reality-based PBS series, *Design Squad*™! Our sponsorship is the newest component of our Intel® Education Initiative, committed to 21st-century teaching and learning through the effective use of technology and excellence in mathematics, science, and engineering.

Design Squad's substantive focus on math, science, and the design process sparks children's curiosity about the world and hones their problem-solving skills. By showcasing engaging, real-life applications of engineering, we believe that *Design Squad* will increase students' interest in the subject. Engineering will be presented as the creative career we know it to be, enabling young viewers and participants to turn science into reality.

We encourage you to use the *Design Squad* Event Guide—in concert with the television series and the Web-based outreach components—to help children investigate and solve challenging problems. The goal is to pique the next generation's interest in engineering as a career, and in science and mathematics as the fascinating means to intriguing ends. The ripple effect you create will change lives.

Sincerely,

Brenda B. Musilli

Brenda Musilli
President, Intel Foundation

Cover photo: Webb Chappell

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INTRODUCING... DESIGN SQUAD!

Getting kids excited about engineering is easy when you have the right ingredients, and *Design Squad* definitely does. *Design Squad* is more than a television show—it's engineers, families, and youth-serving organizations working together to use the show, the educational materials, and the Web site to connect kids to engineering. With the help of real-life engineers (that's you), *Design Squad* can reach kids everywhere through events and workshops that offer hands-on engineering challenges inspired by the show. Just read on and find out how you can get involved. We'll help you every step of the way.

Photo: Webb Chappell

Design Squad, a new PBS television show, gets *real* kids thinking like *real* engineers.

WELCOME TO DESIGN SQUAD™

Besides being highly entertaining television, *Design Squad* shows kids that engineering is fun, creative, and exciting. The show presents engineering concepts and methods in an accessible way that encourages kids to be innovative and think like engineers.

Photo: Mika Tomczak

DESIGN SQUAD: THE SERIES

Design Squad features two teams of high school kids who use their problem-solving skills to design, construct, and test engineering projects, such as a machine that automatically makes pancakes. In the show, each contestant earns points for successfully solving engineering challenges. After completing 13 challenges, the contestant with the most points wins a college scholarship provided by the Intel Foundation.

DESIGN SQUAD: THE WEB SITE

The *Design Squad* Web site offers behind-the-scenes information, games, descriptions of the show's engineering challenges and solutions, plus an e-Zine that highlights the role of engineers in society. The Web site also offers downloadable resources for your events such as video clips and printable signs. Visit the *Design Squad* Web site at pbskidsgo.org/designsquad/engineers.

DESIGN SQUAD: THE OUTREACH CAMPAIGN

Through events, trainings, and educational activity guides, the *Design Squad* outreach campaign goes beyond the television show into the community. Partnering with engineers and informal educators across the nation, we deliver activities to places where kids, ages 9–13, can be found: in afterschool programs, schools, museums, even your local mall.

DESIGN SQUAD: THE OUTREACH PARTNERS

Design Squad is building a community committed to fostering a positive image of engineering. When this guide was printed, *Design Squad* had partnered with:

Engineering Organizations

- American Society of Civil Engineers
- American Society of Mechanical Engineers
- IEEE
- Intel
- National Academy of Engineering
- National Engineers Week Foundation
- National Council of Examiners for Engineering and Surveying
- Society of Manufacturing Engineers
- Society of Women Engineers
- Tyco Electronics

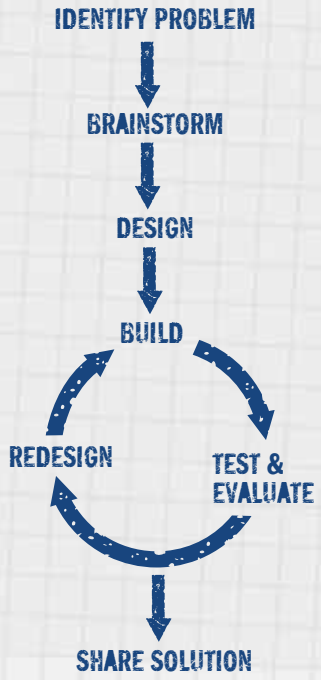
Informal Education Organizations

- 4–H
- Boys & Girls Clubs of America
- Girl Scouts of the USA
- Museum of Science, Boston
- National Afterschool Association
- Tufts University
- YMCA of the USA

THE DESIGN PROCESS

Every aspect of *Design Squad*—the television show, the Web site, and the outreach campaign—reinforces the design process, which is central to engineering.

Use the design process to encourage kids to expand their thinking, become more innovative, and learn from their mistakes. Since you can approach almost any challenge using the steps of the design process, share this with the kids at your events and workshops.



JOIN US!

For a current list of partners, and to join this growing community, visit the *Design Squad* Web site at pbskidsgo.org/designsquad/engineers.

DON'T FORGET

to display the design process sign at your event so kids will learn all about it. Download it at pbskidsgo.org/designsquad/engineers.

ENGINEERING IN ACTION

Want to share your own excitement about engineering to inspire a new generation of engineers? Here's how you can use *Design Squad*™ in your community.

STAY CONNECTED!

Sign up for the *Design Squad* e-newsletter for updates on the show, Web site, nationwide events and trainings, and resources. Send your name, organization, and e-mail address to designsquad_feedback@wgbh.org.

BE A VOLUNTEER

Don't have time to plan your own event? Volunteer at one of our regional *Design Squad* events. Contact *Design Squad's* Outreach Coordinator at designsquad_feedback@wgbh.org to learn more.

Photo: Lauren Feinberg

ATTEND A DESIGN SQUAD TRAINING SESSION

We're hosting a series of nationwide trainings for engineers and informal educators on how to connect kids to engineering. Whether you're inspired or intimidated by the idea of gathering a crowd together to try out engineering challenges, a training will help you understand how to organize an event or workshop, find volunteers, work directly with kids, and train others. To learn more, contact *Design Squad's* Outreach Coordinator at designsquad_feedback@wgbh.org.

HOST AN EVENT

Spark kids' interest and confidence in engineering with a lively, fun-filled event. Whether your event is for lots of kids or just a few, this guide provides you with tips, reproducible handouts, and an evaluation form that will help you plan and organize your event from beginning to end. You'll find additional resources such as signs, the *Design Squad* Educator's Guide, and Challenge Sheets in English and Spanish on the *Design Squad* Web site at pbskidsgo.org/designsquad/engineers.

Photo: Webb Chappell

Meet the hosts of *Design Squad*. Nate Ball is an MIT mechanical engineer grad student, entrepreneur, and pole vaulter. Deanne Bell is a mechanical engineer who travels the globe when not designing aerospace gadgets. Like them, you can have fun hosting events with engineering challenges for kids.

VISIT SCHOOLS OR AFTERSCHOOL PROGRAMS

Bring engineering to small groups of kids by visiting classrooms or afterschool programs. Try doing the challenges in this guide, tell kids how you became interested in engineering, answer their questions, and encourage them to try more engineering challenges in the future. You can use the Challenge Sheets in this guide or for even more ideas, check out the *Design Squad* Educator's Guide, available at pbskidsgo.org/designsquad/engineers.

Photo: Margot Sigur

SPREAD THE WORD

Help us get more people involved in *Design Squad*.

