Advanced Manufacturing & Prototyping Integrated to Unlock Potential

PHYSICAL SCIENCE

Data-Driven Decision Making

RIDING THE CONCRETE WAVE PART II

Skate Park Challenge

Fall 2018

8DMS

SECTION 1 – THE SKATE PARK CHALLENGE

1.1 INTRODUCTION

Skaters clearly need to wear helmets. There are many helmets on the market, so with all this variety, how do skaters decide which helmet to buy? Are all helmets equal in their protection? Do some helmets work better than others? SkateTech wants to investigate these questions.

SkateTech is satisfied with the work you completed during the Helmet Challenge. They have an idea for an article that would appear online and in their monthly magazine, and they want your help again. They are going to publish an article about how to select a helmet for various types of skate parks. The article will feature three teenagers who skate in their community skate parks. Each of these three are representative of many skater park users across the country. Each has a unique combination of ability, experience, and budget.

Your team will gather helmet and skate park data. Your analysis of this data will help you make a helmet recommendation to each of the three skaters. SkateTech hopes that the article and profiles will help readers make good decisions in buying their own helmet.

1.2 SKATER PROFILES

Based on some earlier research, SkateTech feels these three profiles represent the likely skate park users who would benefit from the article. These three profiles will be used by readers to identify their own combination of experience and needs for their helmet purchase.

	**Kaylee, 15** **Experience Skating:** 8 years **Current Savings:** $70 **Notes:** She skates all the time and likes to skate tough challenging bowls, parks, and half pipes, but she will skate anything. She rarely falls, but she knows her limits and tries not to test them too much. She makes most of her money working in her parent's restaurant. It is a steady source of money, though it doesn't always pay a lot.
	**Grant, 13** **Experience Skating:** Less than a year **Current Savings:** $200 **Notes:** Grant really likes skateboarding. He is definitely a beginner, and he has had his share of falls. He realizes his limits. So, he thinks carefully about where he should skate and what challenges he should take on. He hopes that by age 17 he is taking on big air ramps and parks. Grant mows lawns for neighbors, and he is a big saver.
	**Selena, 14** **Experience Skating:** 4 years **Current Savings:** $55 **Notes:** She prefers long, continuous runs. She doesn't really want big air. She is very laid back. She focuses on smooth technique, clean tricks, and flow through the run. Selena is very active in after school sports, so she does not have time for a steady job. She saves her money from birthday presents and extra chores. She would like to keep as much of it as possible.

SECTION 2 – INVESTIGATE HELMET PERFORMANCE

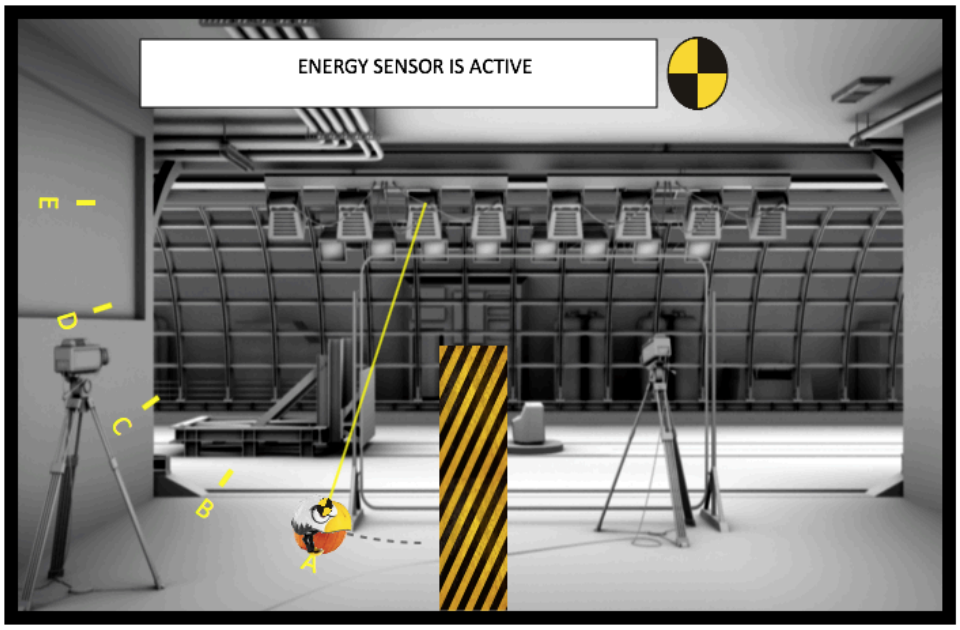
2.1 DETERMINE THE ENERGY ABSORBED BY HELMETS

