

CREATE IT, TRY IT, MANUFACTURE IT

STEM²D Topics:
Manufacturing and Design

Target Population:
Students, ages 9-13



Create It, Try It, Manufacture It is part of the STEM²D Student Activities Series. Developed by FHI360 and JA Worldwide as part of Johnson & Johnson's WiSTEM²D initiative (**W**inning in **S**cience, **T**echnology, **E**ngineering, **M**ath, **M**anufacturing, and **D**esign), the series includes more than 10 interactive and fun, hands-on activities for youth, ages 9-18 globally.

CREATE IT, TRY IT MANUFACTURE IT

STEM²D Topics: Manufacturing and Design

Target Population: Students, ages 9–13

ACTIVITY DESCRIPTION

Students identify the importance of personal experiences to making career choices. They recognize the wide variety of opportunities available in manufacturing for people with STEM²D skills and training.



ESTIMATED TIME

This activity typically takes **45–60 minutes** to complete and should be conducted in one session.

STUDENT DISCOVERIES

Students Will

- Participate in a team-based learning experience.
- Learn how STEM²D-science, technology, engineering, math, manufacturing, and design-subjects are involved in the the creation of something from raw materials by hand or by machinery.
- Build important STEM²D skills, such as exploring problems and design thinking.
- Recognize that STEM²D offers diverse and exciting career opportunities.
- Have fun experiencing STEM²D.

GETTING READY

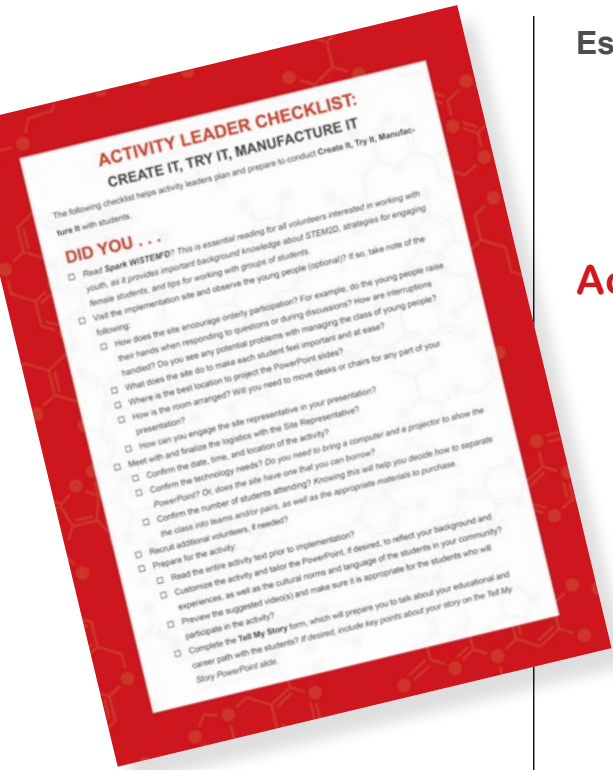
Materials

- Computer with projector, speakers, and Internet access
- PowerPoint: Create It, Try It, Manufacture It
- Activity Leader Checklist
- Tell My Story Form
- Student Handout (*1 per student*)
- Fountain pens (*Create It! Challenge, 1 per team*)
- Copy paper (*Create It! Challenge Optional Activity (5–10 sheets per team)*)
- Pencils



STEM²D Skills

- Creativity
- Critical Thinking
- Decision Making
- Problem Solving
- Teamwork



Estimated Materials Cost:

Activity leaders can expect to incur \$10.00 in materials costs when completing this activity with 20 students organized into teams of four students.

Activity Leader Preparation

1. Read **Spark WiSTEM²D**? This is essential reading for all volunteers interested in working with youth, as it provides important background knowledge about STEM²D, strategies for engaging students, and tips for working with groups of students.
2. Review the **Create It, Try It, Manufacture It Activity Leader Checklist** for details and specific steps for planning and preparing to implement this activity.
3. See the **STEM²D Student Activities Series Overview** for additional information.

STEP-BY-STEP ACTIVITIES: CREATE IT, TRY IT, MANUFACTURE IT

1. Welcome and Introductions (10 minutes)

- Greet the students. Begin the PowerPoint.
- **(Tell My Story Slide)** Tell the students your name and your organization/company. Talk about your educational and career path. Use the Tell My Story form as the basis for your remarks. Be prepared to describe your job or a typical day, and provide information about your background including:
 - Your education—focus on secondary and postsecondary classes and courses
 - Current work projects
 - Interests and hobbies
 - Why you love STEM²D, and how your work is connected

Write your introduction ideas here.

