

Facilitation Guide: Think Inside the Box (Redesigning packaging to reduce waste)

Challenge

Students will choose a product and, using Glowforge, design new packaging that minimizes the amount of materials used, lowers production costs, and maintains the [product's integrity](#) during transport or shipping. They'll consider packaging materials, shape, aesthetics, durability, and usability in their design process. Students will begin by exploring product packaging that manufacturers regularly use, then they'll brainstorm ideas for more innovative packaging. After redesigning the product's packaging, they will develop a prototype using Glowforge and conduct tests to ensure safe transport.

Rationale

Manufacturers are often asked to develop more eco-friendly and sustainable packaging that provides cost savings to businesses. In this challenge, students will consider how to adapt existing product packaging to reduce excess waste and lower company costs for production, shipping, and materials.

If a product's integrity is compromised during shipping, companies incur additional expenses for returns and replacements and risk losing repeat business. Students will employ critical thinking and problem solving skills to create packaging that both maintains their product's integrity during shipment and reduces waste.

Manufacturers are [increasingly using 2D and 3D print technology](#) to create [sustainable](#) and cost-effective solutions. Utilizing Glowforge allows students to strategically design packaging to eliminate excess waste while keeping production costs low. Glowforge can cut, etch, and engrave a wide variety of materials that allow aesthetic appeal, durability, and sustainability.

Standards

Common Career Technical Core Standards

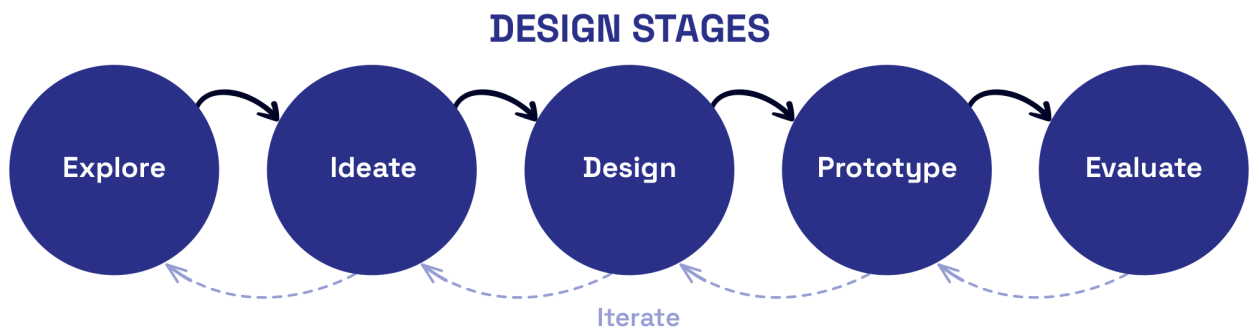
- MN-PPD 4 Implement continuous improvement processes in order to maintain quality within manufacturing production.
- MN 2 Analyze and summarize how manufacturing businesses improve performance.

- MN 6.1 Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing.

ISTE Standards for Students

- Innovative Designer 1.4.c Students develop, test and refine prototypes as part of a cyclical design process.
- Innovative Designer 1.4.d Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
- Creative Communicator 1.6.b Students create original works or responsibly repurpose or remix digital resources into new creations.

Facilitation Steps to Support the Design Process



[Image: Design_stages_graphic.png]

Explore

In this stage, students will research packaging solutions that minimize waste and decrease business costs. To ensure that students have the knowledge and skills they need to complete this stage, use the following steps:

1. Provide students with question prompts from the Explore stage of the challenge to help inspire their research on efficient product packaging.
2. Provide students with resources and a brief introduction to product packaging for waste reduction and cost minimization.
 - Inspire students with resources for [creative packaging solutions](#) and [eco-friendly packaging examples](#).
 - Have students listen to the [McKinsey Talks Operations podcast on the concept of skinny design](#) to learn more about how smaller packaging can benefit companies and the environment.
 - Help students discover ways to [reduce packaging costs and increase profit](#) or learn more about the [problems of packaging waste](#). Students will also want to consider why it is important to [package products appropriately for transport](#).
3. Teach students how to complete a [cost analysis](#) to evaluate the cost savings of their packaging. They will complete this later in the challenge.

4. Ask students to share their findings and discuss what they learned during the Explore stage.
 - Encourage students to share both in small and large groups. If students are working in groups to complete this design challenge, have different groups partner together to discuss what they discovered.
 - Facilitate a class discussion about alternative packaging solutions and materials that are more sustainable, durable, aesthetically pleasing, and cost-effective.