It is clear that helmets are necessary for protecting your head while skateboarding. They absorb some of the kinetic energy that can damage the skull and brain. Selecting a helmet largely depends on how well it absorbs the kinetic energy upon impact.

Let's investigate how various helmet types perform in our simulator. You will generate data for others to consider. And, others will generate data for you to use. So this is going to be a team effort!

Skate Park Sim Investigation #1:

How does helmet type affect the amount of energy transferred to the pumpkin?



SkateTech is testing six helmets for skateboarders. Your group will be assigned one of the helmets to test using the simulation. The pumpkin in the simulation will have a sensor that measures the kinetic energy transferred to the pumpkin. Once all groups have finished collecting their data they will share their results with the entire class.

You will need some of the data collected previously in the Helmet Challenge. If you have your student sheets from that challenge, skip to Part B. If you cannot locate those data sheets, please complete Part A.

Part A: **Pumpkin Energy (no helmet)**

Your teacher will provide you with the code to access the simulation.

Procedure:

1. Inside the simulation, click on “Smashing with Sensor.”
2. Start the pumpkin at Position A.
3. Click “Begin the Simulation.”
4. Record the unabsorbed kinetic energy of the pumpkin in Joules for Position A on the *Helmet Tests* student sheet.
5. Click “End the Simulation.”
6. Repeat steps 2-5 for Positions B, C, D, and E.

Part B: **Pumpkin Energy (with your helmet)**

Your teacher will provide you with the code to access the simulation.

Procedure:

1. Inside the simulation, click on “Helmet Tests.”
2. Choose your assigned helmet from the drop down menu.
3. Record the helmet type on your *Helmet Tests* student sheet.
4. Start your pumpkin at Position A.
5. Click “Begin the Simulation.” Observe the pumpkin crash into the wall.
6. Click “End the Simulation.”
7. On your *Helmet Tests* student sheet, record the unabsorbed kinetic energy that would be transferred to the pumpkin.
8. Repeat steps 3-7 for Positions B, C, D, and E.

Part C: Energy Absorbed by Helmets

Determine the maximum amount of energy absorbed by your helmet type. Subtract the “Pumpkin, with Helmet” measures from the “Pumpkin, No Helmet” measures. Record the result on your *Helmet Tests* student sheet, and be prepared to share it with the class.

PLEASE DO NOT WRITE IN THIS BOOK.

2.2 SHARING THE HELMET DATA

SkateTech provided your class with six helmets to test out in the skate parks. Your group only tested one of them so you are currently missing data from the other five helmets. All groups will need to share their helmet energy absorption data with the rest of the class. This way the entire class has the data about all the helmets.

Procedure:

1. Record the amount of energy each helmet absorbs in the table provided in Part C of your *Helmet Tests* student sheet.

Discuss these questions as a class:

1. What helmets offer the most protection?

2. What helmets offer the least protection?

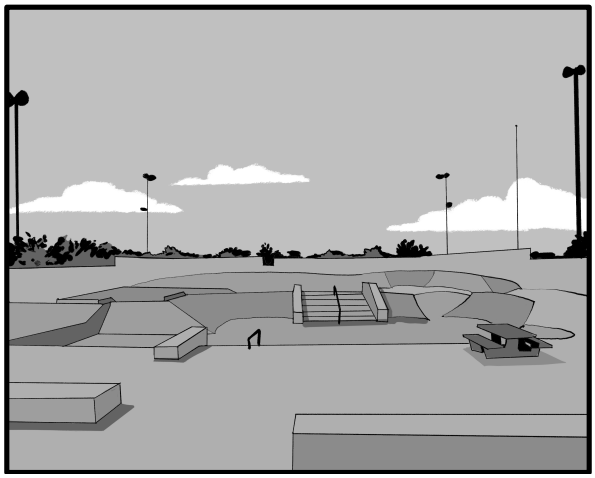
3. Are there any helmets you think you should not consider for any of the skaters? Why or why not?