TIPS FOR STARTING CONVERSATIONS:

Conversation Starters are provided throughout and include questions designed to introduce students to the activity topics. Use the questions—modify them, or add others—to engage your students.

- Ask the students and any volunteers helping today to introduce themselves.
- Use the Conversation Starters to learn more about the students and their interests.
- **(Today's Plan Slide)** Review Today's Plan.
- **(More About Me Slide)** Distribute the Student Handouts. Have the students consider their personal skills and interests. Have them identify three skills and three personal interests. Define **skill** as the ability to do something well, and reiterate that it takes time and practice to acquire new skills. An **interest** is something you are good at doing or enjoy. Allow time for the students to record their responses on the handout.
- Ask the students to consider what or who is the biggest influence on their future career or work choices? Allow time for the students to record their ideas. Ask the students to share their ideas with someone sitting near them. Call time and ask for volunteers to tell you about their conversations.
- Explain that young people have access to more information than ever before, so the big question is, how do you make career decisions?
 - Do you seek advice from your family?
 - Talk with your teachers?
 - What about social media?
 - Are the answers online?
- According to a report conducted by the Manufacturing Institute, Skills USA, and the Educational Research Center of America, an overwhelming number of students identified personal experiences as having the greatest influence over their career decisions. Which means young people are in charge of their career decisions.
- Tell the students about any vocational learning experiences, job shadow experiences, or internship programs you participated in. Share any mistakes you made along the way, and talk about how you were able to overcome them, or how they resulted in a new direction.
- Discuss the opportunities that exist in the local community to support students as they develop their personal experiences.
- Tell the students that your career is only one of the many

CONVERSATION STARTERS: CAREER PLANNING

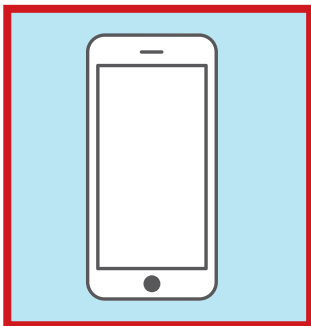
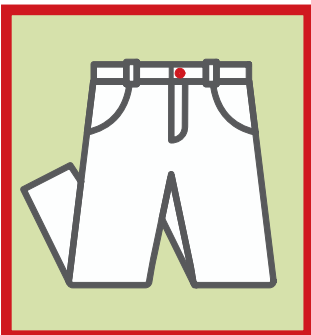
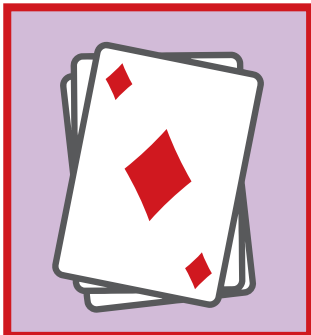
- When you consider your future, what are you most excited about? What interests you?
- Are you familiar with manufacturing? Do you know how people create things? Can you imagine a job in manufacturing? What do you think people do?
- What does the perfect work day look like to you? Are you outdoors? Are you working alone, or with others? Do you solve problems? Do you fix or build things?

KEY WORDS

- Skill
- Interest

KEY WORDS

- STEM²D
- High-demand, high-growth careers
- Technical Skills
- Workstations



careers available in **STEM²D**—science, technology, engineering, math, manufacturing, and design.

- Explain that STEM²D careers are **high-demand, high-growth careers** and are predicted to remain in demand over the next 10 years.
- Some STEM²D careers do not require a college degree and offer young people exciting, high-paying opportunities. Stress the important of gaining math skills and engineering practices to succeeding in any STEM²D career.

