



INNOVATION IN MINING

Overview

In this activity, students will learn about the costs associated with operating a mine and how technology can help to reduce the costs in three areas; energy, resources, and safety. Students will then form groups where they will research one type of emerging technology and how it can benefit and reduce costs in the mining industry. Finally, groups will use technology to create and pitch a sales campaign and create a 3-D prototype model of their technology piece to accompany their sales pitch.

Grade Band: 9-12

Topic

Students will investigate how the mining industry reduces costs, enhances safety, and increases productivity using a variety of techniques and innovations.

Real world science topics

- Geology
- Engineering
- Alternative Energy
- Technology and Science
- Robotics

Objective

Students will

- Explore the costs associated with the mining industry.
- Research emerging technologies that can reduce costs in mining.
- Create a sales pitch that will be presented to peers.
- Create a prototype model of a technology product.



Next Generation Science Standards

[HS-ESS3-2 Earth and Human Activity](#)

Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*

[HS-ESS3-4 Earth and Human Activity](#)

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*

[HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics](#)

Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

[HS-ETS1-2 Engineering Design](#)

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Time Needed: 3-4 hours, with additional time for model production and presentations

Background Information

How does the mining industry use scientific innovation to reduce costs, enhance safety, and increase productivity?

Planning, running, and managing the day-to-day operations in a mine is no easy task! From the largest to the smallest mines, there are many different aspects of mining that need to be taken into account, including the costs of mining. Like any business, when costs exceed income, mines may close and workers may lose their jobs, so expenditures must be balanced against cost savings or production increases. These costs can be placed into three important categories - energy costs, resource (and equipment) costs, and safety costs. The mining industry spends time and money working to increase the productivity of their mines, while reducing the energy costs and ensuring the safety of their workers.

The use of technology in the mining industry has certainly reduced many of these costs when compared to the early days of mining (for example – acid plants on smelters certainly increased the cost of smelting, but provide environmental benefits). Today, various new technologies and innovations such as drones, automated machinery, robots, and even simulation “video games” for training workers continue to change the way we mine our resources, with the goal of making mining cheaper, safer, and more efficient.



In Part 1 of this lesson, students will explore the costs of mining through videos and a virtual mine field trip. In Part 2, students will form groups and pick one emerging technology/innovation in the mining industry and play the role of a sales and marketing company. They will complete research about their technology piece and create a sales pitch for their product. Their pitch will include a slideshow or video presentation and a prototype 3-D model to explain how their technology works and how it will reduce energy, resource, or safety costs for a mining company. Keep in mind, most innovations in practice do not necessarily do all three – there are frequently trade-offs that must be considered. A company may pay more for a safety or environmental innovation if it is the right thing to do.

Key Vocabulary

Prototype - an early sample, model, or release of a product built to test a concept or process or to act as an object to be replicated or learned from.

Drones - unmanned aerial vehicles, aircraft without a pilot aboard that are controlled from the ground

Alternative energy - energy sources that are used as alternatives to fossil fuel. These alternatives can include hydroelectric, wind, geothermal, and solar power.

Materials

- Student device (laptop or iPad)
- Student Resource Sheet 1: The Costs of Mining
- Student Resource Sheet 2: Innovation in Mining Background Information Cards (6)
- Materials for creating prototype models

Procedure

PART 1:

1. Warm-up Activity (Whole Group)

Open by showing the video clip from “Dirty Jobs - Coal Mucker” to the class.

(https://www.youtube.com/watch?v=Jy_xOQhDZig&t=1s)

Explain to students that there are many costs of mining and that in this lesson they will be separated into three major categories: 1) Energy costs, 2) Resource costs, and 3) Safety costs.

Ask students to reflect on this video clip and think about the following questions:



- How did technology (the Coal Mucker) help minimize the costs of coal mining?
- In what ways could the Coal Mucker machine technology be improved to minimize the costs of mining even more?

Give students a chance to share their ideas and answers with the class. Tell students that today they will be learning about how new technology and innovation in the mining industry can help reduce costs, enhance safety, and increase productivity.

Ask students to visit the following links on their device:

<https://energy.gov/eere/amo/mining-industry-profile>

<http://costs.infomine.com/costdatacenter/miningequipmentcosts.aspx>

* If students do not have devices, the instructor can make copies of the articles for students.

Students should identify where the costs of mining are in the articles and reflect on paper, digitally, or verbally - what surprised them:

- the daily costs of running equipment?
- the energy consumption of a mining operation?
- the resources used to get the minerals and metals that we need?

Have students share their reflections with the whole group, teacher may record some ideas on the board or overhead screen if they choose.

