Unit 1: Technological Inventions and Innovations

Lesson 2: Technological Effects on New Processes

Lesson Snapshot

**Big Idea:** New technologies affect how things are invented, produced, and used.

**Teacher’s Note:** Big ideas should be made explicit to students by writing them on the board and/or reading them aloud. For deeper understanding, have students write the Big Idea in their own Engineering Design Journal (EDJ), using their own words, if they choose.

**Purpose of Lesson:** Unit 1, Lesson 2 introduces the concept of technology transfer: New technologies create new processes, and a change in technology can change the process of creating a product.

**Lesson Duration:** Three (3) hours.

**Activity Highlights**

**Engagement:** Students construct a geodesic dome using pipe cleaners and paper straws (File 1.2.1) to gain experience with the geodesic dome as a structure.

**Exploration:** Students reflect on the geodesic dome construction and propose how they could increase the efficiency of the construction (e.g., combination of steps, new tools, gauges, etc.). This leads into the Explanation, which reinforces that development of technology leads to new processes or changes in production.

**Explanation:** The teacher presents that often new technologies lead to new processes or a change in production processes (Presentation 1.2.1), using two examples that relate to the Exploration: 1. The buckyball (soccer ball) as a spinoff from the geodesic dome; and 2. How students generated a new technology to perform a function in the Engagement. The teacher gives another example including a manufacturing process and describes how that process changed with the introduction of robotics (e.g., automotive industry). The teacher explains that technology transfer occurs when a new user applies an existing innovation developed for one purpose to a different function. The human ability to shape the future comes from a capacity for generating knowledge and developing new technologies—and for communicating ideas to others.

**Extension:** Students apply technology transfer to propose a new product (other than a shelter) based on the structure of a geodesic dome (File 1.2.2). Students modify their models from the Engagement to model their proposed designs.

**Evaluation:** Student knowledge, skills, and attitudes are assessed using brief constructed response items and performance rubrics for class participation, discussion, and design briefs.
Unit 1: Technological Inventions and Innovations

Lesson 2: Technological Effects on New Processes

Lesson Overview

Lesson Duration
Three (3) hours.

Standards/Benchmarks

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>STL 2</strong> Students will develop an understanding of the core concepts of technology.</td>
<td></td>
</tr>
<tr>
<td><strong>STL 3</strong> Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.</td>
<td></td>
</tr>
</tbody>
</table>

| Mathematics: Principles and Standards for School Mathematics (NCTM, 2000) |
|---------------------|--------------------------------------------------|
| **Measurement Standard (NCTM, 9-12)** |
| Apply appropriate techniques, tools, and formulas to determine measurements. |
| ● Analyze precision, accuracy, and approximate error in measurement situations. (NCTM, Measurement 13S) |

Learning Objectives
Students will learn to:

1. Discuss how new technologies are used to create new processes.
2. Explain how the introduction of a new technology would change the current process used in creating a product.
3. Describe a technology transfer that took place when a new user applied an existing innovation developed for one purpose in a different function.
4. Analyze precision and accuracy of measurements to construct and modify components as necessary to build a geodesic dome.

Student Assessment Tools and/or Materials

1. Quiz (Pre-/Post-Content Knowledge Questions).
   a. Technology transfer occurs when:
      i. One society uses a product from another society.
      ii. An innovation used for one purpose is used for another purpose.

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1 Standards are listed with the permission of the National Council of Teachers of Mathematics (NCTM). NCTM does not endorse the content nor the validity of these alignments.
iii. An innovation is used in different time periods.
iv. One society deems a product unethical.

b. Which of the following represents new technologies creating new processes?
   i. The integration of robotics in manufacturing.
   ii. Geodesic domes used for structures.
   iii. Inventions being shared between cultures.
   iv. The unintended effects of a product.

2. Brief Constructed Response Item: **Write one-paragraph answers. Include strong topic sentences with good supporting details to support your answers.**
   - New technologies create new processes.
   - All technologies have effects other than those intended by the design, some of which may have been predictable and some not.
   - Side effects of technologies may turn out to be unacceptable to some of the population and therefore lead to conflict between groups.