2. Manufacturing Presentation (10 minutes)

- Ask the students to consider the statement, If I could create or build anything, it would be _____. Give them a minute to write or draw their response on their handout. Ask for volunteers to share their responses.
- **(More About Manufacturing Slide)** Tell the students that manufacturing is creating something from raw materials by hand or by machine. This industry is often overlooked because young people are not familiar with the opportunities that exist across the different industries, including: medical supplies, automobiles, electronics, clothing, toys, and pharmaceuticals.
- Manufacturing today is not necessarily all about big equipment and heavy lifting. Learning more about manufacturing and experiencing it doesn't have to be, either. Experiencing opportunities in manufacturing includes earning a technical education and learning **technical skills** (skills needed to complete specific tasks), but it also is about making things, being creative, designing solutions, solving problems, performing experiments, and making things better.
- Explain that many products are manufactured and assembled on a production line. A typical production line consists of a series of **workstations** where a number of tasks and operations are performed.
- **Try It.** Have the students work with someone sitting close to them to generate a list of products they use. Have them consider different industries including: electronics, automotive, industrial, health care, clothing, and even sports, and record their lists on the handout.

- Evaluate the lists, and as a class consider how these products were manufactured or created. Also consider the industry involved in manufacturing the products. Many of the items were manufactured by skilled trades workers.

3. **Create It! Challenge (15–20 minutes)**

- Organize the students into teams (four students per team). Assign a number to each member of the team (Workers 1–4).
- Explain that today teams will develop assembly instructions to manufacture a fountain pen.
- **(Create It! Challenge Slide)** Distribute a fountain pen to each team. Tell the teams they will have 5 minutes to take the pen apart, **catalog** (generate a list) the raw materials and tools needed to assemble the pen, and write a simple assembly process to manufacture the pen (put it back together).
- Have the teams use their handouts to record their lists and assembly instructions.
- Call time and ask each team to share their materials lists and assembly process. Did the teams test their assembly instructions? Are they confident another team could use the instructions to assemble the pen? Ask if they considered how their process could include workstations. Did each worker complete a separate task to manufacture the pen? Reinforce that workstations are key to a manual manufacturing process, (workers completing separate tasks on a production line).
- Now that they have a list of materials and assembly instructions, ask the teams to estimate the number of pens they could assemble in 10 minutes.
- Have teams share their estimates. Compare the numbers. It was likely easy for the teams to estimate the number of fountain pens they could manufacture in 10 minutes, but it is equally likely that manual manufacturing is not the best way to manufacture this product.
- What if the task was to make hundreds of thousands of fountain pens over an entire year? How would they feel about that? Discuss ways teams could increase the number of pens manufactured.

TIPS FOR WORKING WITH STUDENTS AND STARTING CONVERSATIONS: Create It! Challenge

- Provide support to the teams as necessary, moving around to ensure participation from all team members.
- Encourage teams to consider the different ways to work through these manufacturing challenges.
- Encourage creativity and risk-taking in their discussions.
- Other, more substantial items could be used in place of the fountain pens. This requires additional preparation time, but items could include: used games, toys, electronics, small appliances, or anything that can be safely pulled apart and re-assembled during the activity time.

KEY WORD

- **Catalog**

KEY WORD

• Automation

➤ Assembly lines are a way to mass produce goods quickly and efficiently. Robot and/or humans can make up an assembly line as well.



- Adding more people is one way. But that can be costly and difficult to get the number of workers needed to manually manufacture pens.
- **(Automation Slide)** Ask the teams to consider **automation** or automatically controlling the manufacturing process using mechanical or electronic devices that take the place of human labor.
 - If possible, display the How to Make a Tennis Ball embedded video for a visual representation of an automated manufacturing line.
 - Explain that machinery including robots is great at doing the same tasks over and over without ever getting tired. Machines are often faster and more efficient than humans.
 - This is what manufacturers, engineers, and business people do—they think about what they need to accomplish and weigh their options against cost and time constraints. If you skip the optional challenges, move ahead to the Student Reflection and wrap up the activity.

Create It! Challenge Optional Activity: Paper Airplanes (15–20 minutes)

OPTIONAL

- Organize the students into teams (four students per team). Assign a number to each member of the team (Workers 1–4).
- **(Create It! Challenge Optional Activity Slide)** Explain that teams will manufacture paper airplanes using a manual manufacturing process. Each team member will complete separate tasks to manufacture one plane. Present the basic manufacturing steps required to produce the product prototype.
 - **Worker 1:** Fold the sheet of paper in half the long way to form a crease. Unfold. Next, fold down the top corners toward the centerline to form a triangle at the top.
 - **Worker 2:** Fold the two edges in toward the centerline.
 - **Worker 3:** Fold the paper in half along the original center crease to form a valley. Rotate the paper 90 degrees.
 - **Worker 4:** Create a wing crease that begins at the nose.
- Distribute multiple sheets (start by distributing five (5) sheets) of copy paper to each team. Tell the teams they will have 2 minutes to manufacture airplanes.

