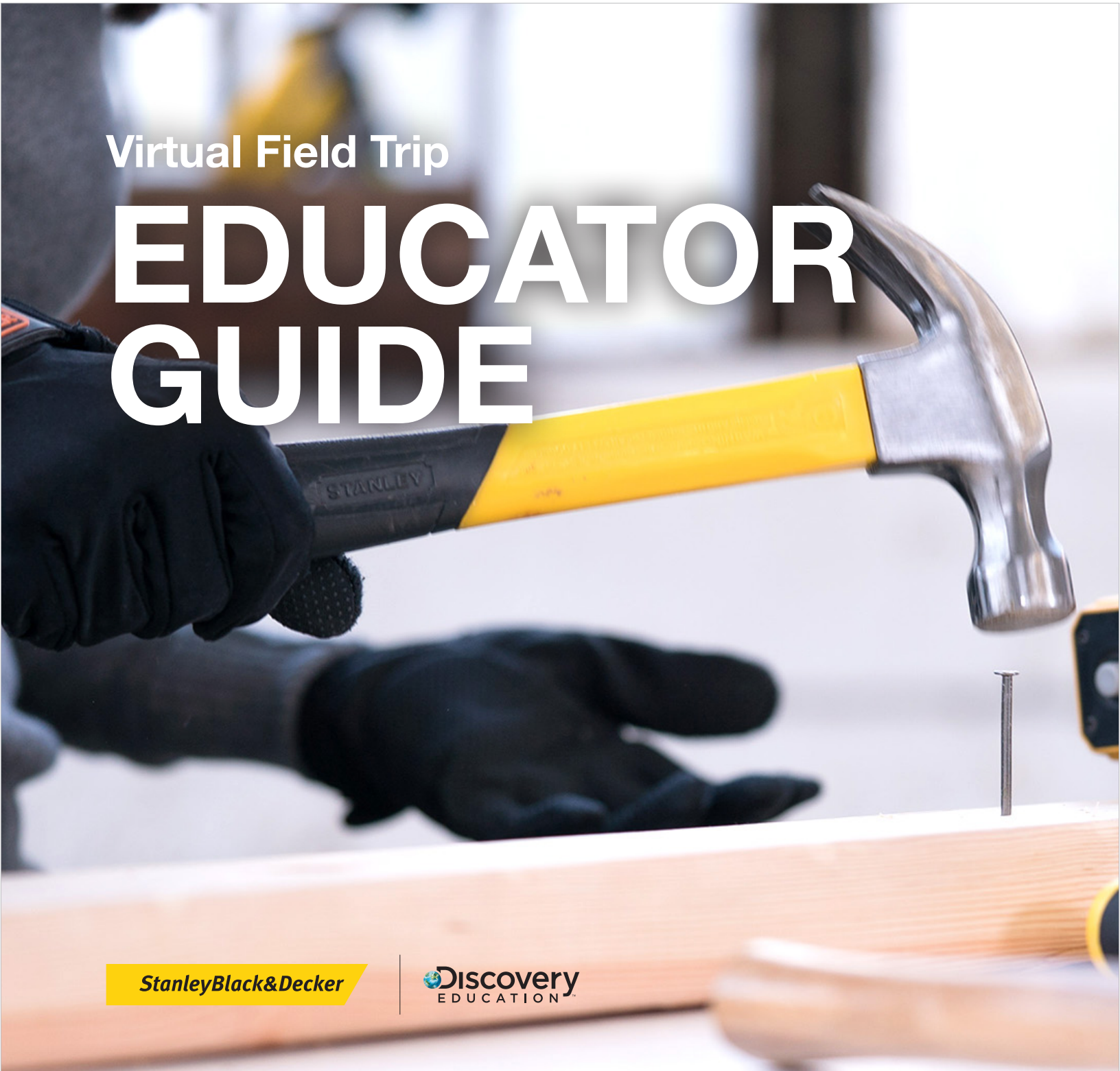
INNOVATION GENERATION
Making an Impact



Virtual Field Trip

EDUCATOR GUIDE

StanleyBlack&Decker | Discovery EDUCATION

Pre- and Post-Activities

Time Frame: Plan for two class periods (45 minutes) over two days.

Background

We live in an era of unprecedented technological advances. Technology today allows people a quality of life unimaginable to our forebears. Electronic devices, modern transport, and a wide range of home appliances enable us to live in relative comfort and ease. It's easy to take modern technological wonders for granted. But how did we get here? What innovations led to the advanced technologies we enjoy today? The basis for technological innovation is the design process. Engineers and scientists follow a formal model of iterative steps that lead to innovation. Each step improves on the last so that the end product optimizes trade-offs between function and cost. In these activities, students will build an understanding of the role of the design process in innovation and technology.They will map steps of the design process to a specific product to relate those steps to stages in production innovation and development. After participating in the Virtual Field Trip, students will work in groups to apply the design process to create a technological solution related to a familiar problem of their choosing.

