

LESSON 2 Engineering Innovative Materials

OBJECTIVE

Students research emerging technologies in materials science and manufacturing processes, and apply their knowledge to make decisions.

MATERIALS

“Drive Progress” worksheet, Internet access, ideally laptops for students or small groups

TIME

75 minutes

CONTEST PREP

This lesson familiarizes students with advanced materials and researching advanced manufacturing. They'll apply this knowledge in their contest entries.



CLASS DISCUSSION

1. Show a short video of a spider spinning a web (there are many readily available online, such as bit.ly/2kenkxL). Explain to your class that Materials Science Engineers are particularly fascinated by the work of spiders. Challenge your students to identify the connections between a spider spinning a web and human activity.
2. Explain that spiders and humans are builders. The similarities are even more specific: For instance, spiders make their webs using a variety of silks with different sets of properties calibrated for different functions. Spiders make a type of silk to create the strong but flexible spokes of their web, a different silk that is sticky to capture prey, and another silk with good bonding properties that attaches the points of the web together. Ask your students: How is the fact that spiders use different types of silk for different purposes relevant to engineering? Based on the discussion, are your students able to figure out what the discipline of Materials Science is?
3. Work together to define the work of a Materials Science Engineer. By studying and understanding how materials work, Materials Science Engineers create new materials for new purposes as well as enhance existing materials to improve their performance, i.e., make them stronger, lighter, more heat-resistant, etc.

ACTIVITY

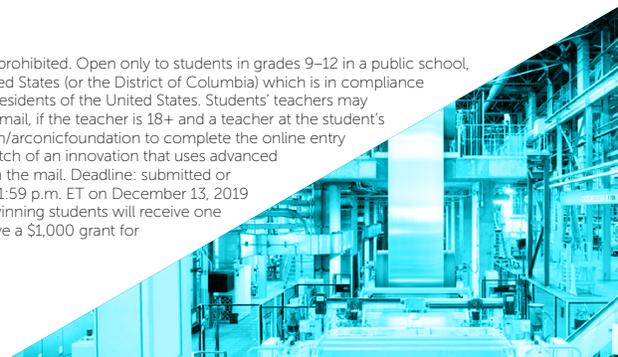
Distribute the “Drive Progress” activity sheet and explain to students that they'll research emerging materials, how they are used, and how they are manufactured. (There is plenty of information readily available online, and if desired, you can also use this as an opportunity to discuss credible sources.) In small groups, students will want to consider not only materials science but also the cost and environmental impacts while they make decisions about a fictional city's fleet of green-energy buses. Use the table below to help jump-start the learning or to lead the discussion at the conclusion of the activity.

CONSIDERATIONS	POINTS FOR DISCUSSION
Technology Electric vehicle Hybrid electric vehicle Hydrogen fuel cell vehicle	<ul style="list-style-type: none"> • Environmental pros and cons • Cost of technology and fuel • Issues with new and emerging technologies
Materials Carbon fiber reinforced polymer Metal foam Aerogel	<ul style="list-style-type: none"> • Interesting properties of each material • Application in green transit • Pros and cons of each material
Manufacturing Processes Carbon fiber reinforced polymer molding 3D printing Supercritical drying	<ul style="list-style-type: none"> • Process for manufacture • Pros and cons of manufacturing process • Current limitations

CONTEST | \$1,000 CLASSROOM GRANTS

Use these lessons to prepare students to enter the Innovators of Tomorrow Contest. Students will develop an invention that uses advanced manufacturing to solve a problem. Five winning students will each receive a tablet and their teachers will receive \$1,000 for the classroom. Get details at scholastic.com/arconicfoundation/contest.

NO PURCHASE NECESSARY TO ENTER OR WIN. Void where prohibited. Open only to students in grades 9–12 in a public school, an accredited private school, or a home school in the 50 United States (or the District of Columbia) which is in compliance with the laws and regulations of its state/district and who are residents of the United States. Students' teachers may also submit entries on their students' behalf both online or by mail, if the teacher is 18+ and a teacher at the student's school. To enter, an eligible student must go to scholastic.com/arconicfoundation to complete the online entry form, as well as create and upload written description and sketch of an innovation that uses advanced manufacturing; or complete entries can be submitted through the mail. Deadline: submitted or postmarked between 12:01 a.m. ET on October 1, 2019, and 11:59 p.m. ET on December 13, 2019 (mail-in entries must be received by 12/20/19). Prize: Five (5) winning students will receive one tablet (ARV: \$79.99). Each winning student's teacher will receive a \$1,000 grant for classroom use (five grants in total). See [Official Rules](#).