- Reinforce the importance of quality control. Each step should be followed completely, and the production done correctly to ensure the planes are manufactured at the highest level of quality.
- Call time. Have teams report on the number of planes they completed. If they produced X number of planes in two minutes, have teams calculate the number of planes they can manufacture in 10 minutes. If students completed the fountain pen challenge the automation information that follows does not need to be repeated.
- What if the task was to make hundreds of thousands of paper airplanes over an entire year? How would they feel about that? Discuss ways teams could increase the number of planes manufactured.
- Adding more people is one way. But that can be costly and difficult to get the number of workers needed to manually manufacture planes.
- Ask the teams to consider **automation** or automatically controlling the manufacturing process using mechanical or electronic devices that take the place of human labor.
 - If necessary, display the How to Make a Tennis Ball video embedded on (**Automation Slide**) for a visual representation of an automated manufacturing line.
 - Also explain that robots are great at doing the same tasks over and over without ever getting tired and most times machines are faster than humans. The best thing is that robots won't get paper cuts! This is what manufacturers, engineers and business people do—they think about what they need to accomplish and weigh their options with cost and time constraints.

(Optional Activity Slide) Need More of a Challenge?

- Have teams test a plane and determine what modifications could be made to improve the design. Challenge teams to “send” you three new plane designs in two minutes.
- Have the teams discuss their strategy before and after manufacturing the planes to determine possible modifications.
- Ask each team to talk about their designs using the following questions to encourage team responses:
 - What is the best feature of the design? Why?

TIPS FOR WORKING WITH STUDENTS:

Optional Create It! Challenges

Consider customizing the activity to the interests, and abilities of your students. Additional challenge options are provided to assist you.

- Have teams manufacture origami cranes. Click <https://search.yahoo.com/yhs/search?p=how+to+fold+a+origami+crane&ei=UTF-8&hspar=mozilla&hsimp=yhs-002> for a visual tutorial.
- Use the optional paper airplane manufacturing activity, and increase the complexity by:
 - Asking teams to determine ways to make and “send” three plane designs to their customers in a very short amount of time.
 - Discussing strategy before and after manufacturing the planes to determine ways to improve plane designs, considering the constraints, and ways used to manufacture their planes.

- Describe the steps it took to get the design to work.
- What was the hardest problem to solve?
- Did the team do anything more than once? If so, what?
- If you had more time, how would you improve the design?

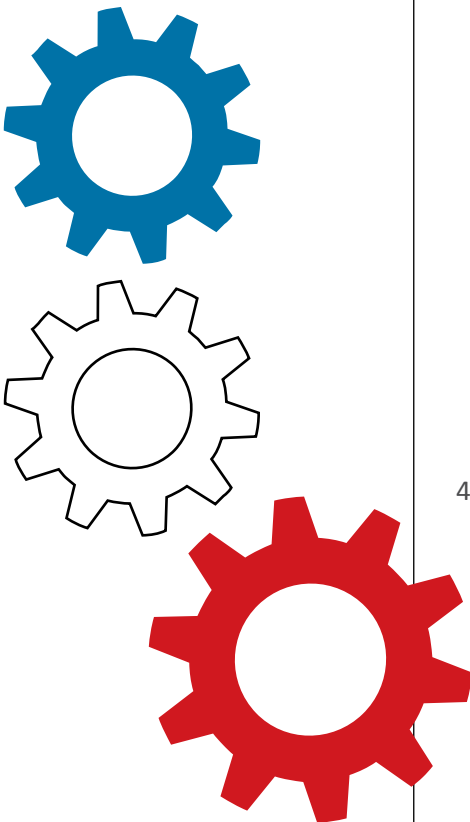
Create It! Challenge, Most Challenging Option (20 minutes)

OPTIONAL. This challenge is only an option for students and activity leaders who completed another activity from the STEM²D Student Activities Series (Change It, Create It, Solve It, Engineer It).

