The guide’s challenges take about an hour, use readily available materials, give kids many ways to succeed, and are aligned with national science and technology standards. You can use them in a:

- **one-time session**—like a workshop or event. Every challenge can be done as a stand-alone experience.
- **series of sessions**—like an invention club or an afterschool science or engineering program. Want to start an invention club? See page 7.

**TO GET STARTED**

- **Read the leader notes.** Found at the beginning of each challenge, they’ll help you understand how to prepare for and run a session.
- **Try the activity yourself.** A practice run will help you figure out the best way to introduce the activity and anticipate potential problems your kids may run into.
- **Print the challenge sheet.** This handout for kids—a cartoon strip featuring Design Squad host Nate Ball—presents the problem to solve. It also provides the context for the challenge, questions to help kids brainstorm design ideas, and tips for building and troubleshooting.
- **Decorate the room.** Set the stage for creative thinking, and get kids excited about invention. Post the tear-out invention posters found in the appendix. Also, Invention Resources (page 42) lists Web sites that feature wacky inventions, inspiring quotes about invention, and interesting profiles of inventors. Visit the Web sites, find items that you like, print them out, and post them around the room.
TO LEAD A CHALLENGE

Never led an invention activity? Don’t worry! The leader notes give you all you need to facilitate a session. The leader notes are divided into the following sections:

- **The invention challenge**—Presents the goal for the session and the steps involved in running the challenge. Each challenge is designed to help kids (who work in groups of two or three) understand that inventors look for ways to improve people’s lives.

- **Prepare ahead of time**—Lists things to do to get ready for the activity.

- **Warm-up activity**—Gives kids an opportunity to practice a particular inventive thinking skill (e.g., improvisation, flexibility, and visualization) that they’ll use more extensively as they tackle the session’s challenge.

- **Introduce the challenge**—Provides an attention-grabbing story for you to read aloud. The story gives kids a real-world context for the challenge’s problem as well as a sense of relevance, purpose, and meaning for their own inventing.

- **Brainstorm design ideas**—Helps kids think about different ways to meet a challenge.

- **Build, test, and redesign**—Lists issues that might surface during a challenge and suggests strategies to use with kids who face these issues.

- **Discuss what happened**—Provides questions (and answers) that review the activity’s key science and engineering concepts, helping kids reflect on the design process and how the challenge relates to invention.

- **Tinker some more**—Presents extension activities that reinforce and expand the experiences kids have had in a challenge.

TIPS FOR FACILITATING OPEN-ENDED CHALLENGES

- There are multiple ways to successfully tackle a challenge. One solution can be just as good as another. Help kids see that the challenges are not competitions. Instead, they’re opportunities to unleash an individual’s ingenuity and creativity.

- When kids feel stuck, have them describe why they think they got the results they did. Ask questions rather than telling them what to do. For example, ask: “Why do you think this is happening?” or “What would happen if...?” or “What is another thing you could try?”

- When something’s not going as desired, encourage kids to try again. Have them compare their design to other kids’ designs. Remind them that problems are opportunities for learning and for using creative thinking.

- Have kids come up with several ways to solve a problem before they move ahead with an idea.
WHO, ME? AN INVENTOR?
Yes! People from every corner of the world, of different ages, with different levels of education invent by identifying problems, pursuing ideas, and developing new solutions. The key to inventing is identifying a need and devising an original solution.

Maybe a better question is, “Is there anyone who isn’t an inventor?” Let kids know that everyone has the capacity for invention. We all solve problems through inventive thinking, whether it’s figuring out a way to prop open a window, stay dry in a rainstorm, or build a playhouse from scrap materials. Creative problem solving, improvisation, flexibility, and tinkering drive the inventive spirit.

WHAT’S AN INVENTION?
Let kids know that an invention is a useful creation that didn’t exist before. Round out their understanding of invention by sharing the characteristics below.

- An invention usually fills a need or solves a problem.
- Inventions often make the world a better place.
- Inventions can be things (e.g., a cell phone or backpack) as well as ideas (e.g., a new method for tying a knot, or a story).
- An invention often makes something better (e.g., faster, stronger, cheaper, easier, safer or more efficient, attractive, useful, accurate, fun, or productive). But as long as it’s a new way to do something, it’s still invention even if it isn’t necessarily better than what existed before.

