APEGA SCIENCE OLYMPICS

Division 3 Challenge: Wilderness Rescue

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OVERVIEW

In 2020, Alberta Parks saw a 20% increase in park rescues from the year before and emergency crews were becoming overwhelmed[1]. Many people were keen to get outside to relieve some of the feelings of isolation due to COVID-19, and quite a few of the visitors of the Provincial Parks were new users and not familiar with safe hiking practices.

When a person is hurt and needs to get to the hospital but is far away from a road, other means of transport are necessary. Helicopters cannot always be used and sometimes rescuers must carry the hurt person out of a remote area.

To make rescuing someone easier, you must design a portable rescue device that can be carried in a backpack and assembled at the site of the accident. Your device must be light-weight, stable, portable, and quick to assemble.

1 Image Credit: Parks Canada/ B. Morin

CHALLENGE SPECIFICS

You must:

- Create a Wilderness Rescue Device that can carry a 10lb bag of potatoes (which we will use to simulate an injured hiker) through 3 different obstacles, as presented in the challenge document.
- Prepare to test your prototype on the day of the event, or in a video submission if you are participating virtually

[1] *https://globalnews.ca/news/7240113/alberta-parks-rescue-calls-increasing/*

    - Be prepared to discuss what problems you discovered during testing, and how you improved upon your initial design to arrive at the final product
- Build your Wilderness Rescue Device within a budget of **$50 CAD** (see additional requirements below)

The intent of your rescue device is to transport a hiker with injuries such as a sprain, broken limb or heat exhaustion, and **not** someone with spinal or neck trauma that would need additional precautions. To make testing more manageable, the device will be a scaled down or alternate version of what could be used to transport an adult hiker.

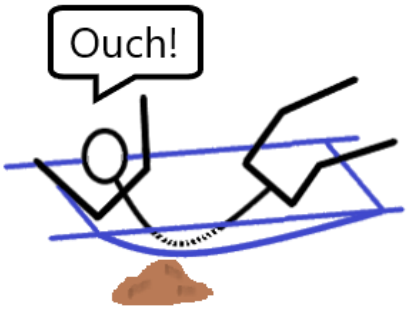
GENERAL REQUIREMENTS

BOTH VIRTUAL AND IN-PERSON EVENTS

Create a Portable Rescue Device

- The device is to be built from scratch - an existing stretcher cannot be used and modified. Materials can be bought but cannot be pre-assembled such as a hiking pole.
    - The materials used for the Wilderness Rescue Device should be low-cost and accessible for most, if not all, communities
    - Using more recycled or reusable materials in the design of your prototype will result in a higher score (refer to rubric).
- The device needs to be designed in a way that allows for an injured hiker to be carried out safely and does not pose further harm to the injured person or injure the rescuer.
- Dimensions:
    - Compacted for storage: 40 x 30 x 10 cm “footprint”
        - When not in use, the rescue device should be portable and able to fit into a closed backpack. The dimensions provided are maximum dimensions, the rescue device can fold/collapse into something smaller but cannot exceed any of the dimensions (e.g. dimensions of **45cm** x 20cm x 10cm are not permitted).
    - Any harnesses or attachments are considered part of the rescue device and must fit into the above footprint along with the main body of the rescue device.
    - The rescue device may have several components that are not connected when disassembled but when bunched together, must fit into the above footprint.
- Assembly Time:
    - Maximum assembly time of 5 minutes, including securing the bag of potatoes (i.e., the injured hiker) to the rescue device for testing.
    - Timing starts from the first touch of the rescue device to the time when it is fully assembled, and team members are not touching it anymore.

- For testing, the bag of potatoes (i.e., the injured hiker) must be safely harnessed to the rescue device; it cannot lay freely on it as it would fall off during transport.
- The rescue device must be stable and should not fall apart when used. The bag of potatoes (i.e., the injured hiker) should not contact the ground at any time when being transported.



- The rescue device should not be dragged across the ground during testing, even if the bag of potatoes (i.e., the injured hiker) does not contact the ground. Dragging the rescue device across rocks would not be comfortable for the person being transported. Comfort of person being transported is an important consideration.
- Points will be rewarded for a light-weight design. The less the device weighs the more points will be awarded (please refer to rubric).