At the end of this stage, students will reflect on the research they did to learn more about product packaging solutions. Encourage them to consider cost saving and waste reduction opportunities as well as packaging that's durable for shipping.

Before moving on, students should consider if there are any other resources or techniques that would be helpful to explore. Next, students will continue to the Ideate stage where they will brainstorm packaging solutions for their chosen product.

Ideate

In this stage, students will take their research and experiment with different ideas for packaging their product. This stage allows students to explore as many ideas as possible without judgment. Remind students to consider both cost and waste reduction as well as shipping integrity. To ensure that students have the knowledge and skills they need to complete this stage, use the following steps.

1. Provide students with question prompts from the Ideate stage of the challenge to help them brainstorm.
2. Encourage students to brainstorm ideas using one or more methods.
 - Allow students to brainstorm individually or in small groups to utilize multiple perspectives.
 - Provide students with [different ideation strategies](#) to help them begin.
3. Inspire students to evaluate the packaging of products they use regularly and consider how it might be adapted to reduce cost or waste while maintaining product integrity and visual appeal.
 - Prompt students to create a mind map or concept map to visualize and organize their ideas by technique, durability, problem solved, or other categories.

At the end of this stage, students will have generated multiple ideas for their product packaging and should be able to narrow their focus to a design that most effectively minimizes waste and decreases cost while ensuring integrity during transport.

Before moving on, students should consider which ideas are more feasible for production. In the next stage, they will select one or two ideas to develop further.

Design

In this stage, students will draft a detailed plan and digital model for their product packaging. Students should focus on one or two ideas to better understand their needs and final design before printing. Encourage students to consider the durability of the packaging as well as how to minimize costs and waste. To ensure that students have the knowledge and skills they need to complete this stage, use the following steps:

1. Provide students with question prompts from the Design stage of the challenge to help them design.
2. Introduce, review, or model available design software options, including [the Glowforge App](#).
 - Assist students as they create sketches or digital mockup of their product design. Consider having students use CAD software like [SketchUp](#) or [AutoCAD](#) to create detailed 2D and 3D designs. Use [this library of dieline templates](#) to help student get started.
 - Remind students that Glowforge can engrave from JPG or PNG image files and cut or engrave from SVG and PDF files. This means students can create something in popular software that they already use, convert it to one of the supported file types, and print using Glowforge.
 - Review page 28 in the [Glowforge Educator Guide](#) for more software tools and information.
3. Assist students as they begin designing their product packaging.
 - Help students identify the materials and tools they may need to create a functional prototype.
 - Remind students to consider the product's size, shape, and fragility. They may need to think about how to most efficiently layout their designs to make the best use of their materials or reuse material scraps for fillers.
 - Support students in selecting sustainable, durable, visually appealing, and cost-effective materials. Have students calculate the difference in surface area as well as individual versus bulk material cost to prepare for a cost analysis.

At the end of this stage, students will have a detailed plan for their product packaging design, including sketches or digital mockups.

Before moving on to the Prototype stage, students should consider if they would like to revisit their design further to change anything.

Prototype

In this stage, students will use their design plan to create physical packaging. Students will select one of their fully developed design plans, print necessary elements on the Glowforge, and test their techniques. To ensure that students have the knowledge and skills they need to complete this stage, use the following steps:

1. Model how to use Glowforge in a safe and efficient manner.

- Review the [Glowforge safety guidelines](#) and support students in understanding what materials can be safely printed on using the [Glowforge User Manual](#).
 - Remind students of any applicable classroom or school policies.
 - Use this [video](#) to demonstrate how to use Glowforge.
2. Provide students with question prompts from the Prototype stage of the challenge to help them develop their prototype.
 3. Give students the time and resources needed to produce their packaging. Then encourage students to test their packaged product to ensure durability in transport.
 - Provide students with access to Glowforge using a classroom print schedule to ensure that all students are able to produce their packaging.
 - Provide students with any additional supplies or materials they may need to add to or test their packaging.

At the end of this stage, students will have a finished packaging prototype that effectively reduces cost and waste.

Before moving on, students should review their finished packaging to ensure it can be shipped efficiently and effectively. Students may need to test multiple times or return to earlier stages of the design process before moving on. Once they are finished, students will continue to the Evaluate stage where they will receive feedback on their finished packaging.