WHY INVENT?
Inventing is a process. It starts with a need and ends up with something new—the actual invention.

- To solve problems: Inventors are skilled at spotting ways to improve a situation or process. The activities in this guide help kids develop solutions to problems by applying the design process.
- To improve our world: Imagine how different our lives would be without inventions, such as computers, refrigerators, electricity, plastic, and medicine. The activities in this guide show how inventions improve things at home, at school, in the community, and in the world.
- To enjoy the creative process: Invention involves both thinking and doing. The activities in this guide help kids become involved in the process of thinking about a problem and then doing something about it. Because they create their own solutions, kids get excited about the process of inventing.
INVENTORS AND ENGINEERS ARE SIMILAR IN MANY WAYS

Engineering is a process for developing solutions to problems. Inventing is a process for creating things that didn’t exist before. Inventors sometimes use engineering to create new solutions, but, as discussed on page 4, many do not. Both inventors and engineers look for ways to improve things in areas like health, food, safety, transportation, aerospace, electronics, communication, and the environment. And when the improvement is something new, it’s an invention.

DISPEL THE STEREOTYPE THAT SURROUNDS ENGINEERING AND INVENTING

There’s a stereotype that engineering is boring and hard. To fight this stereotype, tell kids about some of the exciting challenges inventors and engineers take on to help improve people’s lives, and point out how central invention and engineering are in our daily lives.

- Create more fuel-efficient cars
- Design a lighter bike frame
- Invent a more powerful superglue
- Create satellites that detect droughts around the world
- Develop state-of-the-art cell phones
- Invent artificial retinas for people who are blind
- Develop a feather-light laptop
- Design clothing that repels mosquitoes
- Create a wheelchair that can go up stairs

FIND OUT MORE

Get activities, profiles of cool inventors and engineers, and more. See page 42 and visit:

- Design Squad
  pbs.org/designsquad
- Discover Engineering
  discoverengineering.org/home.asp
- Engineer Your Life
  engineeryourlife.org
- Howtoons
  howtoons.com
- InvenTeams
  web.mit.edu/inventeams
- The Lemelson Center for the Study of Invention and Innovation
  invention.smithsonian.org/home

THE PROCESS OF INVENTION INVOLVES:

- identifying a problem and/or realizing that something can be improved.
- talking to people who might use the invention.
- brainstorming creative solutions to a problem, which often involves making imaginative connections between seemingly unrelated things.
- devising and testing solutions (i.e., experimenting).
- applying science and engineering concepts.
- using tools, materials, and techniques to make workable solutions.
- trying again when things don’t work out. On Design Squad, we say, “Fail fast—succeed sooner!”
- seeing a project through by being motivated, persistent, and dedicated.
Inventors’ and engineers’ initial ideas rarely solve a problem. Instead, they try different ideas, learn from mistakes, and try again. The series of steps they use to arrive at a solution is called the **design process**. As kids work through a challenge, use the questions below to talk about what they’re doing and to tie it to specific steps of the design process.

**BRAINSTORM**
- What are some different ways to tackle today’s challenge?
- How creative can we be? Off-the-wall suggestions often spark GREAT ideas!

**DESIGN**
- Which brainstormed ideas are really possible, given our time, tools, and materials?
- Can we phrase it as an invention statement, such as “I will invent an x that does y”?

**BUILD**
- What are some problems we’ll need to solve as we build our projects?
- What materials will you need to build your invention?

**TEST, EVALUATE, AND REDESIGN**
- Why is it a good idea to keep testing a design?
- What specific goal are you trying to achieve, and how will you know if you’ve been successful?

**SHARE SOLUTION**
- What were the different steps you had to do to get your project to work the way you wanted?
- What do you think is the best feature of your invention? Why?
- What are some things our inventions have in common?
- If you had more time, how could you improve your invention?
- Look at the group to your left. What’s something you like about their invention and something that could be improved? (This helps to develop teamwork by teaching kids how to give constructive criticism.)

* This design process graphic is available as a tear-out poster on page 39.
The club format appeals to kids. They like being part of a group, having fun together, and having an experience that builds over time. In a club, kids will practice and model for each other important skills, such as problem solving, teamwork, critical thinking, and creativity.