Overview

The Stanley Black & Decker Virtual Field Trip introduces your students to a one-of-a-kind Makerspace. Students will learn what it takes to solve problems using the design process. Your students will join two teams of students in the Makerspace to see how expert Stanley Black & Decker employees compete to win our *Challenge, Concept, Create* competition! For this competition, students work with the employees to brainstorm, design and then build crash test cars. Each team has a limited set of materials to create their cars, which have to go as fast as possible while carrying a hard-boiled egg as a passenger. While the teams build their cars using the design process, your students learn more about Makerspaces from Mike Murray, Open Innovation Manager at the Stanley Black & Decker Makerspace. Students also learn about careers in innovation and how Makerspaces have become a key feature of innovative companies. Students then learn from the teams how they applied the design process to building their cars. Finally, the big show is on as the crash test cars race to the finish! As a follow-up, students apply their experience with the VFT to solve their own design problems, and identify STEM careers that match their skills, interests, and experiences.

Objectives

Students will:

- Identify steps of the design process.
- Apply the design process to "reverse-engineer" a specific product.
- Apply the design process to solve a specific problem using a technological solution.
- Identify STEM careers that match their skills, interests, and experiences.

National Standards

Next Generation Science Standards: Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (MS-ETS1-1)

ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the

criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)

- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (MS-ETS1-3)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

Materials

- Access to the Internet
- Presentation software
- Images of machines and devices
- Evaluating Innovation in Technology Careers capture sheet
- Engineering Design Cycle Graphic Organizer
- Engineering Design Process Planning Sheet

Pre-VFT Activity

To help prepare for the Virtual Field Trip, engage students in a discussion around the design process. Explain that the design process is a method that scientists and engineers use to solve problems. To assess prior knowledge and address early misconceptions, use a gallery walk with images of machines or devices that have evolved over time, such as automobiles, aircraft, or various hand-tools. Example questions or prompts for each image:

- How does this prototype differ from earlier or later versions?
- Are there specific innovations of this prototype compared with earlier versions?
- How would scientists or engineers identify features of this prototype that needed improvement?
- What factors would scientists or engineers have to consider when improving an earlier design?

Next, ask students to work in small groups or pairs and distribute the Engineering Design Cycle Graphic Organizer. Invite students to organize the seven steps in a cycle. Review their ideas and clarify the sequence should be: Ask, Research, Imagine, Plan, Create, Test, and Improve. Explain to students that the engineering design process is an iterative "trial and error" method that engineers use to break large problems down into smaller, more manageable parts.

Finally, ask students to brainstorm examples of projects they have worked on where they have had to design something. If needed, prompt students to consider activities that involved an element of design, such as a hobby or craft, experiment, or presentation. In their examples, encourage students to recall "learning moments" where things might not have gone as planned, leading to an improvement or innovation.

Engage with the Virtual Field Trip Today!

Five activity options are available for students to obtain information as they watch the Virtual Field Trip.

Activity 1: Applying the Design Process

Working in small groups or pairs, students make notes about the teams' crash cars. Encourage students to analyze steps in the crash car design process to identify the part of the design process diagram to which each step belongs, and to update their diagrams with the details of that step.

Students also evaluate the teams' actual designs to identify innovations and anticipate potential issues with features of the design. As students work on their diagrams, encourage them to use the #InnovationGenVFT to tweet @discoveryed to ask the teams questions or to share ideas.

Activity 2: How Would You Use a Makerspace?

As students watch the interview with Mike Murray, ask them to make notes about Makerspaces. If needed prompt students with questions such as:

1. What is a Makerspace?
2. What could you do in a Makerspace that would be hard to do at home?
3. Why does the Makerspace inspire innovation?
4. If you had access to a Makerspace, what you make?

Activity 3: Innovation Process

As students watch the segment with Stanley Black & Decker Makerspace's Anna Goodridge outlining the process they use to create new products, ask them to note their ideas arising from Anna's answers to the interviewer's questions. If needed, prompt students with questions:

1. How do you use the 4C's in the innovation process?
2. How is failure a vital part of the innovation process?

Activity 4: Innovation Process

As students watch the segment with Stanley Black & Decker's Audrey Van de Castle talking about some of the machinery and technology available, ask them to note their ideas arising from the descriptions of each piece of machinery or technology. If needed, prompt students with questions:

1. How does machinery or technology contribute to the innovation process?
2. What are the benefits of cutting-edge technology such as 3D printers and CNC routers?