3. Brief Constructed Response Item Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Below Average</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding</td>
<td>Response demonstrates an implied, partial, or superficial understanding of the text and/or the question.</td>
<td>Response demonstrates an understanding of the text and/or the question.</td>
<td>Response demonstrates an understanding of the complexities of the text and/or the question.</td>
</tr>
<tr>
<td>Focus</td>
<td>Lacks transitional information to show the relationship of the support to the question.</td>
<td>Addresses the demands of the question.</td>
<td>Exceeds the demands of the question.</td>
</tr>
<tr>
<td>Use of Related Information</td>
<td>Uses minimal information from lectures, discussions, or texts to clarify or extend meaning.</td>
<td>Uses some expressed or implied information from lectures, discussions, or texts to clarify or extend meaning.</td>
<td>Effectively uses expressed or implied information from lectures, discussions, or texts to clarify or extend meaning.</td>
</tr>
</tbody>
</table>
4. Class Participation Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Below Average</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Rarely prepared. Minimal effort to participate.</td>
<td>Prepared for class. Attempts to answer teacher-generated questions.</td>
<td>Well prepared for class. Attempts to answer teacher-generated questions and adds additional information to class when relevant.</td>
</tr>
<tr>
<td>Curiosity</td>
<td>Rarely demonstrates curiosity.</td>
<td>Usually demonstrates curiosity.</td>
<td>Consistently demonstrates curiosity.</td>
</tr>
<tr>
<td>Use of Time</td>
<td>Gives up easily. Is not engaged. Has difficulty remaining on task.</td>
<td>Makes good use of class time to work on assignments and projects.</td>
<td>Makes excellent use of class time to work on assignments and projects.</td>
</tr>
</tbody>
</table>

5. Design Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Below Average</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Prototype</td>
<td>Product prototype represents the new product design by modifying the original geodesic dome.</td>
<td>Product prototype represents the new product design by modifying the original geodesic dome, paying attention to craftsmanship.</td>
<td>Product prototype accurately represents the new product design by modifying the original geodesic dome using quality craftsmanship.</td>
</tr>
<tr>
<td>Specifications</td>
<td>The product design meets at least two of the specifications.</td>
<td>The product design meets all but one of the specifications.</td>
<td>The product design meets all of the specifications.</td>
</tr>
<tr>
<td>Explanation of Product</td>
<td>Includes the target market, the purpose of the product, and some effects the product would produce.</td>
<td>Includes the target market, the purpose of the product, and positive and negative effects the product would produce.</td>
<td>Includes the target market, the purpose of the product (including the basic human need or want solved by the product), and all conceivable positive and negative effects the product would produce.</td>
</tr>
</tbody>
</table>
Resource Materials

Note: Books, periodicals, pamphlets, and websites may provide teachers and students with background information and extensions. Inclusion of a resource does not constitute an endorsement, either expressed or implied, by ITEEA.

Audiovisual Materials

Print Materials

Internet Search Terms and Suggested Sites
- geodesic dome


Required Knowledge and/or Skills
Students should have some basic graphic, measurement, and Internet research skills.
Unit 1: Technological Inventions and Innovations

Lesson 2: Technological Effects on New Processes

5-E Lesson Plan

Engagement
The students, in groups of three, construct a geodesic dome using pipe cleaners and paper straws (File 1.2.1). During construction, the teacher circulates the room to assist as needed.

*Teacher Note: To help students with construction, it is recommended to provide a color copy of the dome assembly.*

Exploration
The students, within their groups from the Engagement, reflect on the geodesic dome construction and propose how they could increase the efficiency of the construction (e.g., combination of steps, new tools, gauges, etc.) in their Engineering Design Journals. The teacher facilitates a gallery walk from each of the groups to share with the entire class.

*Teacher note: A gallery walk is where each group depicts its ideas on a large sheet of paper (explanation in words, pictures, diagrams), posted around the room. Each group rotates around the room, with the teacher timing each rotation (approximately one to two minutes), until they have observed each group’s responses.*

Explanation
The students take notes in their EDJs on the content delivered by the teacher and actively participate throughout the presentation. The teacher involves students in the following presentation (Presentation 1.2.1) as they contribute their experiences from the Engagement and Exploration activities along with any prior knowledge they may have about the subject:

1. Explains that often new technologies lead to a new process or a change in how processes and products are invented.
2. Provides examples that related to the exploration—for example, the buckyball as a spinoff of the geodesic dome—and of a manufacturing process, describing how that process changed with the introduction of robotics.
3. Explains that technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.
4. Explains that human ability to shape the future comes from a capacity for generating knowledge and developing new technologies—and for communicating ideas to others.
5. Explains that side effects of technologies may turn out to be unacceptable to some of the population and therefore lead to conflict between groups.

