2018 Review

Engineering Gift Guide

Gift ideas that engage girls and boys in engineering thinking and design
The INSPIRE Research Institute for Pre-College Engineering is a center in the School of Engineering Education at Purdue University focused on pre-college engineering education research and integration of engineering with science, technology, mathematics, computational thinking and literacy. INSPIRE is composed of 15+ faculty, staff, and postdoctoral researchers and 40+ graduate and undergraduate research assistants on a mission to study pre-college engineering experiences and environments in order to impact educational systems. You can learn more about INSPIRE and its work at purdue.edu/INSPIRE.

Companies and publishers choose to submit toys, games, books, and applications for evaluation by INSPIRE. These submissions are reviewed by INSPIRE's team, outside engineering/STEM experts, parents, and children. This happens not only in the lab, but also in homes and at events we host throughout the Purdue University campus and the Greater Lafayette community. Gifts receive feedback about whether or not they promote engineering thinking and design, and are rated on their value, fun factor, potential for educational impact, and usability. Altogether, this feedback determines which toys, games, books, and apps are included in the Engineering Gift Guide.

There are no fees for companies and publishers to submit their products to our guide. INSPIRE does not make or sell any of the products featured in the guide, nor does it receive any funds to advertise or promote any of the products included in the guide or on their website. Purdue University does not endorse such products contained herein, but only recommends them solely due to their engineering education value.

INSPIRE creates research-based pre-college resources that can be used at home and in formal and informal spaces. Resources like the ones listed below can be found at purdue.edu/INSPIRE/Resources.

A Parent's Guide to Introducing Engineering at Home
The research-based guide shares engineers’ top responses when asked how they help their children learn about engineering, why parents should help their children learn about engineering and what their children can learn.

Cozmo the Robot Ambulance Challenges
This activity requires children to create a plan and code Cozmo to help deliver sick and injured pets to the hospital. It includes eight computational thinking challenges that gradually go up in difficulty.

PictureSTEM (PictureSTEM.org)
Grades K-2 instructional modules that employ engineering and literacy contexts to integrate science, technology, mathematics, and computational thinking content instruction in meaningful and significant ways.
**Code & Go Mouse Mania Board Game**, a two to four player game for children 5+, has players use code to race their robot mouse around the game board to try and collect the most cheese wedges. To play, players take turns rolling a die to determine how many coding cards they can use to create a sequence of moves for their mouse. Strategy and problem solving come into play as players can add maze walls to block opposing players’ paths and to use warp tunnels to get to locations on the board faster. Parents liked that the game was screen free and that it could be played over and over since the game board changes depending on how players lay down the maze walls and warp tunnel pieces. Children liked the cute 3D robot mice and racing to get the most cheese wedges!
Using just the included marbles, components, and the game board itself, Turing Tumble challenges children to build their own simple mechanical computers through a series of 60 puzzles! We appreciated how the puzzles taught computational thinking while gradually adding more difficulty: the early puzzles were easy enough for an elementary student to solve on their own, but by the last few, they were still a challenge for computer science students at the college level. In testing, children particularly enjoyed the chance to experiment with different solutions and see how their designs could be improved.
What is troubleshooting, and why is it important?
Troubleshooting is the skill of identifying individual flaws in a system or process and solving them in a step-by-step manner. It is an important skill to have, and contributes to a greater understanding of problem-solving as a whole! While troubleshooting is a big part of engineering education at the college level, some researchers feel that the skill is taught insufficiently in the K-12 years. Fortunately, it is not difficult to help children learn to troubleshoot problems! Experts have identified four individual steps that can help teach troubleshooting skills.

1. **Observing**
Making observations is the first step towards solving a problem. Through observation, children can determine which part of the system is failing, and start to identify what the problem symptoms are and how they might relate to flaws in their designs. It is important to pay attention not just to the entire system, but also to specific areas where the problem may be originating.

   - **Expert Tip:** Encourage children to test their solution several times so they can do observations that are more thorough and see emerging patterns.