SECTION 3 – SKATE PARK ANALYSIS

3.1 KINETIC ENERGY PROFILES

Knowing the limits and capabilities of the helmets is only one part of the story. We need to think about the type of skate parks that our skaters will visit. SkateTech has identified two skate park designs commonly built across the nation. One is rated “Difficult” and the other is rated “Moderate.”

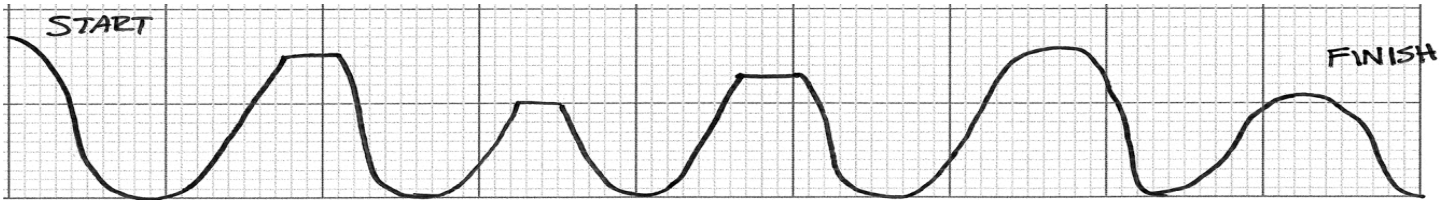
“The Big Kahuna” - DIFFICULT



“Launchpad” - MODERATE

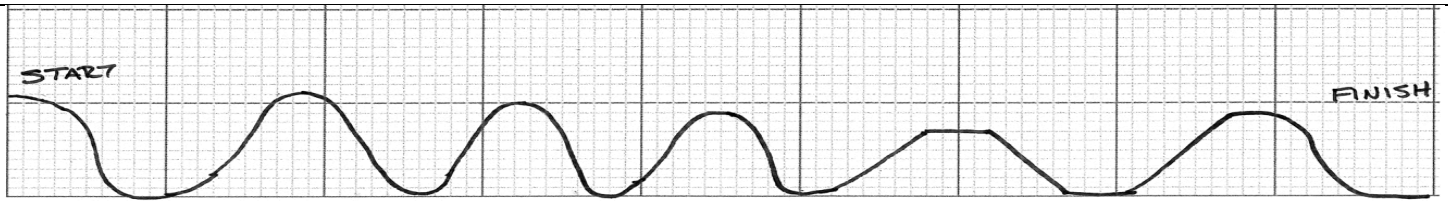
SkateTech analyzed the most common runs through these designs. They were able to create a **Kinetic Energy** profile for those common runs. The profiles below show each run from start to finish from a *side view*. It also provides the maximum kinetic energy level at the bottoms of each hill.

THE BIG KAHUNA



17 J **15 J** **10 J** **13 J** **15 J** **11 J**

LAUNCHPAD



11 J **11 J** **10 J** **9 J** **7 J** **9 J**

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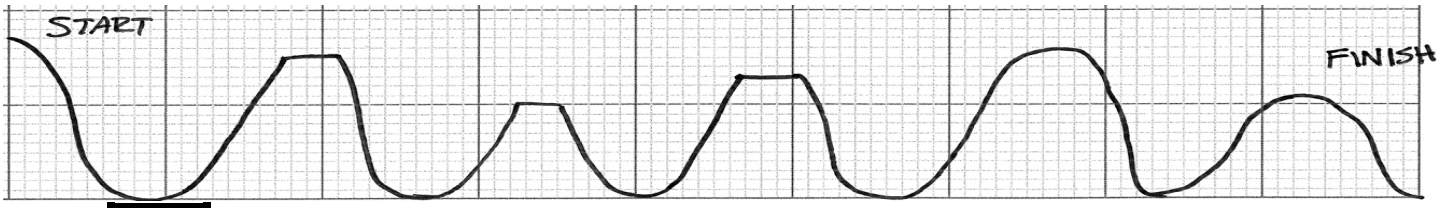
3.2 SKATE PARK INJURY ENERGY ANALYSIS