Activity 5: Innovation and Technology Careers

As students watch the segment with the two coaches talking about the kinds of challenges the students are encountering, encourage students to think about the design process and the role of team work. Then ask students to consider the kinds of careers related to design and innovation. If needed, prompt students with questions:

1. What is the most challenging part of the innovation and design process?
2. What are the benefits of working on a project in a team instead of alone?
3. What are the main challenges of working in a team?
4. What kinds of jobs would be available for someone interested in a STEAM career?
5. What skills would you need to have a career in a STEAM-related field?

Don't forget to also watch the Pre-VFT sneak peek to get your class excited for the live event!

Post-VFT Activities

Two activity options are available for students to apply information they learned from the Virtual Field Trip.

Activity 1: Applying the Design Process

Following the VFT, students will apply the design process to solve a specific problem using a technological solution. Distribute the Engineering Design Process Planning Sheet for students to organize their solution seeking process. Depending on students' abilities, consider assigning an open-ended project in which students create a technological solution related to a familiar problem of their choosing. Students work in small groups to brainstorm daily issues and problems they encounter and select an appropriate problem to resolve. If needed, students can use the crash test car project as depicted in the VFT, or this can be presented as an example of how the design process is applied to a problem of their own choosing. As students approach their design problem, remind them that the design process can be applied to parts of a problem as well as the problem itself. If you wish to use a specific example, the team can use the design process to optimize the design of the wheels of their crash test car, or the design of how the egg is protected from the crash. A full activity guide is included on Innovation-Gen.com.

Procedure for designing and testing the crash test car:

1. Refer back to the VFT to identify the materials, machines and technology available to use in the project. (Not all materials or machines are essential. The key is to apply the design process to create a crash test car that can meet the design requirements.) For a math component to this activity, students can measure independent and dependent variables such as the distance the car moves (e.g., down a ramp of given height) and the car weight.
2. Encourage students to use their prior learning from the pre-VFT activity and during the VFT to apply the design process to their own crash test car design. If needed, guide students through the following steps:
   a. Identify the problem (e.g., how will the design optimize the tradeoff between the car's speed and the safety of the egg? What are the constraints?)
   b. Explore potential solutions (The team brainstorms to explore potential solutions for the design. Bear in mind that brainstorming allows for any and all solutions to be on the table initially. If needed, review brainstorming protocols with students.)
   c. Choose a solution (The team reviews the potential solutions and chooses one that is closest to meeting the design criteria.)
   d. Build the prototype (The team uses the available materials to build the design chosen as a solution.)
   e. Evaluate the prototype (The team evaluates the solution in terms of meeting the initial objectives of the design.)
   f. Improve the design (The team discusses issues with the design and how to improve it. The team then returns to the first step to implement the improvements.)
3. If time allows, teams can create a digital resource to illustrate how they applied the design process and arrived at their final design.
4. Teams race their cars to see which team has the best design

Engage students in a discussion around the following questions about how they applied the design process:

1. What was the biggest challenge in creating your design?
2. What was the value of brainstorming as part of the design process?
3. How well did your prototype meet the initial design requirements?
4. What kinds of improvements did you make to your initial design?

Activity 2: Evaluating careers

In this activity, students identify STEAM careers that match their skills, interests, and experiences. Use a specific teaching strategy such as the PMI strategy. If needed, review the VFT content, focusing on the Stanley Black & Decker employees and their roles. As students consider the video, encourage them to categorize information to determine the elements that help them evaluate the careers of interest. Using the PMI approach, students complete the chart with plus (P) items (e.g., aspects of a career that they would like), minus (M) items (e.g., aspects of a career that they wouldn't like), and then items that need more information (I) before they can evaluate. If time allows, students can research specific careers to add more information to their charts.