Extension
Students complete File 1.2.2 to apply technology transfer to propose a new product (other than a shelter) based on the structure of a geodesic dome. Students will modify their models from the Engagement to model their proposed designs. The teacher distributes File 1.2.2 and provides the appropriate materials for students to model their solutions.
**Evaluation**

Student knowledge, skills, and attitudes are assessed using brief constructed response items and performance rubrics for class participation, discussion, and design briefs. The rubrics are presented in advance of the activities to familiarize students with the expectations and performance criteria. They are also reviewed during the activities to guide students in the completion of assignments. The teacher may wish to develop a collection of annotated exemplars of student work based on the rubrics. The exemplars will serve as benchmarks for future assessments and may be used to familiarize students with the criteria for assessment.
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Laboratory-Classroom Preparation

Teacher Preparation
The classroom or laboratory must provide a learning environment that provides for lecture and demonstration, small-group meetings, and research activities.

Tools/Materials/Equipment

Below is a list of supplies and equipment that are needed to teach this course, assuming a class of 25 students. Optional/additional supplies required for Enrichment Activities are indicated. Where possible and appropriate, merchants are listed that support ITEEA; however, materials may often be obtained from alternative and/or local sources.

Additionally, these materials are based upon the lessons in the course and make no assumptions for classrooms with access to specialized equipment (e.g., fabrication equipment). If the student has access to specialized equipment, the teacher may wish to incorporate the use of it into the lessons, and additional supplies may be necessary (as well as safety procedures).

<table>
<thead>
<tr>
<th>Item</th>
<th>Potential Supplier</th>
<th>Quantity</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Lab</td>
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<td>25</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Research Resources</td>
<td>Not Listed</td>
<td>Not Listed</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Scissors and Rulers</td>
<td>Not Listed</td>
<td>Not Listed</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Materials to Build and Modify Geodesic Dome</td>
<td>Not Listed</td>
<td>Not Listed</td>
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</tbody>
</table>

Laboratory-Classroom Safety and Conduct

Note: Safety is of paramount importance to every classroom. While this Guide contains some general safety guidelines, it does not address the specific tools, equipment, and working spaces found in any specific classroom. Teachers must provide comprehensive safety guidelines to students based upon individual classrooms.

1. Students use tools and equipment safely, maintaining a safety level for themselves and others in the laboratory-classroom.
2. Students demonstrate respect and courtesy for the ideas expressed by others in the class.
3. Students show respect and appreciation for the efforts of others.
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File 1.2.1: Geodesic Dome

What is a Geodesic Dome?
A geodesic dome is a sphere-shaped structure made up of a series of triangles. The dome uses a minimum amount of material to achieve its structural strength. Buckminster Fuller invented the geodesic dome in 1949.

Steps to Building a Geodesic Dome:
With your group, complete the following steps to construct your own geodesic dome. Use the plastic bag given to you to store the parts during construction.

1. Cut the straws given to you by your teacher to the lengths and quantity indicated below.
   
   Straw Lengths Used:
   A = 6.55” (30 yellow)
   B = 7.58” (40 blue)
   C = 7.75” (50 red)

2. Use the pipe cleaners given to you by your teacher to create the appropriate connectors as indicated below:
   
   4-way connectors = 15 (cut 15 pipe cleaners in half and twist together to make an X)
   5-way connectors = 6 (cut 6 pipe cleaners in three parts and twist together)
   6-way connectors = 25 (cut 40 pipe cleaners in three parts and twist together)

   Note: The lengths of the straws and number of pipe cleaners were determined the Dome calculator, located at: http://www.desertdomes.com/rev3calc.html.

3. Use the color copy of the dome diagram on the next page (Figure 1) to assemble the straws and pipe-cleaner connectors.
4. When finished, show the dome to your teacher.
Figure 1

http://www.desertdomes.com/pics/dome/3vdiagram2.gif
Unit 1: Technological Inventions and Innovations

Lesson 2: Technological Effects on New Processes

File 1.2.2: Technology Transfer

Background
Often new technologies lead to a new process or a change in how products are invented. You just learned how the soccer ball was a spinoff of the geodesic dome. Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.

Design Problem
You have been assigned by Inventions and Innovations, Inc. to create a new product based on the geodesic dome. Its manufacturing plant is already outfitted to construct domes, but it is looking to expand to a new market. Your team must propose a new use for the geodesic dome.

Specifications
1. Your new product must maintain the sphere shape of the geodesic dome.
2. Your new product must be innovative, meaning it cannot already exist.
3. Your new product cannot be a shelter or type of housing.
4. Your new product must utilize the geodesic dome you created in the engagement.

Materials
- Pipe Cleaners
- Straws
- Manila folder
- Paper

You may request additional materials from your teacher

Deliverables
1. Each team must submit a prototype of the new product, using its original geodesic dome in the modification.
2. Each student must submit a description of the new product including:
   a. The target consumer.
   b. The purpose of the product.
   c. The positive and negative effects the product would produce on society.
This rubric will be used to evaluate your extension activity:

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