Partner Activity

1. Ask students to find a partner and give each pair a copy of the Student Sheet 1 - Mining Costs

2. Ask each pair to visit the following websites on their device:

Nevada Mining Web

xplorit.com/nevada-mining-web#

Examples of video clips appropriate for each column are (a list of video clips will appear when clicking on the “play” icon on the left menu of the screen):

ENERGY COSTS - Blasting Overview, Truck Maintenance

RESOURCE COSTS - Mine Entrance, Reclamation



SAFETY COSTS - Refuge Underground Mine Rescue Training

Virtual Field Trip videos (Chapters 1-4) from Dig into Mining
<http://www.digintomining.com/virtualfieldtrips/archive>

3. Each pair should explore the virtual field trip of the Nevada gold mine, making sure to watch the short video clips at various icons. As they click through the stops on the tour, they should look for and record examples of costs that they view in the appropriate column on the **Student Resource Sheet 1: Mining Costs**. Students can then use the VFT videos for additional information.
4. Give students 15 minutes to click through the virtual field trip and complete the **Student Resource Sheet 1: Costs of Mining** with their partner. (Although they are working with a partner, each student should complete the Student Capture Sheet 1.)
5. As a whole group, ask student pairs to share and compare their answers from **Student Resource Sheet 1: Costs of Mining** with the class. The teacher should ask students to add new ideas and costs to their Resource Sheets. Ask students to brainstorm with their partners about ways that they might help to lessen these costs in a mine.

PART 2:

Small Group Activity

1. Share the article “Mine Safety: How A Helmet Device Could Save Lives” with students. (Link: <https://www.businesslive.co.za/bd/companies/mining/2017-12-11-mine-safety-how-a-helmet-device-could-save-lives/>) Give students a few minutes to read through the article. Ask students to identify what costs this technology will reduce in mining and how it will achieve this as they read.
2. Explain to students that in the next part of this lesson, they will be researching various types of technology that will help to reduce the cost of mining in the future.
3. Ask students to form groups of 4 (depending on your class size and group preference). Assign each student group (or let student groups choose) a piece of technology associated with the future of mining that will be the focus for the rest of this lesson.

Innovative mining technologies that student groups will be assigned include:

- Wearable technology
- Drones



- Robots
- Mining simulation
- Alternative energy
- Automated (driverless) machines

4. Distribute an **Innovation in Mining Background Information Card** to each student group. This card will help to give groups some information about their technology to support students with their research, model planning, and design. (See **Student Capture Sheet 2: Innovation in Mining Background Information Cards**)

5. Ask students to think about the answers to the following questions as they begin their research on their mining technology (teacher may write the questions on the front board or display on the overhead screen):

- **How is/can your technology be used in the mining industry?**
- **What types of costs will it help to reduce in mining - energy? resources? safety?**
- **How much will the technology cost?**
- **What are the concerns with using the technology – new technology is not without risk. A good sales presentation will include a description of risk and how you as the company selling the item will mitigate risk. For example, if you are selling a drone – one risk would be obtaining permits to fly it – you might include help with permitting as a service option.**
- **What kinds of materials will you need or use to build your prototype model of the technology?**
- **What scale will be used for you model? Will it be life-sized? Will it be scaled down or up?**
- **What are some of the aspects of a good presentation? What is important to highlight to a mining company as you create your sales pitch?**

6. Guide each student group to complete **Student Capture Sheet 3: Product Research** using their Innovation in Mining Background Information card and online resources.

7. When groups have completed their research, they should add their information to a slideshow (google slides, PowerPoint, Prezi) or create a video presentation (iMovie, etc.) to pitch their project.

8. The final step in their sales pitch is to create a prototype model of their product. Show students the following video: https://www.youtube.com/watch?v=k_9Q-KDSb9o to help them understand what a prototype model is and is not. Explain that they should use provided or their own materials to create a non-functional model that could be used to demonstrate how the actual product would look and work. It can be made to scale (if appropriate) or can be a smaller or larger representation of the product.



Teacher note: Talk about safety before students begin creating their prototype or model. Items such as box cutters and super glue can cause serious injury. Mining companies are required by MSHA (The Mine Safety and Health Administration) to hold safety meetings and adhere to safety standards. This would be a good time to talk with students about MSHA and visit the MSHA website. Then you could hold a brief class safety meeting about eye and hand safety before students begin building their prototypes. Talk about what injuries could happen and what students will do to prevent them. For example, wearing safety glasses could prevent glue from getting into someone's eyes and wearing cut proof gloves or using certain cutting techniques could prevent hand injuries.

<https://www.msha.gov/>

Extension

Student groups could do further research on the future of mining, exploring the possibility of mining in space (asteroids, other planets) or mining on the ocean floor. Students could also do research on how our need for mined materials will change in the next 10 to 20 years. For example, students could research materials used in electric cars and batteries and list the mines that mine the necessary commodities. Are the mines in politically stable regions? Are there risks to the supply of critical materials?



Student Resource Sheet 1: The Costs of Mining

As you and your partner explore the virtual mine field trip, record the energy, resource, and safety costs in the mining industry.