Now that you know how much energy the different helmets can absorb, you can analyze the likely performance of each helmet on each of the runs through The Big Kahuna and Launchpad. The run profiles for each park lists the **max kinetic energy** for each dip, or trough, in the run:

THE BIG KAHUNA



17 J **15 J** **10 J** **13 J** **15 J** **11 J**

You have already found the **max absorption** of each of the helmets. If we subtract the max absorption from the max energy at each dip, we will know how much energy would not be absorbed by a helmet. This energy would be leftover to cause injury. We will call this unabsorbed, potentially dangerous, energy... *"injury energy"*.

(Max Kinetic Energy at Dip) – (Max Absorption for a Helmet) = Injury Energy

For example, the results from our simulation tests show that the Stormtrooper helmet absorbs 14 J of energy. Performing the subtraction above...

(17 Joules) – (14 Joules) = <u>3 Joules of Injury Energy remain</u>

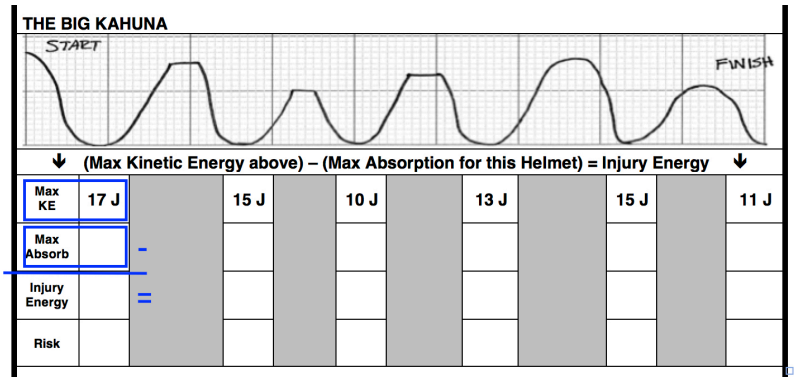
...we see that 3 Joules of energy remain if a skater were to fall in the first dip of The Big Kahuna. Any of this remaining kinetic energy not absorbed by the helmet would be transferred to the skull of a skater and could potentially cause a headache. Recall this table describing the impact joules of energy have on the brain during a fall:

Amount of Energy	Effects on the Brain
0 – 3 Joules	No effect, possible headache
4 – 6 Joules	Headache, possible confusion or mild concussion
7 + Joules	Concussion, possible brain injury

On the *Skate Park Analysis* student sheet, your group will determine the injury energy remaining at the bottom of each hill for each of the six helmets and what potential effects on the brain would result.

Procedure:

1. On *Skate Park Analysis* student sheet, begin the analysis by starting with the **red** helmet.
2. Using the data collected from the helmet tests during Skate Park Sim Investigation #1 Part B, record the maximum amount of energy absorbed by the **red** helmet in the space directly below the first dip in the track (under the "17J" in the example below). Record this number in the Max Absorb row.
3. Perform the following subtraction to reveal the possible injury energy:
   (Max Kinetic Energy at Dip) – (Max Absorption for a Helmet) = Injury Energy. Record the remaining Injury Energy row. If the result is a negative number, record a "0" (zero).