Evaluate

In this stage, students will evaluate their packaging prototype and receive feedback from others. Feedback can be provided in pairs, small groups, or as a whole class. Encourage students to reflect on their process and consider their alignment to cost savings, waste management, and shipping effectiveness. To ensure that students have the knowledge and skills they need to complete this stage, use the following steps:

1. Provide students with question prompts from the Evaluate stage of the challenge to help them evaluate their product packaging.
2. Help students complete a [cost analysis](#) to evaluate the cost savings of their packaging. Remember that time is money, so students should consider [production time and labor](#) as part of their analysis.
3. Encourage students to share and discuss their product packaging to generate feedback and suggestions from their peers to refine and enhance their efforts.
 - Students can use the question prompts from the Evaluate stage to guide their discussions.
 - Use a peer feedback model, such as a gallery walk, trade show reviews, or business pitch panel, to support students as they work together.
4. Facilitate a class discussion that compares and contrasts original product packaging to student's redesigned product packaging.
 - Encourage students to share their reflections and lessons learned from the challenge.

- Inspire students to consider their redesigns from different perspectives, including thinking about shipping effectiveness and durability, cost savings, and waste reduction.

At the end of this stage, students will be able to reflect on the strengths and areas for improvement of their product packaging. Students should determine whether revisions are needed and return to the appropriate stage in the design process to adjust their packaging. Consider assessing student work using one of the Assessment Suggestions or extending the challenge using provided Extension Activities.

Supplemental Supports

- For newer Glowforge users, demonstrate how to use Glowforge and its design features, including the design software, engraving capabilities, and cutting functionality. Check out the [Glowforge Educator Guide](#) for more ideas.
- For students looking to add joinery or movable elements to their packaging, introduce them to [The Miracle Hinge](#) or [Noticing Patterns](#) lessons that help develop an understanding of hinges and gears. Students can also use [this guide](#) to learn more about printing joinery. Check out how to create a living hinge with the help of [Glowforge TV](#) or the [Glowforge Community](#).
- Want to get students started with just a simple box before trying this open-ended challenge? Watch Nick and Bailey on [Glowforge Livestream](#) as they model how to build the perfect box. Then check out [Boxes.py](#) or [Templatemaker.nl](#) to generate box templates.

Assessment Suggestions

Overall Learning Reflection

Learning reflections allow students to reflect on their learning experiences, identify key concepts, and explain how they have grown throughout the packaging design process. Ask students to write or record a video about what they learned throughout the challenge and how their learning will impact future product packaging, waste reduction, and cost savings efforts. Students can incorporate feedback elements from the Evaluate stage to describe their strengths and areas for improvement.

Self-Assessment

Self-assessments allow students to reflect on their learning through portfolios, presentations, or learning journals that involve evaluating their own progress and identifying areas for improvement. Consider providing criteria to students prior to beginning the challenge that can be used by the student to reflect on their progress throughout the challenge. The criteria may include:

- Innovation: How well did I incorporate new materials or manufacturing processes to develop creative, unique packaging that is sustainable?

- Feasibility: How feasible is the new packaging for large-scale production and distribution?
- Aesthetics: How visually appealing is the new packaging to potential consumers?

Educator or Peer Assessment

Educator or peer assessments allow educators or students to review the quality and effectiveness of the finished product packaging. The assessment can be based on specific criteria, such as waste reduction, cost-effectiveness, and product integrity, or use a more open approach like a trade show gallery walk. Some criteria to consider may include:

- Waste Reduction: Did the packaging effectively reduce waste in both production and consumer use?
- Cost-Effectiveness: Did the packaging effectively minimize company costs?
- Product Integrity: Was the product able to withstand transport and maintain its integrity?

Extension Activities

Design challenges often inspire students to think about what's next. For some, this could mean connecting with people within the manufacturing industry or applying their skills in new ways. Here are a few ideas for how you can help students extend this challenge:

- Encourage students to conduct consumer research to gather feedback on their new packaging design. They can use this feedback to improve their design and make it more appealing to consumers.
- Help students connect with local businesses to identify and develop more sustainable and cost-effective packaging solutions. Students will be able to network with local manufacturers to gain real-world expertise related to business and consumer needs.
- Help students understand the business dynamics of product development through [Waste to Wealth](#), where students examine how decisions about materials, production time, and selling platforms can impact the profitability of a product. They might also enjoy [Sold! Build e-Commerce Success](#), where students consider how a product design and pricing can be adapted to support a successful e-commerce business by thinking about the cost of production, labor, and shipping.

If your students enjoyed this challenge, they might also enjoy [Shrink-o-Matic Challenge](#), a design challenge that engages students in understanding product scale to adapt a product's dimensions while maintaining quality and efficiency.

Ready to take the students to the next level? Try the Capstone Challenge: [Sustainable Strategies for Circular Design](#), where students redesign a disposal product to incorporate circular design principles for manufacturing.