All you need to run an invention club is a large room, some tables, some basic tools, and some low-cost materials. The resources in this guide and on the Design Squad Web site make it easy to facilitate a club and engage kids in invention and engineering.

**STARTING AN INVENTION CLUB**

**Recruit club members**

- Create a “Coming Soon” bulletin board and post a flier about the club.
- Advertise the club in your organization’s newsletter. Tell families about the challenges that kids will do and how to sign up their kids.
- Determine the number of kids you feel comfortable managing (we suggest 8 to 12 per leader). If more sign up, get more leaders, divide the club into two sessions, or keep a waiting list for the next time you offer the club.

**Schedule the dates and arrange a meeting place**

- Decide how many weeks your club will meet and the duration of each meeting. (We recommend at least an hour for five or six sessions.) Then select and reserve a space that has ample room and tables for materials. A place to store kids’ work is also helpful.

**Give your room an invention club look and feel**

- Tear out the posters in this guide and hang them in your clubroom.
- Make a bulletin board and post photos of kids doing the challenges so others can see what goes on at invention club meetings.
- For more ideas on how to give your room an “invention” look and feel, see page 2.

**Partner with inventors and engineers**

- Invite inventors and engineers to talk about everyday examples of inventing and engineering. The guests will serve as role models and can introduce kids to career options. To find volunteers, contact local universities and colleges with engineering programs. Also try manufacturing plants and public works and water departments. In addition, the Design Squad, InvenTeams, and Lemelson Center Web sites list engineering societies that can recommend potential partners. (See page 42.)
- Show video clips of engineers and kid inventors talking about how they became interested in engineering and inventing and the rewards of being an engineer. Get the D-Squad ProFiles at pbs.org/designsquad/profiles and InvenTeams profiles at web.mit.edu/inventeams/about.html.

**WHY A CLUB?**

An invention club draws kids who are interested in (or who might want to check out) invention and engineering. It gives them a defined time to do the guide’s activities, refine their designs, and even develop their own inventions.

**CONNECT YOUR KIDS WITH INVENTEAMS**

There are InvenTeams at schools throughout the country. If one’s nearby, connect your kids with what’s going on there. To find the nearest one, visit web.mit.edu/inventeams.
INVENT IT, BUILD IT PARTNERS

• **Design Squad**
  pbs.org/designsquadt
  *Brings engineering to life and engages kids with episodes, games, 35 hands-on challenges, and much more.*

• **Lemelson-MIT InvenTeams**
  web.mit.edu/inventeams
  *Offers a unique invention experience for high school students through its nationwide grants initiative, as well as information on invention and on awards to outstanding inventors offered by the Lemelson-MIT Program.*

INVENTION PROJECTS

• **Discover Engineering**
  discoverengineering.org
  *Find a host of projects, games, online activities, and videos about cool things engineers do and design.*

• **Howtoons**
  Howtoons.com
  *Uses a cartoon format to step kids through 15 fun build-it-yourself projects.*

• **Inventors/Inventions**
  edtech.kennesaw.edu/web/inventor.html
  *Offers lesson plans, activities, and research sites on invention for kids and educators.*

• **The NASA Science Files**
  scifiles.larc.nasa.gov/text/kids/D_Lab/acts_invention.html
  *Includes invention experiments and simulations. Also get kids inventing with “The Case of the Wright Invention,” a video and educator guide from the 2001–02 Scifiles season.*

• **U.S. Patent and Trademark Office: Kids’ Pages**
  uspto.gov/go/kids
  *Offers an interactive kids’ page with games, puzzles, and links.*

INVENTION CONTESTS

• **The Christopher Columbus Awards**
  christophercolumbusawards.com/enter.php
  *Challenges middle school students from around the country to identify a problem in their community and create an innovative solution.*

• **eCYBERMISSION**
  https://ecybermission.apgea.army.mil
  *Has kids in grades 6–9 invent science-, math-, and technology-based solutions to problems in their community and enter them in a free, Web-based competition.*

• **ExploraVision**
  exploravision.org
  *Encourages K-12 students to create and explore current technology and envision its future.*

• **INVENT AMERICA!**
  inventamerica.org
  *Provides K–8 students opportunities to learn critical and creative thinking skills through the process of inventing. Also hosts a national student invention contest.*

• **National Museum of Education**
  nmoe.org/competitions.htm
  *Offers a series of fun invention contests and a gallery of America’s young inventors.*

• **Tech Challenge**
  techchallenge.thetech.org
  *Inspires kids’ inner innovator by getting teams of 5–12 graders to develop creative solutions to real-world challenges in familiar settings.*

• **TOYchallenge**
  sallyridescience.com/toychallenge
  *Runs a national contest in which 5–8 graders create a new toy or game.*
ABOUT INVENTION AND INVENTORS

- **Inventors and Inventions for K–12 Education**
falcon.jmu.edu/~ramseyil/inventors.htm
Lists Web sites about invention and inventors.