- This option is provided for students that completed the Change It, Create It, Solve It, Engineer It activity. Student teams can use their Learning Game Concept (prototype) to complete this challenge option.
- **(Learning Game Concept Challenge Slide)** Ask the students to start considering how they would manufacture their game (board or card) after developing the concept and prototype. Have the students list all the game pieces involved, including those they need to design and create, in order to manufacture the game. Consider sharing the following questions as students begin designing and creating their games:
 - What materials are needed if they decide to sell this game?
 - What is the current demand on supply?
 - How many game sets would teams need to make?
- **(How It's Made Slide)** After designing and making their learning games, show students how toy figurines are made. Display the video. Students will be surprised how making simple things like toy figurines involves a significant amount of design, materials, science, and automation!

4. Student Reflection (10 minutes)

- **(Reflection Slide)** Wrap up the activity by asking the following student reflection questions:
 - What are three things you are learning in school that will help you prepare for a career in STEM²D?
 - Complete the statement. "I'm interested in creating a personal experience by spending time with or learning more about someone who works as a _____."
 - If you had the opportunity to explain why STEM²D skills



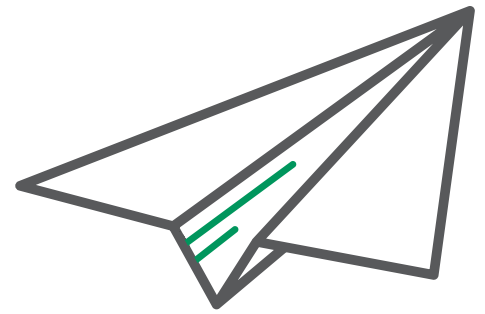
are important to acquiring your ultimate career goal, what would you say?

- Did your original thinking about STEM²D careers and professionals change? Why or why not?
- Can you see yourself working in manufacturing? Why or why not? What is needed to make this happen?
- Thank the students for their efforts and participation, and congratulate them on completing this activity. Encourage the students to continue exploring careers in STEM²D. Reassure them that they can do STEM²D!

Extended Learning

Here are a few ways to extend the learning:

- Another exciting manufacturing opportunity is in the efforts by industries to grow a workforce capable of designing, specifying, making, and supporting 3D printed products. 3D Printing, also known as additive manufacturing, refers to various processes used to produce a three-dimensional object.



➤ A robotic arm is an automated way to control the manufacturing process.



- Successive layers of material are formed under computer control to create the object.
- These objects can be of almost any shape or geometry and are produced from a 3D model or other electronic data source such as an Additive Manufacturing File (AMF) file. The possibilities are endless.
- Flipped Classroom Option, Work with the teacher to assign the 3D Printing Explained and Building Structures with 3D Printing videos. Have the students watch the videos and prepare questions or observations to discuss prior to meeting as a class.
 - 3D Printing Explained:

<https://www.youtube.com/watch?v=Vx0Z6LplaMU>

With 3D Printing you can create your own jewelry, toys, and even food! Before, it was difficult to make customized or personalized parts especially out of plastic or metals because of the manufacturing process. Now with 3D Printing, it is easy for anyone to design and make their creations in their own home! Scientists and engineers are now also researching how this can be used to manufacture custom products and even implantable body parts. What would you want to make with 3D Printing?
 - Building structures using 3D Printing:

<http://thekidshouldseethis.com/post/building-a-house-the-eco-friendly-way-with-3d-printing>

Inspired by plant patterns, the reusability of waste materials, and architecture made from the earth in locations around the world, Ronald Rael and Virginia San Fratello of Emerging Objects studio are exploring, testing, failing, and learning about their large-scale 3D Printing structures.
- The Maker Movement is making its move and involves everything from making terrariums to building instruments. It is a fun way to get kids excited about how things are made and provides a learning environment that encourages kids to use manufacturing processes to create objects. Visit Make at <http://makezine.com> to learn more about maker spaces and get ideas for DIY (do it yourself) activities for the classroom.
- Complete the career interactives (Play the Part) at

<http://www.juniorachievement.org/s3/apps/STEM/index.html>

presented in the JA Assembling Your Career supplement. This online resource provides students with an opportunity to create personal STEM²D career experiences.

Key Words

Automation: Automatically controlling the manufacturing process using mechanical or electronic devices that take the place of human labor.

Catalog: Generate a list of materials and tools.

High-demand, high-growth careers: Occupations predicted to have more positions available than qualified applicants over the next 10 years.

Interests: Things you like and enjoy.

Prototype: An early model or experiment to rapidly create solutions to challenges and problems.