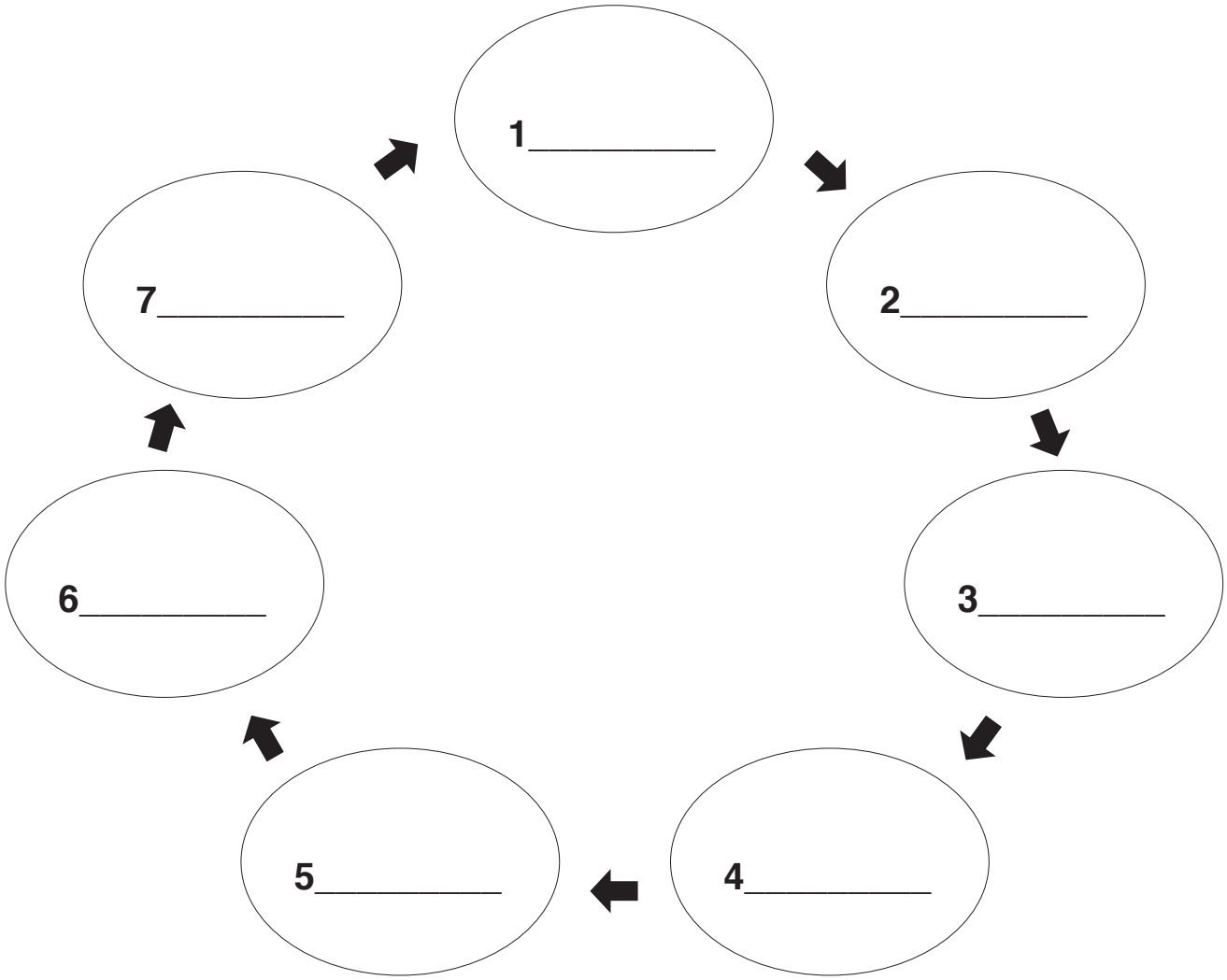
Engage students in a discussion around the following questions:

1. What career do you think is most appealing or interesting?
2. What requirements for college might prepare you for this career?
3. Imagine yourself having this career. How do you see yourself after two, five or ten years in that career?

Engineering Design Cycle Graphic Organizer

Directions: Place the steps in the engineering cycle from the Word Bank in the correct order in the diagram.

Word Bank				
Imagine Improve	Test Plan	Create	Ask	Research



Engineering Design Process Planning Sheet

Directions: Use this planning sheet to help you create a solution to a problem you identified with your small group.

Ask
Identify a problem you want to solve.

Imagine
Brainstorm ideas and solutions.

Plan
Draw a diagram or sketch out your ideas. Make a list of materials you may need.

Engineering Design Process Planning Sheet

Directions: Use this planning sheet to help you create a solution to a problem you identified with your small group.

Create
Follow your plan and make something.

Test
Plan how you can test your idea and record data.

Improve
Discuss what can work better next time. How can you change your design?

Evaluating Innovation in Technology Careers

Directions: Complete the columns of the graphic organizer below as you watch the Stanley Black & Decker employees in the Virtual Field Trip (Day 2). In the plus column, write the things you would like about that career. In the minus column, write the things you would not like about that career. In the Information column, write the things about that career that you find interesting and would like to learn more about.

Career: Open Innovation Manager

Plus (+)	Minus (-)	Information

Career:

Plus (+)	Minus (-)	Information

Career:

Plus (+)	Minus (-)	Information