Test Your Device

- Your Wilderness Rescue Device will be challenged with 3 obstacles to mimic wilderness challenges (going uphill, downhill, navigating obstacles etc):
    - Carrying the bag of potatoes (i.e., the injured hiker) for 10 meters on flat ground
    - Carrying the bag of potatoes (i.e., the injured hiker) up and down a flight of at least 5 steps of stairs to mimic hiking across rocky terrain
        - Your entire stretcher must pass over a minimum of 5 steps.
    - Carrying the bag of potatoes (i.e., the injured hiker) underneath a height of 1.5 meters and within a width of 2 meters for a length of 2 meters (to mimic walking through dense low hanging forest or a tunnel)

<u>Note that if the obstacle challenges can be completed but not all of the design requirements are met, the team will not be eligible to receive full marks.</u>

- Rescue device must be assembled, and 10 lb bag of potatoes (i.e., the injured hiker) strapped on in 5 minutes or less
- A maximum of 2 people may carry the device at one time.
    - If you are participating individually, you can ask someone to help you with this part of the challenge.
    - It will be important for other team members to offer clear guidance to help their team navigate any obstacles.
- A maximum of 2 minutes may be taken for the stairs portion of the obstacle (up and down)
- A maximum of 1 minute each may be taken for the flat surface and the ‘tunnel’ portion of the obstacles.

PLANNING

You may want to ask some brainstorming questions to start your planning process. Some brainstorming questions are included in the PowerPoint, but the following are potential prompts or brainstorming questions to ask as you begin to think about your prototype:

- What materials could you use to create your prototype?
- Are those materials easy to find or low-cost materials?
- How can you make your prototype portable?
- How can you make your prototype lightweight, but strong enough to carry the bag of potatoes?

Planning is an essential part of this challenge, as well as needed in any problem-solving task. For this challenge, please show in the chart provided how you followed the steps of the engineering design process below.

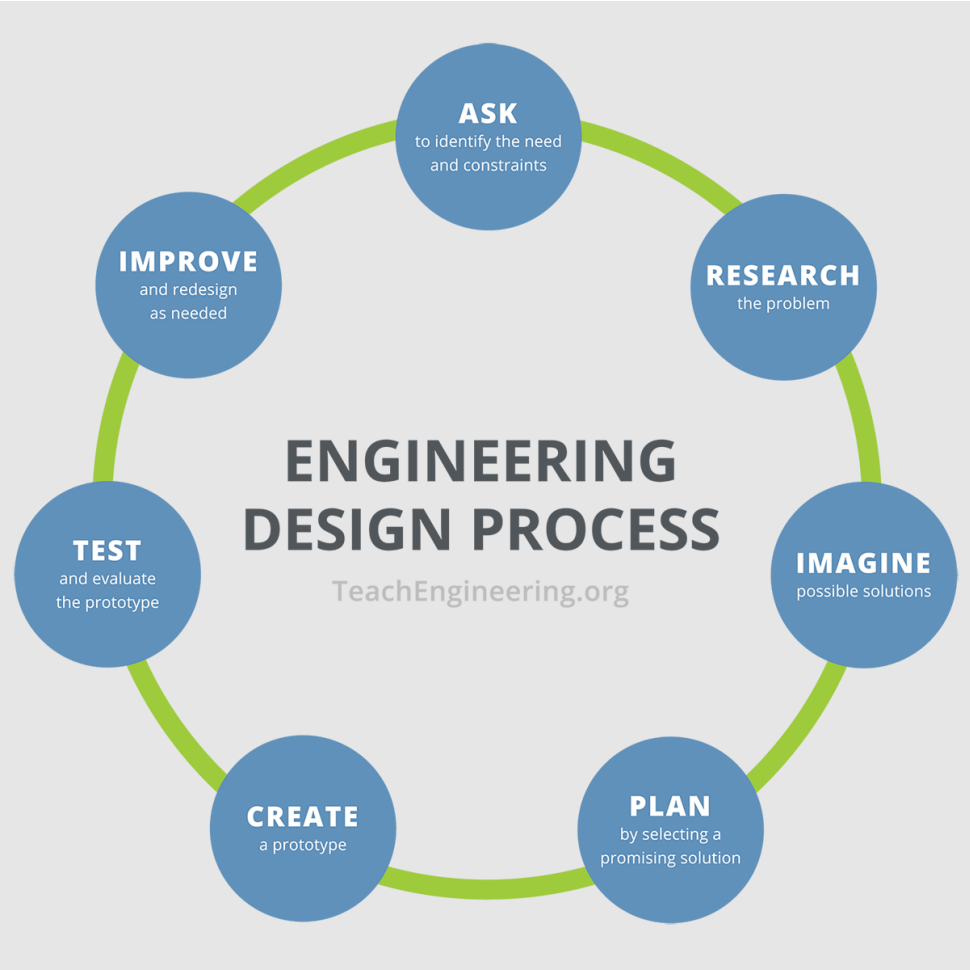


Image Credit: TeachEngineering.org

Specific information about the engineering design process, and its individual steps can be found on this website. It is important to remember that this is a cycle; Well-designed products involve multiple prototypes that are modified after testing and careful observation of how/when the product fails. Failure should be viewed as a positive part of the design process and should be embraced as a positive opportunity to continually improve the device until an ideal design has been found.