Resources: Materials used to develop solutions people need and want.

Skill: The ability to do something well.

STEM²D: Is an acronym that refers to science, technology, engineering, math, manufacturing, and design.

- **Science:** Observing, studying, and experimenting in an effort to better understand the natural world and how it works.
- **Technology:** Putting science and other knowledge to practical use to solve problems, invent useful tools, envision new possibilities, and establish meaningful connections between people and the world that surrounds them.
- **Engineering:** Applying science and math principles to design and develop products, structures, machines, tools, or systems that improve everyday life.
- **Math:** Using a quantitative framework (numbers, quantities, shapes, abstract principles, and problem solving) to describe the world.
- **Manufacturing:** Creating something from raw materials by hand or by machinery.
- **Design:** Creating, constructing, or inventing an object, plan, product, or system; it is also a human-centered mindset and collaborative approach that results in better experiences by uncovering unmet needs and championing meaningful relationships through user-friendly products, environments, and systems.



➤ Engineering students use a 3D printer in the lab.

Workstations: Points along a production line where a number of tasks and operations are performed.

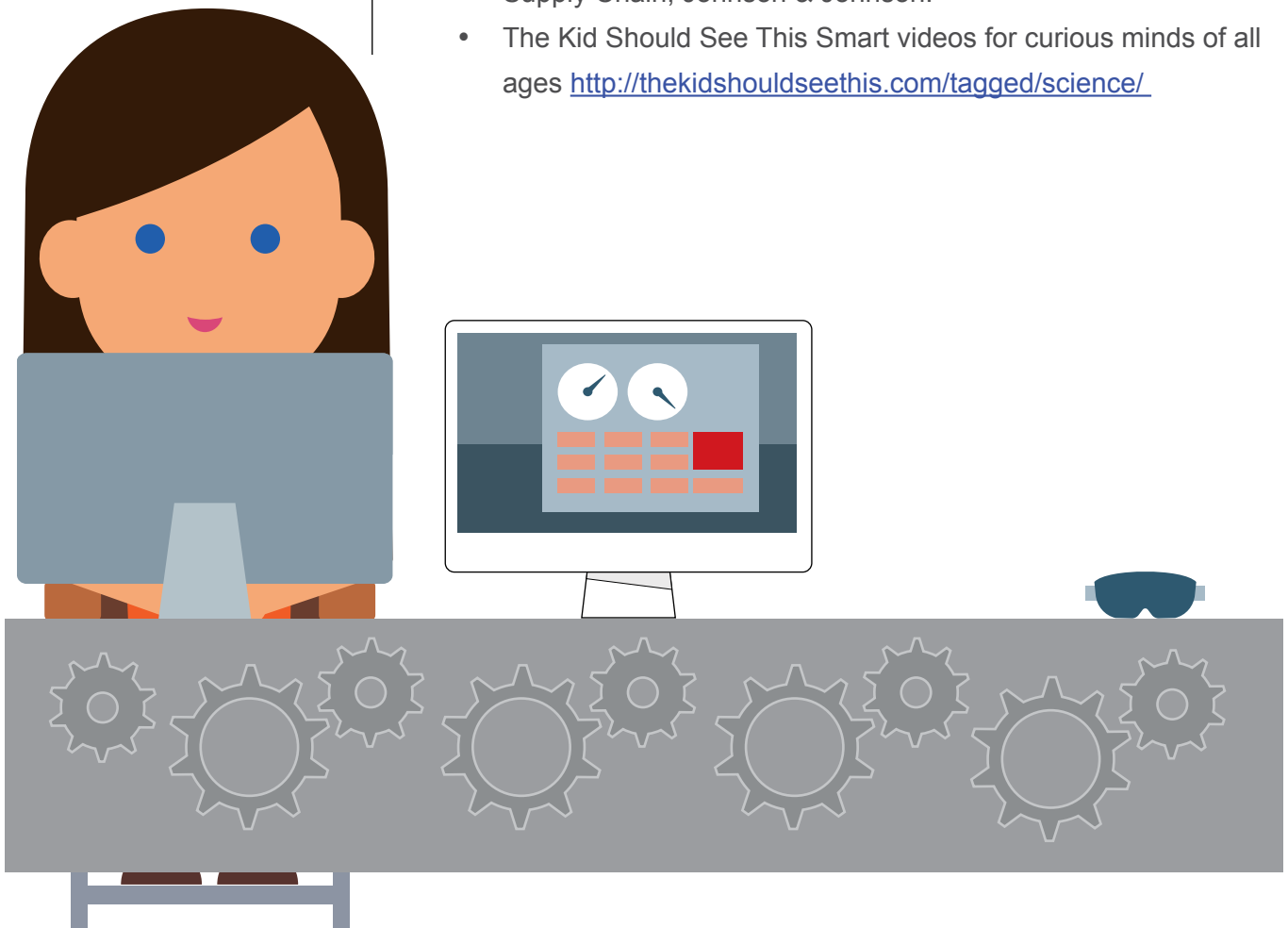
Activity Leader Reflections

After completing the activity, take a few moments to reflect on the following questions about implementing this activity:

- What went well and what could be improved? What would you do differently next time?
- How comfortable did you feel talking about STEM²D, including: manufacturing and design?
- Do you have a better understanding of STEM²D concepts?
- How useful was the information presented in **Spark WiSTEM²D** to implementing this activity?
- Will you volunteer for this type of experience again?

Resources and References

- Activity concepts and real-life connections provided by Ellen Oh, Global Strategic Design Office, and Binyah Kesselly, J&J Supply Chain, Johnson & Johnson.
- The Kid Should See This Smart videos for curious minds of all ages <http://thekidshouldseethis.com/tagged/science/>



ACTIVITY LEADER CHECKLIST:

CREATE IT, TRY IT, MANUFACTURE IT

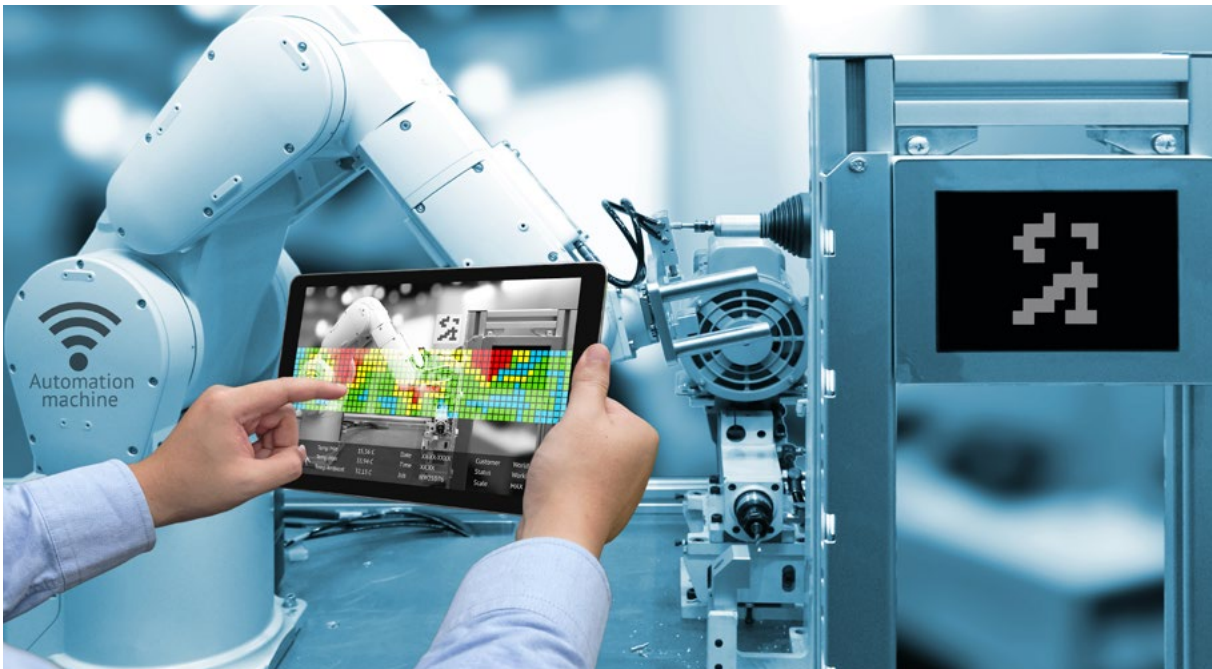
The following checklist helps activity leaders plan and prepare to conduct

Create It, Try It, Manufacture It with students.

DID YOU . . .