- **Publish** an article about your successful *Design Squad* event or workshop in your organization's print and electronic publications. It will bring recognition to your program and may inspire others to try an event or workshop. For additional press materials, images, and other media opportunities, contact *Design Squad*'s National Publicist at design_squad@wgbh.org.
- **Link** your Web site to the *Design Squad* Web site at pbskidsgo.org/designsquad/engineers.
- **Share** how rewarding it is to get kids excited about engineering. Motivate your colleagues to get involved by telling stories about working with the kids and about the fun of doing the challenges with them.

DESIGN SQUAD EDUCATOR'S GUIDE

A great thing about 9- to 13-year-olds is their curiosity and interest in doing hands-on projects. The *Design Squad* Educator's Guide, geared to afterschool programs, provides four multi-session engineering challenges that you can use with fifth to eighth graders over a 10-week period. Each challenge takes two to three meetings to complete and includes leader notes, science and engineering background, and group management strategies. Download the *Design Squad* Educator's Guide at pbskidsgo.org/designsquad/engineers (available January 2007).

DESIGNING YOUR EVENT

You can host a *Design Squad*™ event just about anywhere. All you need is a large room, some tables, and a whole lot of low-cost materials. Science and children's museums, malls, professional conferences and meetings, afterschool programs, schools, libraries, and youth and recreation centers are all excellent locations. The following resources will help you visualize your event and make it a success.

MORE RESOURCES ARE ON THE WEB!

Visit pbskidsgo.org/designsquad/engineers to download:

- **SIGNS:** Tabletop signs for the Welcome Table, Challenge Stations, Video Station, and Testing Zones. A sign that displays the design process is also available.
- **VIDEOS:** A clip introducing the show, short profiles of real engineers, and animations that clearly demonstrate engineering principles.
- **CHALLENGE SHEETS:** Available online in English and Spanish.
- ***DESIGN SQUAD* LOGO TRANSFERS:** Iron these onto T-shirts for volunteers. Don't forget to wear one yourself!

WELCOME TABLE

Set up a Welcome Table. It's a great way to greet participants and distribute giveaways. It also gives you a place to display the Welcome Sign that you must use at all events. The sign credits our funders and without them none of this would be possible. In addition to the Welcome Sign, stock the table with colorful piles of giveaways, including:

- Information about your organization or association.
- Handouts describing upcoming events.
- Giveaway bags for storing Challenge Sheets, pencils, and the participants' engineering creations. If possible, fill the bags with small engineering-related giveaways. Visit eweek.org to order inexpensive giveaways or ask your partners to donate them.
- Event Evaluation Forms (see page 14)

CHALLENGE STATIONS

There are five hands-on engineering challenges provided in this guide: Rubber Band Car, Kinetic Sculpture, Pop Fly, Hidden Alarm, and Four Corners. Invite kids (and the adults who came with them) to try out *Design Squad* challenges at the Challenge Stations. Each Challenge Station should offer a different activity and include everything needed to complete the challenge. Offering 3 to 5 different challenges will provide variety, assist with audience flow, and give participants experience with many engineering concepts. (See the Event Checklist on page 8 for more information on setting up your stations.) Staff each station with volunteer engineers who can help participants work on the challenges. Now let the engineering fun begin!

Challenge Sheets provide instructions for each engineering challenge, plus background information.

VIDEO STATION

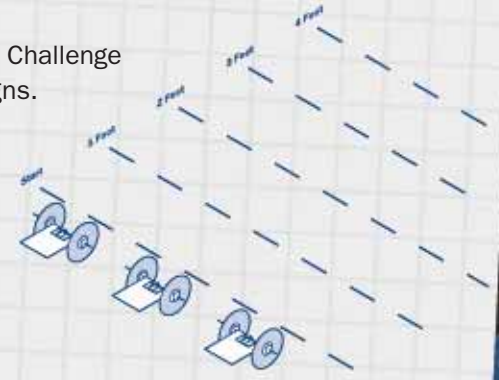
Show video clips of real engineers from *Design Squad* episodes by setting up a computer or video monitor in a place where participants can watch. These clips will dispel the "I can't do that" stereotype and replace it with "That's engineering? I *want* to do that." Be sure to staff the station with engineers, so they can talk about their own work and answer questions.

Visit pbskidsgo.org/designsquad/engineers to download the *Design Squad* video profiles of engineers.

TESTING ZONES

Create a space where participants can test their results—how far their rubber band car travels, how well their sculpture holds up in the wind, or how high their Ping-Pong ball flies. Staff the Testing Zones with one or two volunteers. They can encourage kids to test their creations to see what works and what doesn't. Volunteers can also direct kids back to the Challenge Stations to modify their designs until they get the results they want. A major part of the design process is finding out how solutions work in the real world.

- Set up the Testing Zone near the corresponding Challenge Station.
- Mark the area with a colorful Testing Zone sign (available at pbskidsgo.org/designsquad/engineers).
- Provide measuring tools. If you're measuring distance, create a start line and mark one-foot increments with tape on the floor.
- Set up a data-recording chart. Use an easel and a large pad of paper to record kids' names (first names only, please) and results.
- Encourage kids to return to the Challenge Stations and modify their designs.



SET THE STAGE

Give your whole event a *Design Squad* look and feel. Hang *Design Squad* signs everywhere. Make sure your volunteers are easily identified in their matching T-shirts. Use the *Design Squad* colors (either gray and purple or gray and red) for your tablecloths.

MAKE T-SHIRTS

You can create your own *Design Squad* T-shirts using an inkjet printer, iron-on transfer paper, and the downloadable logo available at pbskidsgo.org/designsquad/engineers. Pre-made *Design Squad* T-shirts are available for purchase at eweek.org.

EVENT CHECKLIST

The term "event" can mean anything from having a guest speaker visit a classroom to hosting an all-day event for a large crowd. The type of event you choose depends on lots of things, especially your time, budget, and the goals you set for your outreach. The *Design Squad*™ resources support all kinds of events, large or small. The Event Checklist can help you get started.

ENGINEERS WEEK®

You'll definitely want to host an event during Engineers Week (visit eweek.org for more information), but you can schedule an engineering event any time of year.

CONVENE A COMMITTEE

Don't try to do everything yourself—get some help! In addition to helping you organize the event, committee members may be able to offer a venue, volunteers, and/or publicity opportunities. Consider asking representatives from various engineering disciplines and companies, schools and afterschool programs, universities and colleges, and your local public television station and other media partners to volunteer.

IT'S ALL IN THE PLANNING

Here are some questions to address at your first planning meeting:

- ☐ What are your goals for the event?
- ☐ Who is your target audience?
- ☐ What is the ideal number of attendees?
- ☐ What's the best date? (Consider holidays, religious observances, or other conflicting events.)
- ☐ What's your budget? (You'll need to pay for challenge materials, tablecloths, photocopying, T-shirts for volunteers, and refreshments. You may also need to pay for your venue.)
- ☐ Which challenges will you select? Review the Challenge Sheets and select the ones that are right for your event.

LOCATION, LOCATION, LOCATION

Pick a spot that's appealing, convenient, and kid-friendly. When choosing a venue, consider the following:

- ☐ **Number of people** the site can accommodate (be sure the location is accessible to people with disabilities and find out the maximum number of people the venue can safely hold).