4. Using the key below, find the Injury Energy level that corresponds to the result from Step 3. Use the color-code below to shade-in the Risk square using a color pencil:

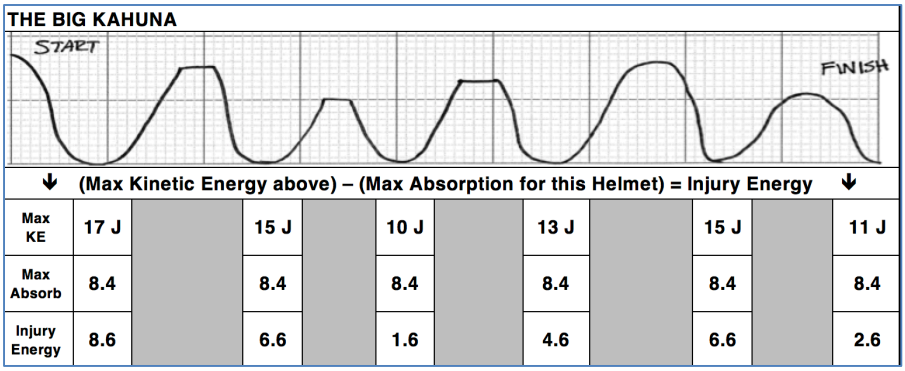
Amount of Energy	Effects on the Brain	Risk
0 – 3 Joules	No effect, possible headache	GREEN
4 – 6 Joules	Headache, possible confusion or mild concussion	YELLOW
7 + Joules	Concussion, possible brain injury	RED

5. Move to the next dip in the run, and repeat Steps 2 – 4.
6. Complete this analysis for all the dips in The Big Kahuna skate park run.
7. Continue analyzing the **red** helmet and repeat Steps 2-6 for the Launchpad skate park run.
8. Complete this analysis for each of the remaining helmets.

PLEASE DO NOT WRITE IN THIS BOOK.

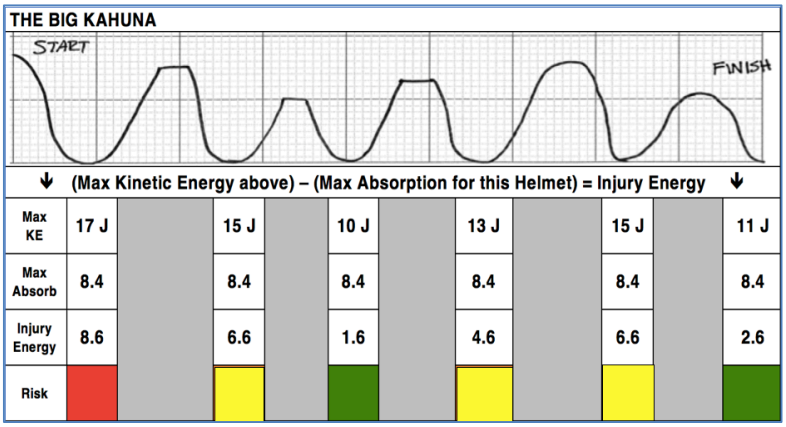
3.3 REFLECT ON THE SKATE PARK RUN ANALYSIS

Let's step back and review your analysis. You probably noticed that some of the helmets offer more risk on these two runs than other helmets do. By color-coding you were able to better visualize the data and the risk for injury of each helmet on each of the runs. If you had only used the numerical Joules of energy to determine the risk of injury, the picture would not be as clear:



Max KE	17 J		15 J		10 J		13 J		15 J	11 J
Max Absorb	8.4		8.4		8.4		8.4		8.4	8.4
Injury Energy	8.6		6.6		1.6		4.6		6.6	2.6

By coding the three levels of injury with red, yellow, and green, you are able to get a quicker sense of the risk:



Max KE	17 J		15 J		10 J		13 J		15 J	11 J
Max Absorb	8.4		8.4		8.4		8.4		8.4	8.4
Injury Energy	8.6		6.6		1.6		4.6		6.6	2.6
Risk										

Discuss these questions as a class:

1. Which helmets offer more protection on The Big Kahuna?
2. When you look at the results for Launchpad, does the list of effective helmets change? Why or why not?
3. Are there any helmets you think you should not consider for any of the skaters? Why or why not?
4. Do you think that you have enough information to make a decision for each skater, or do you think you need to consider more information? Explain your answer.