2. **Diagnosing**
After observing potential issues, it is important that children also identify what specifically might be the cause of the issue and communicate it to others. Experts suggest this step is also a good place for children to begin relating the observed issue to past experiences and using prior knowledge to understand what factors might be causing the issue.

   - **Expert Tip:** Ask questions about the problem to assist children in identifying possible issues.

3. **Explaining**
Once children develop a diagnosis, they tend to express the problem as a cause-and-effect relationship (e.g. because the ball was moving too fast, it jumped out of the track). While this is an effective way of talking about the problem, often, it can also minimize the degree to which other factors influenced the setback.

   - **Expert Tip:** Encourage children to look deeper for other underlying or incidental issues that contributed to the problem.

4. **Fixing**
Once all the work leading up to this step has been finished, it is important to give children a chance to stop and think about how they can address the concerns they have previously expressed, then put those changes into practice. Experts suggest that it is important to recognize the patterns that led to the system’s failure and utilize previous experience to fix those problems. However, many young children will not have enough previous experience to know how to fix the observed issues, and in these cases, it is important for parents to ask questions and provide suggestions to help lead children to a functional solution.

   - **Expert Tip:** If children get stuck or lack previous knowledge to get to a functional solution, ask questions and provide suggestions. Resist taking over. Support children as they decide how to use the information and suggestions you have provided.

Note: When children troubleshoot on their own they may not complete the steps in a particular order and may revisit steps a number of times. In addition, children do not inherently verbalize all of their thoughts and ideas so you may not easily recognize when they are completing a particular step.


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The **Grand City Station** railroad set presents young engineers with the chance to work through the operation of a transit hub and set up their own rail lines. The gift includes a single, two-level central rail station as well as various track pieces (including ramps, curves, and switching sections) and miniature figures to represent clients and employees. In developing their own rail line, users develop their spatial reasoning abilities and design knowledge. Children especially enjoyed this gift and commented on how they liked the ability to build on upper and lower levels and loved reenacting a busy commute—lights, PA system, and all!
Squirrels Go Nuts!  
smartgamesusa.com  
$14.99

6+  
LT, P

IQ Stars  
smartgamesusa.com  
$9.99

6+  
LT, P

Kanoodle Extreme  
educationalinsights.com  
$14.99

8+  
CriT, PS

Asteroid Escape  
smartgamesusa.com  
$14.99

8+  
LT, P

Kanoodle Head to Head  
educationalinsights.com  
$21.99

7+  
CriT, PS

Kanoodle Extreme includes over 300 2-D, 3-D, and sliding 2-D puzzles. To play, select a puzzle from the provided book, set up the pieces according to the diagram, and then place on the remaining pieces to solve the challenge. Users will need to use logical thinking, spatial reasoning, and critical thinking skills as they problem solve through this puzzle game. Parents appreciated that the playing pieces, puzzle board, and booklet with instructions and challenges all compactly fit together in its carrying case making it perfect for travel and storage. Kids loved the variety of challenges and enjoyed solving the puzzles!
Otis and Will Discover the Deep is the story of two people, a scientist and an engineer, who shared a dream to explore the deep ocean, a place where humans had never been before. In its 44 pages, it follows the interests that inspired Otis Barton and Will Beebe to design their incredible Bathysphere submarine and brave the deep, where any crack in their machine could cause water to gush in at nearly the speed of a bullet! As readers follow along with Otis and Will preparing for the deep ocean and designing their craft, they can learn about some of the incredible discoveries that were made as a result of this amazing engineering project.
Rosie Revere and the Raucous Riveters is the first book in the Questioneers chapter book series. In the story, the Blue River Riveters elicit a solution from Rosie to help a fellow Riveter participate in an upcoming art contest after she breaks both of her wrists in an motor-scooter accident. We love that Rosie is designing for a purpose, applies her knowledge and experience to create a solution, works with a team, and persists until she has a viable solution. Kids familiar with Beaty’s work loved reading more about Rosie Revere, Ada Twist, and Iggy Peck and enjoyed being introduced to new characters. Parents liked the diversity of characters in the book and that the main character is a strong, smart female.
Engilina’s Trains is the third book in the Engibears series written by Andrew King and illustrated by Benjamin Johnston. The 40-page story brings back Engilina, Engibear and Bearbot in a story that explores trains of the past, present and future as the bears work to build a new maglev train that will run from Munagong to Billaburra. Parents and children both especially loved all of the details on the pictures and diagrams. They felt it added additional content to the story and made it fun to read over and over.