- ☐ **Visualize how you will fit** the different stations into the space. When placing tables, materials, and volunteers, think about creating a smooth traffic flow so participants can get to every challenge easily. Don't forget that your Video Station needs to be near an electrical outlet.
- ☐ **Access to tables, chairs, stanchions, sign-holders**, and other furniture or materials: Are they available on site or will they need to be rented? You'll need 3–4 tables for each Challenge Station.
- ☐ **On-site A/V equipment** and technical support: Who provides it?

SPREAD THE NEWS

Make sure people know about your event well in advance.

- ☐ **Send out a press release** to promote the event through your media partners on air, in print, and online.
- ☐ **Put calendar listings** in daily and weekly newspapers (both print and online versions).
- ☐ **Spread the word** through your committee members' newsletters, listservs, blogs, etc.
- ☐ **Create flyers** to post in schools, libraries, science and children's museums, youth organizations (Boys & Girls Clubs, YMCAs, arts programs), coffee shops, and local businesses.

ON YOUR MARK: BEFORE THE EVENT

Here are some tips for setting up your Challenge Stations.

- ☐ **Collect materials ahead of time** for the challenges and the testing. (Each *Design Squad* Challenge Sheet provides a list of materials needed per participant. Multiply by the number of participants you expect and then add a few more.) Most supplies can be found at grocery, office supply, hardware, electronics, and craft stores or at the websites provided in the materials list on page 12.
- ☐ **Purchase colorful tablecloths and balloons.** Use gray and purple or gray and red to match the *Design Squad* colors.
- ☐ **Download and print *Design Squad* signs** on a color printer and mount them on foam core or put them in plastic frames to display at the event.
- ☐ **Create directional signs** so people can find the event easily.
- ☐ **Photocopy the Challenge Sheets** on colorful paper. Make sure you have enough copies of each Challenge Sheet for every participant. Spanish versions are available online.


PREPARE YOUR MATERIALS

GET READY FOR YOUR EVENT!

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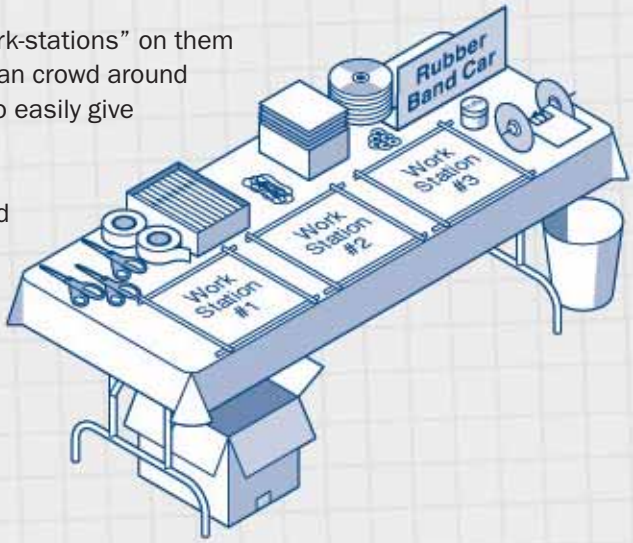
IMPORTANT!

Before you set up your event, read **Prepare Your Materials** on page 12.

GET SET: DURING THE EVENT

- ☐ **Have volunteers make samples** for their Challenge Station. The samples will serve as models for the kids to use when they try the challenge.
- ☐ **Ask volunteers to stand inside a U-shaped configuration of tables** at their Challenge Station so they can easily interact with participants and restock supplies. Be sure to provide chairs or stools for the volunteers.
- ☐ **Cover tables with colorful tablecloths** and make individual "work-stations" on them with masking tape. This limits the number of participants who can crowd around a table at one time. The "work-stations" also allow volunteers to easily give instructions to a small group.
- ☐ **Put a trash container at each Challenge Station.**
- ☐ **Put the *Design Squad* tabletop signs at each station.** Download them from pbskidsgo.org/designsquad/engineers**.**
- ☐ **Set the Challenge Sheets on the table** in a basket or box, so kids can take one home and continue experimenting.
- ☐ **Put materials in containers** (i.e., all the rubber bands in one container, all the Ping-Pong balls in another) to keep them organized and easy to use.
- ☐ **Store extra materials under the table**, so they will be readily available but not in the way.
- ☐ **Help people navigate** within the venue with directional signs. Don't forget to point out where the bathrooms, water fountains, and other essentials are.



HOW DID IT GO?

It's always useful to know what worked and what didn't. Make copies of the Event Evaluation Form (see p. 14) and put them on the Welcome Table. Place a volunteer at the exit to thank participants and collect evaluation forms from them as they leave. If a participant forgets to return the form, ask the volunteer to encourage them to do so. After the event, read the evaluations carefully so your next event can be even better. It would help us to have copies of the evaluation forms you receive. Please fax them to the *Design Squad* Outreach Coordinator at 617-300-1040 or send them to *Design Squad* Outreach, WGBH, 125 Western Avenue, Boston, MA 02134.

WORKING WITH VOLUNTEERS

One of your most valuable resources is your volunteers. Here are some helpful hints on how to find and coordinate them.

SIX TO EIGHT WEEKS BEFORE THE EVENT

Recruit engineers as volunteers. You might be surprised at how excited kids are to meet real engineers and how willing engineers are to participate. Ask people from engineering firms, societies, organizations, or local universities to volunteer. Let them know this is a chance for them to have fun and tell kids what a rewarding and interesting career engineering is.

Ask high school and college kids to volunteer. Contact the community service programs at local high schools and colleges to see if students would like to volunteer.

Staffing the stations.

- Assign two volunteers to each Challenge Station. Have some extra volunteers on hand to fill in for volunteers who can't make it to the event at the last minute.
- Assign one or two volunteers to each Testing Zone. These volunteers can help participants test out and modify their engineering creations.
- Ask additional volunteers to welcome guests, explain the day's events, answer questions, and be on hand as "floaters" to cover Challenge Stations during assigned breaks and lunch time.

Make T-shirts. T-shirts are a great way to identify the volunteers. Download the *Design Squad* logo and transfer instructions from pbskidsgo.org/designsquad/engineers or purchase pre-made *Design Squad* T-shirts at eweek.org.

Order materials. Schedule time to prepare the materials for each of the challenges (see p. 12). You may want to use volunteers to help.

ONE WEEK BEFORE YOUR EVENT: HOST A TWO-HOUR TRAINING

Make copies and distribute the handout "Working with Kids" (see page 13).

Create and distribute an event schedule, complete with volunteers' assignments, break times, mealtimes and your contact information in case of emergency.

Explain the goals of the event, then have volunteers try the challenges. Once they've had a chance to experience the challenges themselves, discuss ways to do them with kids.

ON THE BIG DAY

Schedule a **day-of-event orientation** at least one hour before your event begins. Give volunteers an overview of the day, provide schedules, and review bathroom locations, emergency exits, and other venue-specific information. Show volunteers where each Challenge Station is set up and wish them luck!

- Distribute nametags and T-shirts.
- At the end of the day, gather your volunteers to say thank you and give them individual certificates of appreciation. (You can download these at pbskidsgo.org/designsquad/engineers.)

PREPARE YOUR MATERIALS

To make your event run smoothly, collect and prepare materials for the challenges ahead of time. The following is a list of online sources that can save you time and money when buying materials. Most supplies can also be found at grocery, office supply, hardware, electronics, and craft stores.