SECTION 4 – MAKING DECISIONS BASED ON EVIDENCE

4.1 COMBINING MULTIPLE SOURCES OF INFORMATION

Your team learned in Section 2 that each helmet provides a unique maximum level of protection during impact. Some helmets absorbed more energy than others. This might suggest that the helmet with the most absorption should be the selection for every skater. That certainly is one approach to take in selecting a helmet, but it is an example of making a decision only considering ONE PIECE of information. Making a decision without considering all the important information could lead to a poor decision because the best helmet might be too expensive.

There are other pieces of information that we must consider. Earlier, we read about the skill level of each skater. Additionally, the helmets each cost different amounts.

Helmet Design	Cost
 **Red Helmet**	**$60**
 **Black Helmet**	**$15**
 **Blue Helmet**	**$45**
 **Pink Helmet**	**$100**
 **Eagle Helmet**	**$70**
 **Green Helmet**	**$25**

How should we factor all the factors and information into making helmet recommendations for the profiled skaters?

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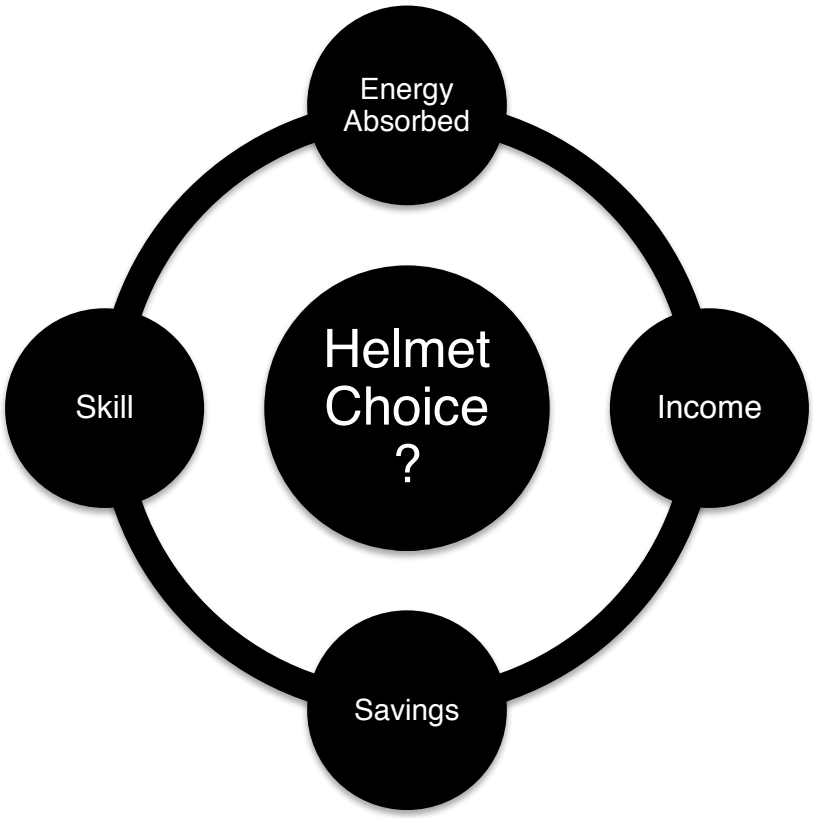
When making a decision, all the evidence and information need to be considered together. We need a method to help combine and compare all this information.



4.2 USING A DECISION MATRIX TO HELP MAKE A GOOD DECISION

You and the rest of the team will use something called a Decision Matrix to help you sort through and balance the evidence you have. You will be able to analyze the helmet type, skater skill, skater's savings, and skater's income to narrow the helmet options down to 1-2 choices. You will need to have your Skate Park Analysis sheets on hand for this.

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Follow these directions and complete the *Skate Park Decision Grid* student sheet with your team.