Engilina’s Trains written by Andrew King illustrated by Benjamin Johnston littlesteps.com.au $24.95 hardcover

Coder Academy written by Steve Martin illustrated by Essi Kimpimäki usbornebooksandmore.com $12.99 paperback

Sasha Savvy Loves to Code written by Sasha Ariel Alston illustrated by Vanessa Brantley Newton sashaarielalston.com $14.99 hardcover

Max the Demon vs Entropy of Doom written by Assa Auerbach illustrated by Richard Codor maxthedemon.com $24.95 paperback

Hubots: Real-World Robots Inspired by Humans written by Helaine Becker illustrated by Alex Ries kidscanpress.com $17.99 hardcover

Jack and the Geniuses: Lost in the Jungle (#3) written by Bill Nye & Gregory Mone illustrated by abramsbooks.com $13.99 hardcover

Artificial Intelligence written by Henry Brook usbornebooksandmore.com $8.99 flexi-binding
Curiosity: The Story of a Mars Rover tells the story of how scientists and engineers worked together to design, build, and launch the titular Mars rover, but readers get to see the process from the rover’s point of view! It’s 48 pages long, and follows from Curiosity’s design process to its launch, its voyage across space, and finally to its experiments on the Red Planet. It was a favorite of both parents and children for its engaging illustration style and exciting story.
The Circuit Blox electronic building kit offers users the chance to develop circuit design skills without the hassle of breadboards, wire stripping, or easy-to-lose components by embedding its parts within versatile plastic building bricks. Through its included step-by-step instructions, children are taught the fundamental principles of parallel and series circuits and learn how to design various electrical creations including lights, motors, and a crystal radio! Parents appreciated how easy it was for users to manipulate the components and redesign their solutions, and children loved the chance to work with lights, sound, and movement.
We sat down with Monica Cardella and asked her to share advice and tips for doing engineering at home based on her research and experience as a mom.

**Do you need to be an engineer to engage your child in an engineering activity?**
Absolutely not! They key thing is that you know your child. This is more important than having an engineering background. Even if you don't have a lot of time to learn about engineering, you can do things like use the words “engineering” and “design”, ask your child questions about who they are designing for and what they need, and encourage your child to keep trying. Using spatial language (like “length”, “width” and “height”) also helps children develop spatial reasoning skills.

**How do you let your children know you want them to take the lead?**
There are a variety of ways that you can let your child know that you want them to take the lead. Sometimes when my daughter asks me a question, rather than immediately answering her question I ask her “what do you think?” If we are just starting an activity, I might say “what do you think we should do?” or “how should we get started?” or “what do you think our goal is?” I also try to watch my daughters to get a sense of how they are approaching a project or a problem so that I can ask questions that match what they are already doing. Other times I might remind them of a previous experience where they were successful — “I bet you have some good ideas for how we can do this, because I remember you did a great job with …”

**How do you encourage persistence when your children want to give up on a tough problem?**
I sometimes will say that “this is tricky” or “this is frustrating that we haven’t figured this out yet” to show them that it’s okay that they are experiencing some frustration. But then I add that “the key thing is that you are still trying.” Or at other times I might suggest that we take a break so we can get a fresh perspective. I often remind my daughters that engineers usually don’t get it right the first time, but they learn from their mistakes. The book “The Most Magnificent Thing” helps kids to see another child go through a process of getting stuck and getting frustrated but then trying again and finally getting it right.