Bamboo skewers
We like: Good Cook brand (1/8" diameter)
Netgrocer.com
Item #07675324451
$1.29 for 100

Buzzers
We like: two-wire lead buzzers
APC International
570-726-6961
Item #KPI-2210L
$1.00 each, minimum order of 50 (reference code *WGBH SQ2124200* with order)

For a louder buzzer:
Radioshack.com
Item #273-053
$3.29 each

Chipboard
We like: 11 x 17"
Uline.com
Item #S-8293
$49 per case (375 Sheets)

Compact discs
Collect used CDs and DVDs or order new
thetechgeek.com
Item #01-VDPD801-100
$15 for 100

Corrugated cardboard
We like: 11 x 17"
Uline.com
Item #S-3585
28¢ per piece

Faucet washers
We like: ¼" L flat or beveled
Doityourself.com
Item #4001095
$1.19 for card of 10

Metal washers
We like: Zinc-plated Cut or Fender washers
Offer a variety of sizes
Approx. 5–10¢ each at hardware store

Ping-Pong balls
Nationaltabletennis.com
Martin Kilpatrick brand
144 One Star balls
$36 for 144

Poster or mounting putty
We like: Duck Brand
Officemax.com
Item #07014884
$1.49 for 2 ounces

Hookup wire
We like: stranded, 22-gauge
Radioshack.com
Item #278-1224
$5.99 for 75 feet

Wooden spools
We like: hourglass shape
1 3/8" diameter x
1 15/16" long x 5/16" hole
Woodcrafter.com
Item #NS28
$1.80 for package of 10

If you are buying small quantities, try these types of stores:
Electronics: wire, buzzers, compact discs
Hardware: faucet washers, metal washers, paint stirrers
Craft: wooden spools
Grocery: bamboo skewers
Office: corrugated cardboard, chipboard, poster putty

Please note: Although these sites were verified at the time of publication, Web site addresses and content are frequently subject to change.

GET READY FOR YOUR EVENT!

Rubber Band Car	• Cut all of the cardboard pieces with a paper cutter before the event. • Make sure the cardboard's corrugation is parallel to the short side of the car body.
Kinetic Sculpture	• Cut strips of cardboard, colored paper, and fabric.
Pop Fly	• Ask your local hardware store if they are willing to donate a large number of paint stirrers.
Hidden Alarm	• Strip the electrical wire before the event. (Use a wire stripper or scissors.) • Cut wire into 6-inch, 1-foot, and 2-foot lengths.
Four Corners	• Cut all of the cardboard pieces with a paper cutter before the event. The cardboard's corrugation should be parallel to the short side of each piece. • Put cardboard into bins labeled "tracks," "paddles," and "handles." • Set up easel with chart paper to record kids ideas.

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WORKING WITH KIDS

DESIGN SQUAD

While kids are doing the challenges, take the opportunity to talk with them about engineering. Tell them your favorite thing about being an engineer. Is it working with people? Is it seeing your ideas and creations come to life? If you share this with kids, you'll give them a whole new perspective on engineering.

Make the most of your *Design Squad* experience.

Try every challenge yourself before doing it with kids. This will help you respond to kids' questions and anticipate where they might need help.

Be friendly and patient. People of all ages may feel shy about joining in the challenge. Smile and encourage them to take part.

Let kids explore freely as they investigate. They will come up with lots of interesting solutions and learn from their mistakes.

Enlist the help of the adult who came with the children. Ask them to read instructions and help younger kids with cutting, taping, and folding.

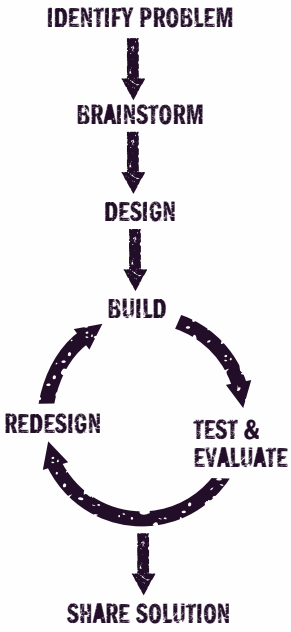
Adapt instructions to fit your audience. Younger children may need to have you show them how to do the challenge step-by-step.

Talk to the kids about what you do, what projects you are working on, and the people you work with—all in kid-friendly language. Rather than talking about the process of becoming an engineer, focus on the rewards of being an engineer. Ask kids what they like to do and see if you can link their career interests to engineering.

Point out to kids which part of the design process they are doing as they progress through the engineering challenges.

Ask kids questions to guide them as they are working (see chart below for examples).

THE DESIGN PROCESS



ASK QUESTIONS TO GUIDE KIDS

To help a child stay focused on the activity, ask:
"What do you need to do now?"
"How does your idea work?"

To help a child answer his/her own question, ask:
"That's an interesting question, how can we find out?"
"Why do you think this happened?"

To help a child problem-solve or try another approach, ask
"Is there another way to look at this?"
"Why do you think this is happening?"

To help a child make connections to the real world, ask:
"What does this remind you of?"
"What are other examples where this happens?"

To help a child improve his/her design, ask:
"Could you change something to make it work better?"
"What else would you like to try?"
"Do you have any questions?"

(Adapted from Harlen,Wynne, (ed.), *Taking the Plunge: How to Teach Primary Science More Effectively.* Westport, CT: Greenwood Publishing Group, 1985. Also, from "Putting Girls at the Center in Math, Science and Technology." © 2003 Girl Scouts of the USA. Used with permission.)

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EVENT EVALUATION FORM

1. Are you ☐ Male or ☐ Female?

2. How old are you? _____ years old

3. Who did you attend the event with today? (Check all that apply)
   - ☐ friends
   - ☐ family members
   - ☐ other: _____

4. How did you find out about today's event? (Check all that apply.)
   - ☐ I was in the area and dropped in
   - ☐ Newspaper
   - ☐ Friend
   - ☐ TV
   - ☐ Web
   - ☐ Radio
   - ☐ other: _____

5. How likely would you be to go to another event like this?
   Not likely **1 2 3 4 5** Extremely Likely

6. Would you recommend an event like this to others?
   Not likely **1 2 3 4 5** Extremely Likely

7. How would you rate this event overall?
   Disappointing **1 2 3 4 5** Fun

8. What did you like best about today's event?

9. What did you like least?

10. Write down one cool thing that you learned about engineering.

11. Other comments:

THANKS!

Your feedback will help us improve future events.

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RUBBER BAND CAR

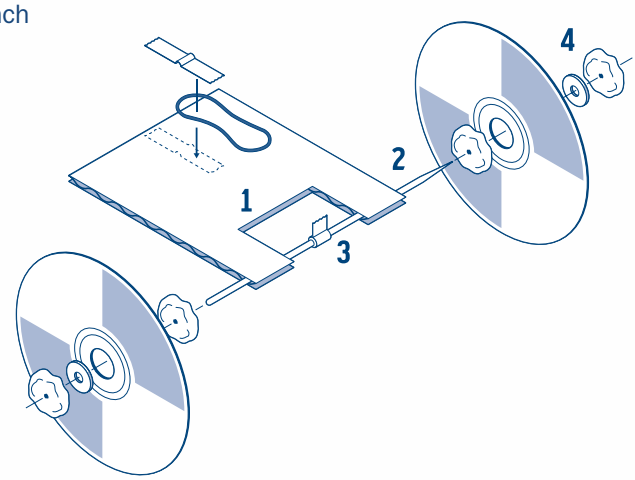
DESIGN SQUAD

YOUR CHALLENGE

Build a car that goes really far, really fast. Oh, by the way, your power source is a rubber band, and your car can only have two wheels. Start your engines!