CREATIVITY

When we look at the creativity of a design, we consider a basic prototype and define creativity as a departure from that basic prototype (though your prototype should still be able to successfully accomplish the challenge). The basic prototype for this challenge:

- Design is a basic stretcher (2 solid poles with a sheet of material attached to the poles to hold the bag of potatoes).

Additional considerations for Creativity:

- Consider how to make your wilderness rescue device identifiable to Search and Rescue Teams.

ADDITIONAL RESOURCES

BACKGROUND INFORMATION

When somebody gets injured in the wilderness, rescuers cannot just pick up the injured person and carry them out. People are heavy and awkward to carry when they cannot support their own weight, which can be hazardous to rescuers when being carried over steep or rocky terrain.

Designers must consider different human shapes, weights, and how the person got injured. If a spinal or neck injury is suspected, a rescue device would require a different design than if someone needed to be carried out due to heat stroke. Medical devices should always consider the people using them and under what conditions. A wilderness rescue device or stretcher may have different criteria than one used in a hospital or transported in a helicopter.

Kinesiology is the scientific study of the mechanics of body movement. Using information from this specialty can help mechanical engineers design medical devices and sporting equipment. Engineers may also speak with doctors, search and rescue volunteers, and hikers to learn about what would make a good rescue device. Average human information for weight, limb lengths, and heights is also frequently referenced in design to accommodate the greatest number of

people. Afterall, if a design only works for a small percentage of the population, it's potential to help is limited.

CURRICULAR OUTCOMES

These are possible curricular outcomes that can be covered while completing this challenge. Please note that other curricular outcomes could also be addressed.

GRADE 7

Topic D: Structures and Forces

- Investigate and analyze forces within structures, and forces applied to them

When building their prototype students will need to investigate what types of forces will occur and evaluate whether their device is appropriate based on the forces that will be applied by the bag of potatoes

- Investigate and analyze the properties of materials used in structures

When building their prototype students will need to investigate what types of materials are best to use and evaluate whether different types of joints in the structure are appropriate.

- Demonstrate and describe processes used in developing, evaluating, and improving structures that will meet human needs with a margin of safety

When building the prototype changes in design may occur and they will have to continually evaluate how to successfully complete the challenge while developing their prototype.

GRADE 8

Topic D: Mechanical Systems

- Illustrate how trial and error and scientific knowledge both play a role in technological development (*e.g., development of aircraft*).

While building their prototype participants will have firsthand experience with trial and error and seeing how scientific knowledge helps build an effective prototype.

- Illustrate how technological development is influenced by advances in science, and by changes in society and the environment

While building their prototype participants will be able to illustrate how a change in society (increased participation in outdoor activities) relates to the advancement of technology and devices

GRADE 9

Topic D: Electrical Principles and Technologies

- Investigate and interpret the use of devices to convert various forms of energy to electrical energy, and electrical energy to other forms of energy

While building their prototype participants may need to investigate the conversion of electrical energy (this would be dependent on the design of their prototype and may not need to be addressed).

ARTICLES AND/OR VIDEOS

- Global News – Alberta Parks
- Welcome to Foothills Search and Rescue - YouTube

IN-PERSON EVENTS – RUBRIC AND ADDITIONAL REQUIREMENTS

ADDITIONAL REQUIREMENTS (SPECIFIC TO IN-PERSON EVENTS)

- Be prepared to discuss with your judge the following:
    - Describe a problem your team encountered and how it was solved
    - Any disagreements your team encountered and how this was resolved
    - What roles did each of your team members have in developing the prototype for this classroom challenge?
    - Address how the Engineering Design Process was used in developing your prototype
    - Address how the Wilderness Rescue Device should be assembled and disassembled
    - What parts of your prototype uses reusable or recyclable materials?
- Show evidence of the weight of your prototype
    - A scale to measure the weight of your prototype will be provided on event day
- Identify/indicate the physical footprint of your Wilderness Rescue Device prior to assembly
    - Your judge will provide a container to place your prototype in to assess that the dimensions of your Wilderness Rescue Device fit the requirements of the challenge
- Assemble your prototype and secure the bag of potatoes (i.e., the injured hiker) in 5 minutes or less
- Once the prototype test has begun you will need to complete the following obstacle course with your prototype carrying the bag of potatoes:
    - 10 meters flat
        - 10 meters will be measured out on the event floor in an open area of the venue. Your team will be directed there prior to testing, and you will be required to carry the bag of potatoes the 10 meters with your prototype
    - Rocky Terrain
        - To mimic navigating over rocky terrain your team will be asked to test your prototype by walking up 5 steps within the venue, followed by walking 5 steps down with your prototype
    - Overhanging forest/tunnel
        - Your team will test your prototype by navigating through a makeshift tunnel (e.g., made of string, tape, tables or chairs or other items available in the venue). This tunnel will be 1.5 meters high, 2 meters wide, and 2 meters long.
- The budget sheet provided must be completed and presented to your judge on event day. The budget only applies to materials that need to be purchased to design your