Name: _____

Drive Progress

AS MAYOR OF ECO CITY, you are considering proposals for three green-transit bus options. Research the cost, the materials science, the manufacturing process, and the environmental impacts of each company's proposal below. Which buses would you select for your city? Use your understanding to award the transit contract to the most qualified firm.

FUEL YOUR THINKING

1 CONSIDER THE ENERGY SOURCE FOR EACH BUS.

What are the environmental benefits of each technology? What are some of the drawbacks?

2 CONSIDER EACH OF THE INNOVATIVE MATERIALS.

How are they used in transportation applications? What are their benefits? What are their drawbacks? Why are these materials especially useful in green-transit applications?

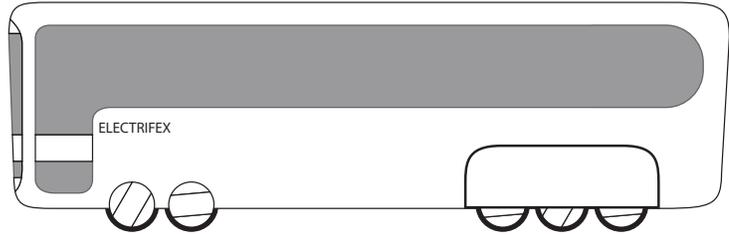
3 DO SOME CALCULATIONS.

What is the total cost of each bus once the additional cost of innovation is considered?

4 WHICH COMPANY WOULD YOU AWARD THE CONTRACT TO?

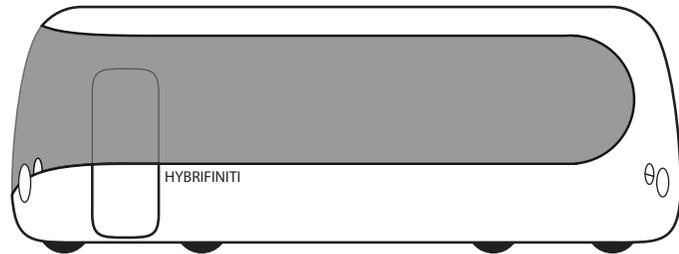
Provide your rationale, including the factors you compared and considered. What questions would you like to ask before awarding a final contract or making a final decision?

PROPOSAL: ELECTRIFEX | Commute in step with community



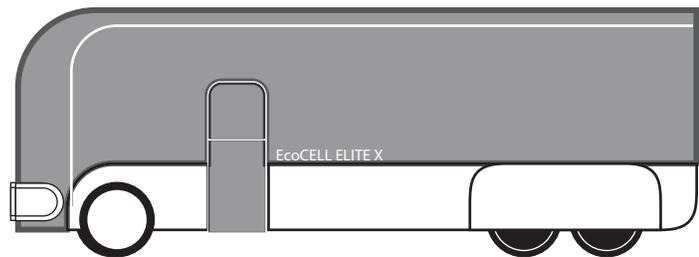
- **Energy Source** Electric
- **Innovative Material** Carbon fiber reinforced polymer
- **Innovative Manufacturing Technique** Carbon fiber reinforced polymer molding
- **Base cost of one bus** \$800,000
- **Additional cost of innovation** Will use 4,022 units of polymer at a cost of \$24.79 per unit.
- Total cost per bus** \$ _____

PROPOSAL: HYBRIFINITI | A ride worth sharing



- **Energy Source** Hybrid electric
- **Innovative Material** Metal foam
- **Innovative Manufacturing Technique** 3D printing
- **Base cost of one bus** \$600,000
- **Additional cost of innovation** Will use 2,851 units of metal foam at a cost of \$70.56 per unit.
- Total cost per bus** \$ _____

PROPOSAL: ECOCELL ELITE X | Innovations for an innovative world



- **Energy Source** Hydrogen fuel cell
- **Innovative Material** Aerogel
- **Innovative Manufacturing Technique** Supercritical drying
- **Base cost of one bus** \$1,000,000
- **Additional cost of innovation** Will use 890 units of aerogel at a cost of \$112.16 per unit.
- Total cost per bus** \$ _____