**What are examples of good open-ended questions to use with children?**
Some of my favorites are: “What are you designing? Who are you designing it for? What do they need”, “Tell me about the approach you are taking. What’s working well? What might you do differently?” and “Tell me about your design. Why did you decide to …”

Dr. Monica Cardella is an Associate Professor in the School of Engineering Education at Purdue University and Director of the INSPIRE Research Institute for Pre-College Engineering. For additional resources for parents based on her research go to: purdue.edu/INSPIRE/Resources.
The **Grippies Shakers** construction toy is an introductory building toy to help young children develop design and spatial reasoning skills. Between oversized, textured gripping surfaces, large-scale parts that are easy to manipulate and hard to misuse, and magnetic connection points to reduce dependence on fine motor skills, Grippies possesses a number of features that are well-suited to young builders. Parents appreciated the tactile and audible functions of the gift, while children at the intended age particularly liked the smooth shapes and bright colors!
IO Blocks Vehicles
guidecraft.com
$49.95

Panelcraft Rainbow Solids
panelcraft.com
$149.00

Magformers Sky Track
magformers.com
$99.99

TileBlox Rainbow 30 pc set with Magnetic Activity Board
magformers.com
$49.99

Mini Unit Bricks
Builder Set - 40 pc.
unitbricks.com
$42.00

Mini Unit Bricks
Architect Set - 72 pc.
unitbricks.com
$55.00

Interlox Squares
guidecraft.com
$19.95

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Each Hape **Flexistix Kit** comes with varying flexible silicone connectors and bamboo rods. This simple but innovative toy allows children to build using the provided instructions or to design and create something new! We loved how the instructions are clear, but not step-by-step, allowing children to exercise their spatial reasoning skills. Children loved how easy the pieces were to put together and take apart and that the pieces allowed them to build whatever they wanted, while parents liked the price point and versatility of the toy.
Pattern Play 3D, designed to help teach spatial reasoning skills, includes 22 wooden blocks of various shapes and 40 individual challenges. Each challenge shows the user a 2D view of a wooden structure, and using the provided blocks, he/she must construct the corresponding 3D picture. Children enjoyed the variety of challenges and loved using the brightly colored blocks. Parents liked the fact that kids were having fun but were challenged and learning at the same time.
The Toca Blocks app by Toca Boca is designed for creative open-ended block play. Players are able to construct an endless number of worlds. The game gives inspiration through its blocks with a variety of attributes and characters that have unique abilities. Players are able to snap photos and share block codes with others. Children loved building and creating their own worlds and making new block combinations. Parents liked that there were no ads, in app purchases or violence.
The Tinker Hydraulic Claw, one of Tinker Crate’s monthly “crate” releases, challenges users to build (and then redesign) a hydraulic-powered, actuating mechanical hand. Included are a number of structural components, tubes, and syringes to build the model, along with instructions for the basic claw design and discussion about why the model works the way it does. We really liked that users were encouraged to modify the design after they’d built the standard model, introducing the concept of an iterative design process!
Letting children take the lead is the first step to increasing their interest and levels of persistence, says Monica Cardella, Ph.D., Associate Professor in the School of Engineering Education at Purdue University, Director of INSPIRE and a mom of two girls. She shares with us tips for parents and educators based on research that studied 39 family groups interacting at a museum exhibit that engaged visitors in an engineering design activity.

**PLAY A SUPPORTING ROLE**

Children will often take charge of problems presented to them, especially in environments where they feel comfortable and supported. Researchers observed that children have a greater degree of interest in an activity when they are leading interactions. While it’s important to engage with them and with the problem at hand, too much adult input is likely to take ownership of the problem away from them; help children learn, but give them space to direct and lead.

**BEGIN A DIALOGUE**

It is important to provide more than acknowledgment or praise when children work to solve engineering problems. Contributing suggestions, constructive comments, and asking clarifying questions can cause children to think more about different aspects of the problem at hand, and it helps children to see their parents as role models who are also engaging in the engineering process.

**ENCOURAGE PERSISTENCE**

Being willing to stay focused on a problem even after setbacks is an important skill to learn in early childhood. Parents can assist not only by providing encouragement on tough problems, but also by acting as a role model and sticking with the problem, providing positive feedback and new perspectives even when children may be discouraged about their progress.


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