- Read **Spark WiSTEM²D**? *This is essential reading for all volunteers interested in working with youth, as it provides important background knowledge about STEM²D, strategies for engaging students, and tips for working with groups of students.*
- Visit the implementation site and observe the young people (optional)? If so, take note of the following:
 - How does the site encourage orderly participation? For example, do the young people raise their hands when responding to questions or during discussions? How are interruptions handled? Do you see any potential problems with managing the class of young people?
 - What does the site do to make each student feel important and at ease?
 - Where is the best location to project the PowerPoint slides?
 - How is the room arranged? Will you need to move desks or chairs for any part of your presentation?
 - How can you engage the site representative in your presentation?
- Meet with and finalize the logistics with the Site Representative?
 - Confirm the date, time, and location of the activity?
 - Confirm the technology needs? *Do you need to bring a computer and a projector to show the PowerPoint? Or, does the site have one that you can borrow? Does the site have Internet access? Can you use it for this activity?*
 - Confirm the number of students attending? *Knowing this will help you decide how to separate the class into teams and/or pairs, as well as the appropriate materials to purchase.*
- Recruit additional volunteers, if needed?
- Prepare for the activity:
 - Read the entire activity prior to implementation?
 - Customize the activity and tailor the PowerPoint, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
 - Preview the suggested video(s) and make sure it is appropriate for the students who will participate in the activity?
 - Complete the **Tell My Story Form**, which will prepare you to talk about your educational and career path with the students? If desired, include key points about your story on the PowerPoint (see **Tell My Story Slide**).

- Determine how you will assign the teams? Students will be working in teams of four students. It is recommended that you randomly assign students to each team; this will foster the skills needed to work with new people.
- Obtain the required materials (see the **Materials** and **Estimated Materials Costs** section) and photocopy the **Student Handouts**? In addition:
 - Practice completing the Manufacturing Challenge(s) you identified for the activity.
 - Practice your presentation, including the hands-on, minds-on activity? Be sure to:
 - Review the Key Words and be prepared to discuss your skills and interests.
 - Consider the types of jobs you interact with daily to help the students recognize what or who can influence their future careers and work choices (see **Student Handouts**).
 - Review the Manufacturing Challenge options and determine which you will use during the activity.
- Set up the site appropriately for the activity? Specifically:
 - Make sure tables and chairs are arranged to accommodate teams of students—four students per team.
 - If additional volunteers are available, assign one adult to work with two or three teams.
 - Set up the computer and projector for the PowerPoint presentation; be sure that speakers and an Internet connection are available.
 - Bring a camera, if desired, to take photographs.
- Obtain and collect permission slips and photo release forms for conducting the activity if applicable?
- Have fun!**



Tell My Story Form

This form will help volunteers serving as activity leaders prepare to talk about their **STEM²D** interests, education, and career path.

ABOUT YOU

Name: _____

Job Title: _____

Company: _____

When/Why did you become interested in STEM²D? _____

What do you hope young people will get out of this activity? _____

FUN FACT

Share a little about your background. Ideas:

- Share a memory from childhood where you first had your spark or interest in STEM.
- Detail your journey; highlight what you have tried, what you learned, steps to success, etc.
- Failures or set backs are also great to talk about—difficulties, and/or challenges and how you overcame them.

EDUCATION AND CAREER PATH

What classes/courses did you take in secondary school and in college that helped or interested you most?

How did you know you wanted to pursue a STEM²D career?

What was your postsecondary path, including the institution you attended and your degree? *If you switched disciplines, make sure you explain why to the students.*

What your current position entails. *Be sure to include how you use STEM²D on a typical work day.*

CREATE IT, TRY IT, MANUFACTURE IT

Student Handouts

Use the space to record your responses.

My three skills:

My three interests:

What or who is the biggest influence on my future career or work choices?

If I could create or build anything, it would be:

Try It. My list of products manufactured across multiple industries:


Create It! Challenge

Teams have 5 minutes to take the pen apart, catalog (generate a list) the raw materials and tools needed to assemble the pen, and write a simple assembly process to manufacture the pen (put it back together). Consider the assembly order when writing/sketching your assembly procedure.

Raw materials and tools

Assembly process

Raw materials and tools	Assembly process

The background of the page is a solid red color with a repeating pattern of white chemical structures. These structures include various organic molecules such as benzene rings, alkenes, alcohols, and complex ring systems, all rendered in a light, semi-transparent white color.

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