MATERIALS (PER CAR)

- 5 x 6-inch piece of corrugated cardboard (cut so the holes from the corrugation are visible along the long edge)
- Ruler
- Scissors
- 1 wooden skewer (Use the thinnest available skewers. These probably will be ⅛ of an inch thick.)
- Tape (masking or duct)
- 2 faucet washers (Size: ¼-inch Large)
- 2 CDs
- Poster putty (¼ package)
- 1 rubber band
- Pencils, pens, or markers

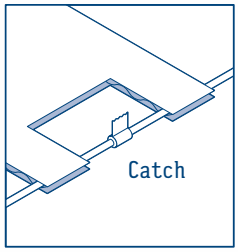


BUILD

1. **Notch the body.**
Cut a notch in the center of the five-inch side of the cardboard. Make the notch 2 inches wide and 1 ½-inches deep. Throw away the piece you've cut out.

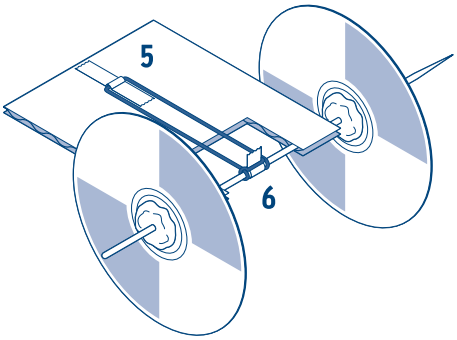
2. **Make the axle.**
Slide the skewer through the cardboard, close to the outer edge. Make sure the axle sticks out the same amount from each side of the body. When we made ours, the skewer didn't always rotate freely. If this happens to you, twist it until the opening stretches.

3. **Modify the axle.**
Find where the skewer goes across the notch. In the middle of this section, wrap a small piece of tape to make a "catch" for the rubber band. Try twisting the tape that is sticking up to make sure the catch is thick enough to hold the rubber band.



4. **Assemble the wheels.**
Hold a washer in the center hole of a CD. Slide the washer and CD onto the axle, leaving lots of room between the CD and cardboard. Put poster putty on each side of the washer to join the CD, washer, and axle tightly together—REALLY TIGHTLY. The wheel and axle should now rotate together. Make the second wheel the same way.

5. **Attach the rubber band.**
Tape one end of a rubber band to the cardboard at the end opposite the axle.

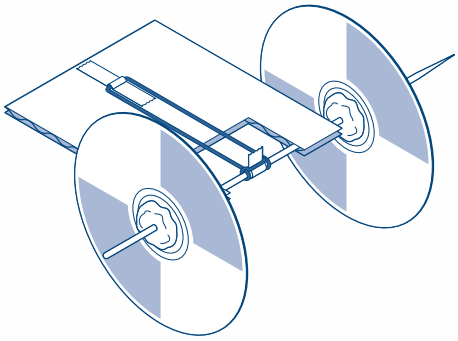


6. **Power your car.**
Wrap the unattached end of the rubber band over the catch. Turn the axle several times. You've given the rubber band **potential** (stored) energy. When it unwinds, this potential energy is transformed into **kinetic** (motion) energy, and the axle spins. The more you wind the rubber band, the more energy is available for your car's wheels—and the farther and faster your car goes.

RUBBER BAND CAR Continued

TEST

It's off to the races. Set your car on the floor, rubber band side down. What happens when you let your car go? When we made ours, our wheels didn't always turn freely. If this happens to you, make sure the catch isn't hitting the cardboard when the axle spins. Also, check to make sure the rubber band isn't jamming itself against the cardboard. We found that wrapping the rubber band more carefully usually solved the problem, but you can also create more space for the rubber band by making the notch just a little wider.



If your cardboard body buckles, think about ways to reinforce it.

REDESIGN

You've just built a **prototype**, which is an early version of a product. Prototypes help engineers understand a product's strengths and weaknesses and how it might be improved. Thinking about your car, try to come up with some ways to make it perform even better. You can also redesign it for new challenges, like making it work on sand or thick carpet. Brainstorm ideas, revise your design, and then build and test it.

INSIDE THE ENGINEERING

Your car is powered by a rubber band, but most cars use gasoline. The average car gets around 20 miles per gallon, but gasoline is an expensive, limited source of energy that pollutes. Many people want an alternative fuel source that is more affordable, more efficient, and more environmentally friendly. In 2006, two engineering students created the MIT Vehicle Design Summit—challenging students from around the world to build cars that didn't use gasoline and could get the equivalent of 500 miles per gallon… and they did it! One car used a hydrogen fuel cell (a device that converts hydrogen and oxygen into electricity.) Another combined human power and solar power, while a third was entirely electric. A fourth car used biodiesel, an environmentally friendly fuel that can be made from grass, corn, or soybeans. Today you're working with rubber bands, but tomorrow, who knows!

Photo: Mika Tomczak

The *Design Squad* cast converted a traditional kid's tricycle into a motorized race car using battery-powered drills as their power source. The vehicle reached 20 miles per hour.

If you liked this challenge, go to **pbskidsgo.org/designsquad** to download more challenges to try at home.

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KINETIC SCULPTURE

YOUR CHALLENGE

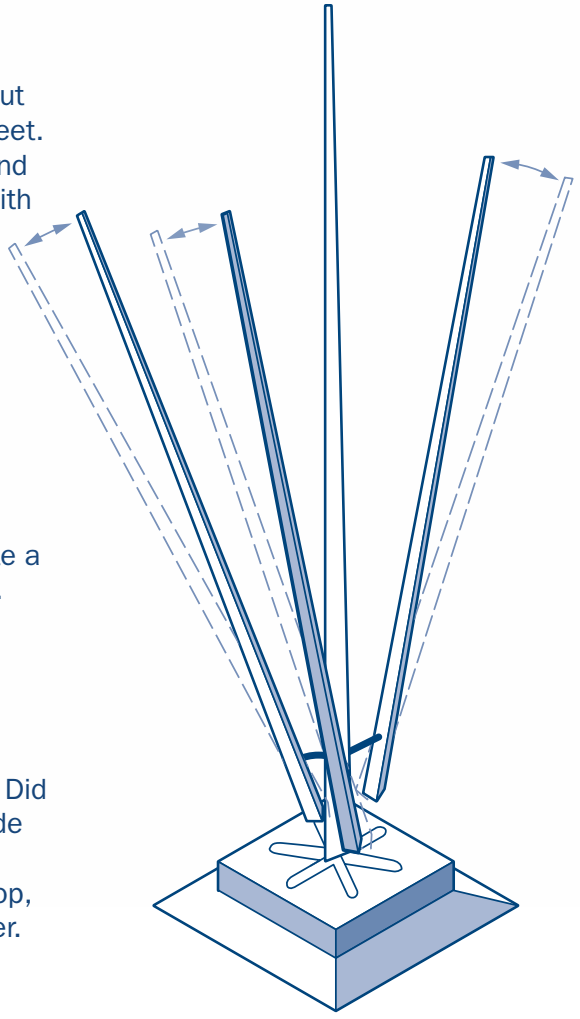
Make a sculpture that is at least six inches tall and has at least two parts that move in the wind. That's what makes it kinetic—it moves. But watch out, wind can also knock it over. So, make sure the tower is sturdy enough to stand up in the wind.