- **The Lemelson Center for the Study of Invention and Innovation**
invention.smithsonian.org/home
Hosts a wide variety of resources to encourage kids’ inventive creativity and to enhance their appreciation for the role that invention and innovation plays in the history of the United States.

- **National Institute of Environmental Health Sciences Kids’ Pages**
kids.niehs.nih.gov/quotes/qtinvent.htm
Offers inspirational quotes related to invention.

- **PBS’s American Experience: Forgotten Inventors**
pbs.org/wgbh/amex/telephone/sfeature/index.html
Presents a diverse set of inventions from the past.

 SOURCES FOR MATERIALS

Most of the required materials are easy to find at local stores. Often local merchants will offer educators discounted prices if you ask. If you are buying small quantities, try:

- **craft stores** for wooden spools and paper confetti;
- **office supply stores** for corrugated cardboard;
- **grocery stores** for aluminum baking tins, straws, and paper cups;
- **sporting goods and toy stores** for tennis balls and Ping-Pong balls;
- **party stores** for paper confetti;
- **school nurse’s office** for crutches. (Also ask kids to bring crutches from home.); and
- **hardware or home-supply stores** for paint stirrers, bamboo plant stakes, duct tape, and large garbage bags.

Large quantities of these items are available online*. For example:

<table>
<thead>
<tr>
<th>Corrugated cardboard</th>
<th>Ping-Pong balls</th>
<th>3-foot bamboo stakes</th>
<th>Wooden spools</th>
</tr>
</thead>
<tbody>
<tr>
<td>papermart.com</td>
<td>target.com</td>
<td>acehardware.com</td>
<td>craftamerica.com</td>
</tr>
<tr>
<td>Item #261811</td>
<td>Item #10731581</td>
<td>Item #048307210036</td>
<td>item #SP138-50</td>
</tr>
<tr>
<td>uiline.com</td>
<td>ustoys.com</td>
<td>aubuchon.com</td>
<td>woodcrafter.com</td>
</tr>
<tr>
<td>Item #S-2437</td>
<td>Item #GS29</td>
<td>Item #277616</td>
<td>Item #NS28</td>
</tr>
</tbody>
</table>

* Sources listed are examples of vendors who offer these items. Research the sources that best fit your needs.
RELATED PBS RESOURCES

**Peep and the Big Wide World**

*Ages 3-6*
Celebrate the curiosity and adventure of young children with simple science exploration.
peepandthebigwideworld.org

**Curious George**

*Ages 3-6*
Discover science, engineering, and math in the world around us.
pbskids.org/curiousgeorge

**ZOOM**

*Ages 8-11*
Try ZOOM’s fun science and engineering activities, featuring ideas sent in by real kids.
pbskidsgo.org/zoom

**The Greens**

*Ages 9-12*
Investigate environmental issues and take action to protect the planet.
pbskidsgo.org/greens

**Fetcher**

*Ages 6-10*
Put problem-solving skills to the test to tackle science challenges inspired by ones seen on the show.
pbskidsgo.org/fetch

**NOVA**

*Ages 11 and up*
Dig deep into science topics with classroom-ready resources from the most-watched science television series on PBS.
pbs.org/wgbh/nova

**NOVA ScienceNOW**

*Ages 11 and up*
Find out the latest research and meet intriguing personalities in science and technology.
pbs.org/wgbh/nova/sciencenow

**Engineer [Your Life]™**

*Ages 14-18*
Meet inspiring women engineers who make a real difference in the world. Find out if engineering might be your dream job.
engineeryourlife.org

**Teachers’ Domain**

*Educators*
Use this media-rich library of teaching resources to make concepts come alive in engaging and interactive ways.
teachersdomain.org