ENERGY COSTS	RESOURCE COSTS	SAFETY COSTS



DIG INTO MINING

THE STORY OF COPPER

Student Capture Sheet 2: Innovation in Mining Background Information Cards

WEARABLE TECHNOLOGY

What is it?

Wearable technology is a general term for a group of devices that are meant to be worn or kept with you throughout the day. Wearable technology that you are already probably familiar with include things like smartphones, smartwatches, fitness trackers, and google glass.

How can it be used in mining?

One example of wearable tech used in mining is a small beeper-like communication device with a red and green lit buttons. The device is attached to the bottom front of the miner's helmet and the lights flash when they have a message or warning is sent. The device also has four sensors to detect methane levels, carbon monoxide, diesel fumes and even radiation levels, depending on the mining conditions. The device can warn a miner of potentially harmful or dangerous situations and the company can communicate directly with miners to better manage them. Each beeper also has a radio-frequency identification tag on it so companies know exactly where their workers are.

TASK: Conduct research with your group to discover other ways that this technology is being developed to improve mining practices.

Think about how this technology could be used to help reduce specific costs in the mining industry and design or refine a product (existing or new) that can achieve your goal!

ALTERNATIVE ENERGY

What is it?

Alternative energy are energy sources that are used as alternatives fossil fuel. These alternatives can include hydroelectric, wind, geothermal, and solar power.

How can it be used in mining?

Mining operations require large amounts of energy for day-to-day operations, and much of this energy comes from the use of fossil fuels, such as oil and coal. By using alternative energy to power mining equipment, companies can help to cut costs and reduce their environmental footprint.



TASK: Conduct research with your group to discover other ways that this technology is being developed to improve mining practices.

Think about how this technology could be used to help reduce specific costs in the mining industry and design or refine a product (existing or new) that can achieve your goal!

AUTOMATED (DRIVERLESS) MACHINES

What is it?

Automated or driverless machines are vehicles without a person on board. Un-crewed vehicles can either be remote controlled or remote guided vehicles, or they can be autonomous vehicles which are capable of sensing their environment and navigating on their own.

How can it be used in mining?

Driverless trucks and trains used in mining are cost-effective for mining companies as they can spend more time working, saving companies money and time, and increasing production. The software used to control and guide the vehicles can be more precise than those controlled by humans, and reduce the need for local labor in mining towns.

TASK: Conduct research with your group to discover other ways that this technology is being developed to improve mining practices.

Think about how this technology could be used to help reduce specific costs in the mining industry and design or refine a product (existing or new) that can achieve your goal!

DRONES

What is it?

Drones are unmanned aerial vehicles without a pilot aboard that are controlled from the ground. Drones are used commercially, by the government and military, and by hobbyists, and can be the size of a Boeing 737 or small enough to fit in your hand. One of the advantages of using drones is that they can fly for long distances and fly into areas that are dangerous without the risk of human life. They are also useful for aerial photography of large areas.

How can it be used in mining?

As the price of drones continue to drop, it's likely that they will be used more and more for things such as surveying land to aid in mine planning and exploration for minerals in underground mines. Drones require much less fuel than larger vehicles and can go places that would be risky or impossible for humans to go.



TASK: Conduct research with your group to discover other ways that this technology is being developed to improve mining practices.

Think about how this technology could be used to help reduce specific costs in the mining industry and design or refine a product (existing or new) that can achieve your goal!

ROBOTS

What is it?

Robots contain sensors, control systems, manipulators, power supplies, and software all working together to perform a task. The type of robots that you will encounter most frequently are robots that do work that is too dangerous, boring, onerous, or just plain messy. Most of the robots in the world are of this type. They can be found in auto, medical, manufacturing, and space industries.

How can it be used in mining?

Robots can be used to explore and map mines and to enter areas and parts of a mine that may be dangerous for humans to test for things such as toxic gases. They can find and mine for ore, and could help to rescue trapped miners in the event of an emergency. Robots can also change large equipment tires. Changing large mining equipment tires is dangerous because tires can fall and crush workers and, if a blowout occurs while a person is working on a tire, the forces generated can be very dangerous. A robotic forklift can drive up to a piece of equipment, use lasers to locate lug nuts, robotically remove the lug nuts, change the tire, and reattach the new tire – all without a person being in the vicinity of the work.

TASK: Conduct research with your group to discover other ways that this technology is being developed to improve mining practices.

Think about how this technology could be used to help reduce specific costs in the mining industry and design or refine a product (existing or new) that can achieve your goal!



Student Capture Sheet 3: Product Research

How is/can your technology be used in the mining industry?	What types of costs (energy, resources, safety) could your technology help to reduce in mining?	What kinds of materials will you need or use to build your prototype model of the technology?

Sketch your ideas below:

Large empty rectangular area for sketching ideas.