MATERIALS

- Electric fan (you only need one)
- Strips of colored paper or fabric
- Ruler
- Pens or markers
- Cardboard
- Metal washers (various sizes)
- Markers
- Ping-Pong balls
- Poster putty
- Paper cups (various sizes)
- Scissors
- Wooden skewers
- String
- Tape (duct or masking)

BRAINSTORM AND DESIGN

Looking for inspiration? Get your creative juices flowing by checking out the illustrations of kinetic sculptures on the front and back of this sheet. Don't worry, it's not cheating! Being inspired by other people's work and combining the parts you like in new ways is a great way to come up with a unique creation of your own. Now, look at the materials and think about how you can meet the challenge.



Tall Grasses

BUILD

1. **Assemble your sculpture.**
2. **Name your sculpture.**
   Artists typically name their sculptures because it can add meaning. Look at the picture. Why do you think it is named Tall Grasses? Create a name for your sculpture that is accurate, funny, poetic, or mysterious.

TEST

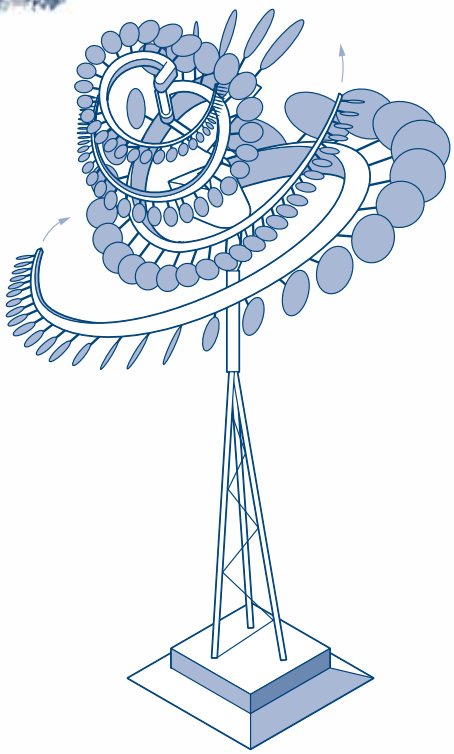
Set your sculpture in front of the fan. Do the parts move as you expected? We had to tweak ours to get it to work the way we wanted. Did the wind knock your sculpture over? It knocked ours over! So, we made ours more stable by giving it a wide, heavy base. Where the weight is located also effects how it stands. If too much weight is toward the top, it may tip over. If most of the weight is at the bottom, it stays up better.

KINETIC SCULPTURE Continued

REDESIGN

What adjustments will help your sculpture's parts move in the wind? Does it need additional support to keep it from falling over? How can you make it more stable? Once everything's working the way you want, how about:

- adding another moving part?
- making your sculpture taller?
- changing it to work in either more or less wind?



The Cyclone

INSIDE THE ENGINEERING

What would you have to do to make your sculpture stand up in typhoon-strength winds (74 miles per hour or greater)? That's something the engineers who built one of the tallest buildings in the world—the Taipei 101 Tower of Taiwan (1,670 feet tall)—were worried about. Very worried! Typhoons regularly slam into Taiwan. So to keep the tower from being blown over, engineers made the skyscraper much wider at the bottom than at the top. They also used special materials, including strong, flexible steel to make the building sturdy enough to withstand those typhoons. So the next time you're visiting the top of the Taipei 101 Tower during a typhoon, you don't have anything to worry about. Right?

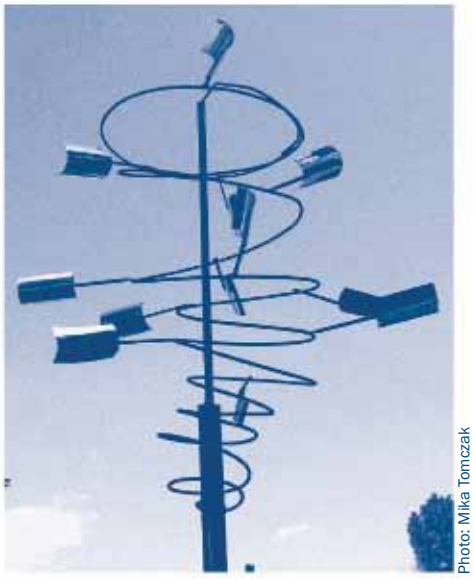


Photo: Mika Tomczak

The *Design Squad* cast welded their kinetic sculpture, called the Urban Tornado, out of heavy scrap metal.

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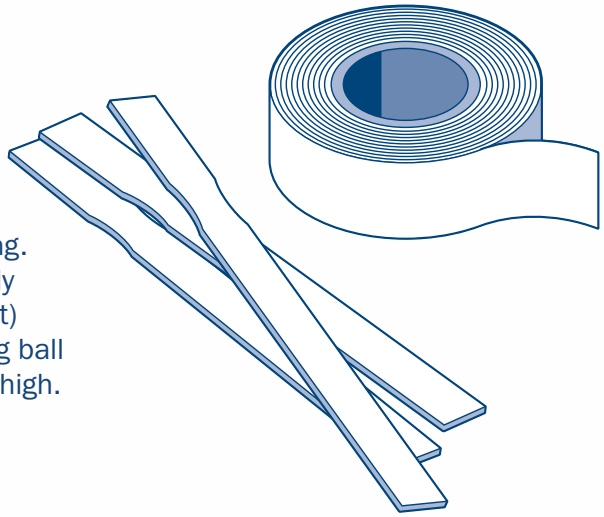
POP FLY

YOUR CHALLENGE

It's football with a twist. Invent a way to send a Ping-Pong ball flying high enough to catch it. Take some paint stirrers, a wooden spool, and tape. Now, add your foot. Ready, set, launch!

MATERIALS

- Duct tape
- 3–5 paint stirrers
- 1 Ping-Pong ball
- 1 wooden block or spool
- 3-oz paper cups (for your redesign)



BRAINSTORM AND DESIGN

Using the materials (and your foot), make something that launches a ball high enough so you can catch it. When we made ours, we came up with lots of ways to send our ball flying. Most of our designs (but not all) used levers. Levers are handy because they can convert a small motion (the flick of your foot) into a large motion (the end of the lever flinging your Ping-Pong ball into the air). Now, let your imagination (and Ping-Pong ball) fly high.

BUILD

Think of different ways to put it all together and get that ball flying!

TEST

How high did it go? Did it fly high and straight enough for you to catch? Could your tallest friend catch it?

REDESIGN

Even the best inventions can be improved. Now that your ball can fly through the air with the greatest of ease, challenge yourself to:

- send the ball twice as high
- pop up a tennis ball
- pop up two balls at once
- launch a ball for a partner to catch

POP FLY Continued

INSIDE THE ENGINEERING

Levers, levers, everywhere. Yup, they're all around you. You see, levers make work easier by converting a little effort into a lot of force (like a hammer) or by converting a little movement into a large movement (like a broom or golf club). And who doesn't want to get more done with less effort? Baseball players use a lever every time they are up at bat. When you swing a bat, you move the part you're holding just a little bit. But the other end of the bat moves a lot! The same with the flippers on pinball machines—a little flick sends the ball flying. A see-saw is a big lever, though you'd need a lot of force to send someone flying! And hundreds of years ago, soldiers hurled heavy stones using catapults, which use a lever system to send the rocks flying. We think Ping-Pong balls are much more civilized!