Procedure:

1. Begin by analyzing Kaylee's options, starting with the **red** helmet. You will need your Skate Park Analysis sheet for the **red** helmet.
2. Complete the first space in the, "Injury Risk Big Kahuna" column. Analyze the overall injury risk for this helmet on THE BIG KAHUNA run.
    a. If many of the dips in the track are yellow and red, use a **red** pencil to shade in the space in the first column. This would indicate this helmet performs poorly on the The Big Kahuna.
    b. If many of the dips are colored green, use a **green** pencil to shade in the space in the first column. This would indicate this helmet performs well on the The Big Kahuna.
3. Complete the first space in the, "Injury Risk Launchpad" column. Analyze the overall injury risk for this helmet on the LAUNCHPAD run.
    a. If many of the dips in the track are yellow and red, use a **red** pencil to shade in the space in the first column. This would indicate this helmet performs poorly on Launchpad.
    b. If, however, many of the dips are colored green, use a **green** pencil to shade in the space in the first column. This would indicate this helmet performs well on Launchpad.
4. Move to the "Skill Fits Risk" column. Consider whether Kaylee's experience and skill level will help Kaylee to avoid any injury risk the helmet might present.
    a. If Kaylee's skill and experience <u>will not</u> help her, use a **red** pencil to shade in the space.
    b. If Kaylee's skill and experience <u>will</u> help her, use a **green** pencil to shade in the space.

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5. Move to the "Effect on Savings & Income" column. Consider whether Kaylee can live with this purchase and what it will do to her savings.
    a. If Kaylee has not saved enough and/or there is not a good source of income to support choosing this helmet, use a **red** pencil to shade in the space.
    b. If Kaylee has saved enough and/or there is a good source of income to support choosing this helmet, use a **green** pencil to shade in the space.
6. Move to the "Finalist for Skater" column. Review the four spaces in the row. Based on red or green spaces in the row, decide whether this helmet is a possible option for Kaylee.
    a. If this is not a good helmet option for Kaylee, use a **red** pencil to shade in the space.
    b. If this is a good helmet option for Kaylee, use a **green** pencil to shade in the space.
7. Repeat steps 1-6 for each of the remaining helmets.
8. Repeat Steps 1-7 for Grant and Selena.

SECTION 5 – MAKE YOUR RECOMMENDATIONS

5.1 ENGINEERING RESEARCH TO KEEP YOUR BRAIN HEALTHY

You and your classmates were asked to assist SkateTech with testing crash helmets at different skate parks. Now it is time to make recommendations about which helmets would be most appropriate for each skater.

In this challenge and in the *Helmet Challenge*, you learned about energy transfer, the importance of wearing helmets while skateboarding and what causes traumatic brain injuries. The risk of concussions and other brain injuries is not unique to skateboarding. There has been an increased focus on concussions in other sports, especially at the youth level. The symptoms for concussions can vary and they might appear right away or be delayed after the injury. Concussions temporarily affect how the brain functions and processes information. A person with a concussion might have trouble with their memory, speech, balance and coordination. Most people recover in 7 – 10 days. But, once you have had a concussion, you are at a greater risk for additional concussions.

Football and soccer are the most common sports with concussion risks for athletes. Athletes are encouraged to report any possible concussion symptoms to their coaches and not try to hide it to stay in the game. Coaches are advised to remove the athletes from play and seek medical attention but it is not always easy to determine whether or not an athlete has sustained a concussion. Researchers and engineers from Georgia Tech and Emory University have collaborated together to develop a medical device that can be used to assess the effects of concussions right on the sidelines. With improved medical technology, athletes can be better protected.

Watch ***Head Injuries Technology*** video.

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5.2 ANSWER THE CHALLENGE

On the *Helmet Recommendations* student sheet, write recommendations for each skater. Use the prompts and any other guides from your teacher to make your recommendation. Pay close attention to the prompts on your student sheet. Be sure to include all of that information. Use the skater profiles, the Skate Park Analysis sheets, and the Decision Grid to customize the helmet recommendation for each skater. Pay attention to their profile information carefully.

There may not be a clear recommendation in some instances. If that is the case, you can recommend that a new helmet be identified or that the skater needs to wait to purchase their helmet later and stay off their skateboard for a while. No matter what you decide, your recommendation must include multiple pieces of evidence to support your final decisions.

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