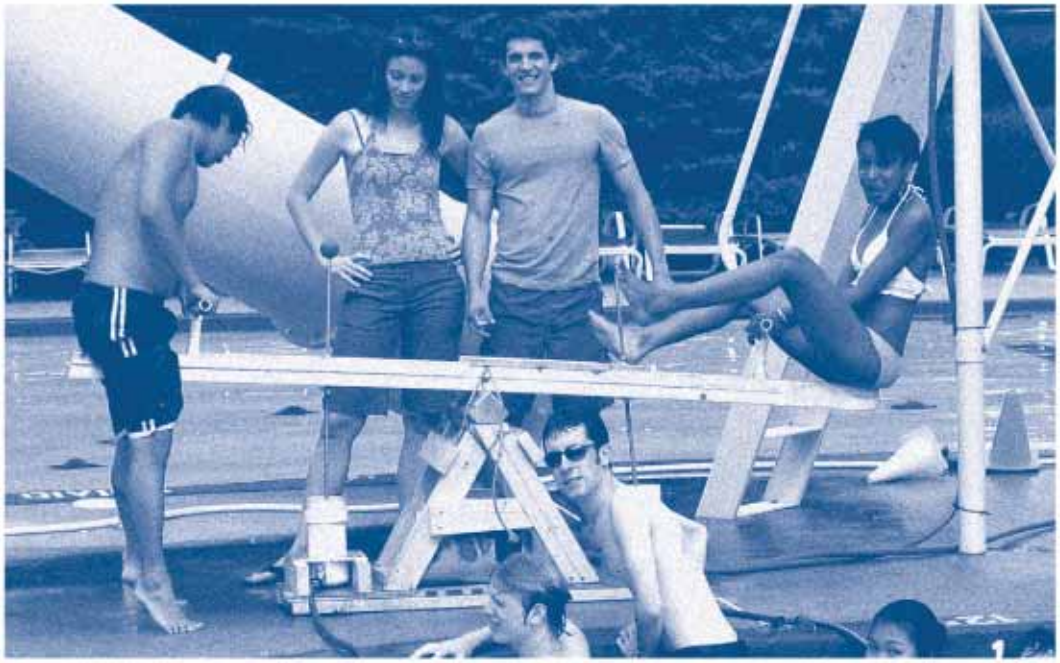


Photo: Mika Tomczak

For their water slide challenge, the *Design Squad* cast needed to pump water to the top of a slide to make it slippery. One team used a seesaw to help push and pull pistons to pump the water.

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HIDDEN ALARM

YOUR CHALLENGE

Here's a chance for a little mischief–just a little. Design an alarm that you can turn on and off and is small enough to hide. Make your friends and family ask, "What's buzzing?"

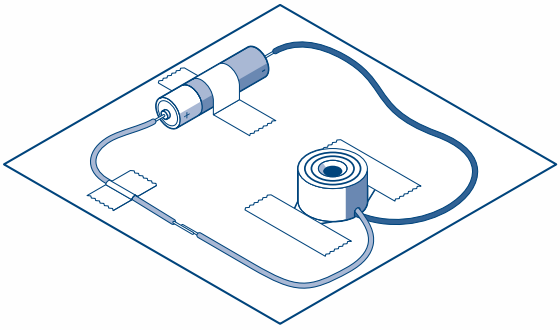
MATERIALS

- 1 AA battery
- 1–2 feet of electrical wire (Ask an adult to help you strip the plastic coating off the ends to expose the wires.)
- 1 buzzer (wires attached preferred)
- Tape (duct or masking)
- Thin cardboard (Also called chipboard; you can use cereal boxes, too.)
- Tin-foil
- Scissors
- Wire strippers

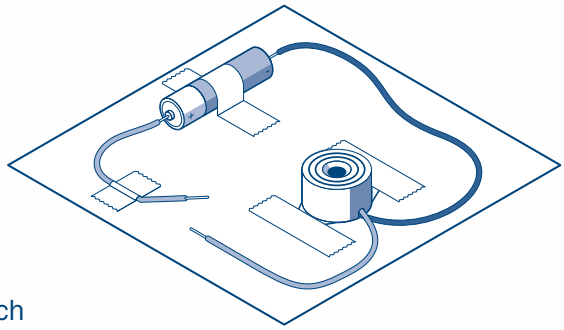
BRAINSTORM AND DESIGN

The thing that makes a hidden alarm cool is that it can be hidden and it can sound an alarm. That's why we call it a hidden alarm! Before you start, think about:

- where you want to hide your alarm
- how small you think it needs to be to fit in your hiding place
- how you'll turn your alarm on and off



Closed Circut



Open Circut

BUILD

1 Sound your alarm

- Check the buzzer. To make your buzzer buzz, you need to make a complete pathway for electricity to get from the battery to the buzzer. To do this, connect the buzzer, battery, and wires. This makes a closed circuit.
- Did it buzz? Ours didn't the first time we tried. That's because the buzzer's red wire needs to be attached to the positive (+) side of the battery and the black wire to the negative (-) side. Check the wires and reverse them, if necessary.

2 Add a switch

As you build, you also want to think about ways to turn your alarm on and off. A switch starts and stops the flow of electricity. When the switch is closed (called a closed circuit), electricity flows to the buzzer and it buzzes and buzzes and buzzes. Would somebody *please* open that switch!

3 Put it all together

Mount everything (your circuit, battery, etc.) onto a cardboard frame. We turned our frame into a switch—the folded cardboard acted like a spring that could open and close our circuit.

HIDDEN ALARM Continued

TEST

Did your alarm buzz on command? Did it fit in its hiding place? Did you trick anyone? When we were building our buzzer, the wires sometimes got loose and our alarm stopped working. If that happens to you, check your connections.

REDESIGN

Try to make your hidden alarm more reliable or make it even smaller. Is there another hiding place you want to try?

INSIDE THE ENGINEERING

Like your hidden alarm, computers basically work by switching circuits on and off. The first computer, called the Electronic Numerical Integrator and Computer (ENIAC), was built in the 1940s (not so long ago, really). ENIAC was so big it filled a small building and weighed 30 tons! Since then, engineers have been making computers smaller and smaller and smaller. Today, the average laptop computer weighs just 6 pounds. That means it would take 10,000 laptops to weigh as much as ENIAC. We don't even want to think about carrying all those around. On top of that, today's laptops are even more powerful than ENIAC. How'd they do it? By making the parts smaller and making them better conductors of electricity. Just think, ENIAC, laptops, and the alarm you made work the same basic way—by switching circuits on and off.

Photo: Mika Tomczak

The *Design Squad* cast designed a dance, music, and light show that used circuits. Sensors made out of thin foam and metal served as switches that turned the sound on and off.

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FOUR CORNERS

YOUR CHALLENGE

To operate efficiently, machines need their parts to fit precisely and to work together smoothly. Your challenge is to build a machine out of cardboard that runs smoothly and dependably. Here's a hint—be precise, be very precise.

MATERIALS

- Chart paper
- Marker
- Tape (masking or duct)
- 1 wooden skewer
- Scissors
- Ruler and pencil
- Corrugated cardboard
  - Base: one piece at least 6 x 6 inches (could be bigger)
  - Corners: four 5 x 1-inch strips*
  - Handle: one 4 x 1 ½-inch strip*
  - Paddles: two 2 x 1 ½-inch pieces*

* Cut the cardboard so the holes from the corrugation are visible along the long edge of every piece.

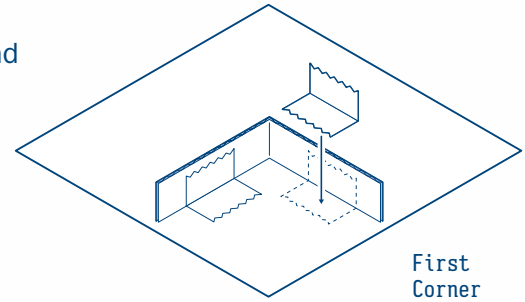
BUILD

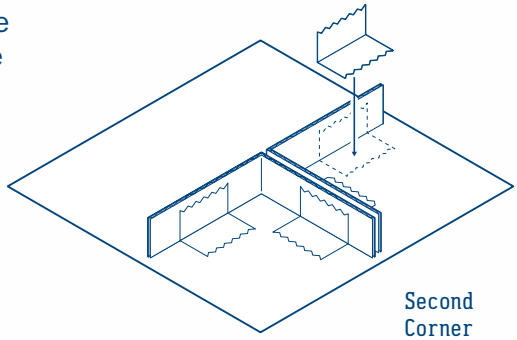
1. **Measure and cut** the cardboard to make your base, corners, handle, and paddles. Make sure the corrugation runs parallel to the short side.

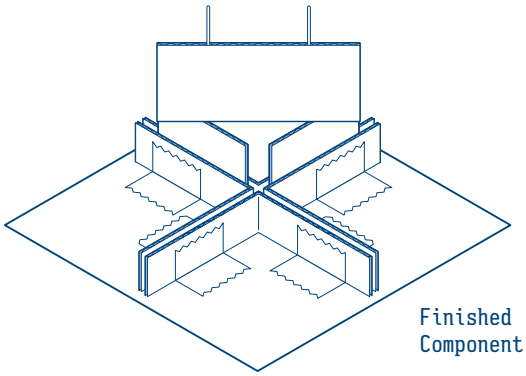
2. **Make your track.**
   - Bend your first corner (5 x 1-inch piece) precisely in half.
   - Tape your first corner to the base. Keep the tape on the side facing the outside of your base
   - Bend your second corner in half. Line up a second bent strip next to the first one. Create a track by leaving a narrow gap between the two pieces—that's where the paddles will go.
   - Bend your third and fourth corners in half. Use your ruler to make sure that the tracks are all ¼-inch wide. Make sure your creation looks like the illustration of the four corners.

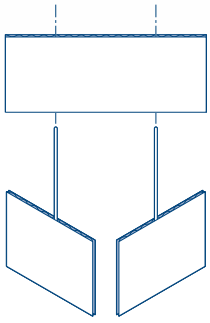
3. **Make your paddles.**
   Break your skewer in half. Slide one piece through the center corrugation of one of the paddles (2 x 1 ½-inch piece of cardboard). Repeat for the second paddle. Make sure the skewers turn easily.

4. **Add your handle to the two paddles.** Set the paddles and the handle in the track as shown in the Finished Component illustration. Slide the handle onto the two skewers that are sticking up. Twist the handle so the paddles slide along the track.

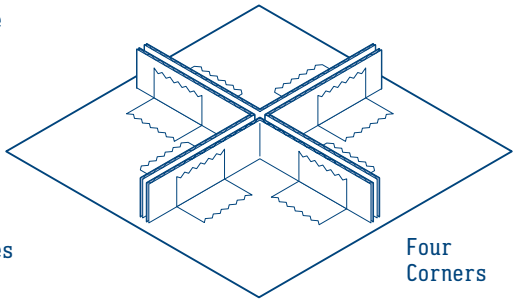

First Corner


Second Corner


Finished Component


Handle

Paddles


Four Corners

FOUR CORNERS CONTINUED

TEST

To work smoothly, all machines, including the one you just made, need to be made with great precision. That way, all the parts can work efficiently together to produce the same motion over and over again. Test how smoothly everything's working.

REDESIGN

You've just built a **component**, which is a part of a system. Examples of components include motors, light bulbs, computer chips, gears, sinks, and roofs. A component can't do much by itself, but put it together with other components and you've got something impressive, like a car, house, or spacecraft! But just what exactly is your component a part of? That's where your creativity comes in. How could the Four Corners component be used as part of something else? Is it a chopper? A puller? You decide. Brainstorm some ideas and write them down.

INSIDE THE ENGINEERING

Faced with a design challenge, engineers try to make a job go faster and cost less by using readily available parts whenever possible. Did you know that NASA engineers used many "off-the-shelf" parts to build the Mars Pathfinder spacecraft? For example, the control and guidance systems used common computer chips. Cameras developed for medical and scientific imaging—not outer space—took the pictures of the martian landscape. One communication system used radio modems developed for pagers. The end result was a spacecraft that was built quickly—38 months from concept to touchdown—and was inexpensive—Pathfinder cost about one-twentieth as much as earlier Mars missions. Imagination and creativity are important parts of engineering. Innovative engineers and designers often imagine new ways of combining and using standardized parts, which lets them produce quality products more quickly and cheaply.

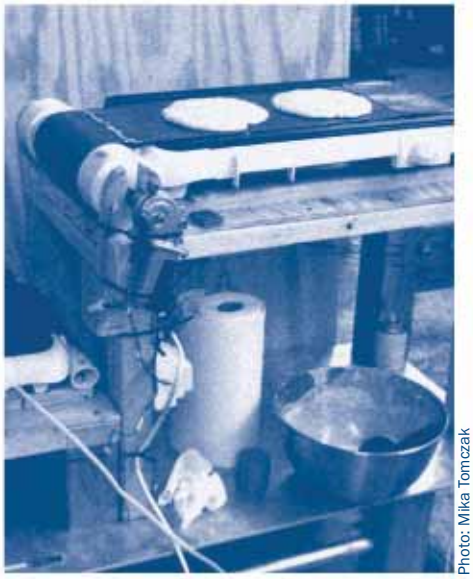


Photo: Mika Tomczak

When the *Design Squad* cast created pancake-making machines, they relied on commonly available components. This pancake machine relied on windshield wiper motors to drive the conveyor belt rollers over ordinary electric griddles to cook the pancakes.

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CONTENT STANDARDS

The challenges in this guide address the following ITEA National Study of Technology Content Standards and the Massachusetts Curriculum Frameworks Science and Technology/Engineering Standards.

	Massachusetts Curriculum Frameworks Science and Technology/Engineering													Study of Technology Content Standards					
	Grades 3–5							Grades 6–8						Grades K–12					
	Materials and Tools		Engineering Design		Physical Science			Materials, Tools, and Machines	Engineering Design				Physical Science	The Nature of Technology		Design		Abilities for a Technological World	
Challenge	1.1	1.2	2.1	2.3	4	5	6	1.1	2.1	2.2	2.3	2.4	13	1	2	9	10	11	12
Rubber Band Car	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Kinetic Sculpture	●	●		●	●	●		●	●	●	●	●		●	●	●	●	●	●
Hidden Alarm	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
Pop Fly	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Four Corners	●	●	●	●				●	●	●	●	●		●	●	●	●	●	●

ENGINEERS FOR DESIGN SQUAD

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