Wilderness Rescue Device. This does not apply to materials that are reused or recycled in your prototype – these materials can be added to your budget at a cost of $0.00.

RUBRIC (SPECIFIC TO IN-PERSON EVENTS)

Category	Points Awarded				Score
Problem Solving	**0**	**3.5**	**7**	**10**	
Engineering Design Process (EDP) Discussion	No part of the EDP was evident in the discussion/how the team approached the challenge	The EDP was evident in how the team approached the challenge, but some steps of the EDP were missing	The EDP was evident based on how the team approached the challenge, but more details could be included in their explanation	The team clearly shows how they implemented the EDP by explaining the steps they took to create their prototype, and how it evolved over time	**/10**
Budget	**0**	**2.5**	**5**		
Did the team stay within their **$50 CAD** budget for their prototype?	No, the team either did not hand in a budget sheet or exceeded the $50 limit	The team is within budget; however, their budget sheet is not representative of all materials used for the prototype.	Yes, the budget sheet is representative of the materials used for the prototype and is equal to, or under, the $50 limit.		**/5**
Teamwork and Communication	**0**	**2.5**	**5**		
Problem Identification	No problem was identified, or the explanation was unclear	A problem was identified, but the team's attempt to prevent or resolve the problem was not mentioned or unclear	The team identified a problem and clearly described how they resolved the problem		**/20**
Conflict Resolution	No disagreement was identified, or the description was unclear	A disagreement was identified and described, but there was no mention of how they prevented or resolved their disagreement	A disagreement was identified and described. The team explained how they successfully resolved their disagreement		
Collaboration	Participants were unable to describe how they contributed to the making of their prototype	Participants were able to identify how they worked as a team, but lacked details in their explanation	Participants were able to clearly describe their roles in the team and how they contributed to the prototype		

Communication *(Participants communicated with one another while completing the obstacles by providing instructions and guidance to one another)*	No communication occurred during the challenge, or the communication was very unclear	Some communication was evident during the challenge and mostly clear	Communication during the challenge was ongoing and clear/understandable	
Creativity	**0**		**5**	
Design	Design is a basic stretcher		Wilderness Rescue Device exceeds expectations in design and differs from a basic stretcher	**/10**
Identifiable	**0** Prototype lacks characteristics that would make it identifiable to Search and Rescue Teams		**5** Prototype incorporates an element(s) that would be easily identifiable to Search and Rescue Teams.	
Device Design	**0**		**5**	
Positioning of Device	The prototype comes into contact with the floor while navigating the obstacle course		The prototype does not come into contact with the floor at any point in the obstacle course	**/25**
Dimensions - **Footprint** *(40 x 30 x 10 cm)*	Footprint of wilderness rescue device exceeds all 3 dimensions when **packaged/stored** together		The footprint of the wilderness rescue device meets or is smaller than the required dimensions for when the prototype is **stored/packaged** together	
Dimensions - **Weight** Maximum of 10 lbs.	**0** The Wilderness Rescue Device weighs more than 10 lbs.	**2.5** The Wilderness Rescue Device weighs 5-10 lbs.	**5** The Wilderness Rescue Device weighs less than 5 lbs.	
Materials - Wilderness Rescue Device	Device incorporated pre-assembled pieces	n/a	Device had no pre-assembled pieces	
	Device used no reusable/ recyclable materials	Device used 1-2 reusable/recyclable materials	Device was constructed of at least 3 different reusable/recyclable materials	

Device Functionality	**0**	**5**	
Obstacles	Participants were unable to safely carry the bag of potatoes 10 meters on a flat surface	Participants were able to safely carry the bag of potatoes 10 meters or more	
	Participants were unable to carry the bag of potatoes safely down all of the steps to mimic hiking downwards	Participants were able to carry the bag of potatoes safely down all of the 5 steps to mimic hiking downwards	
	Participants were unable to safely carry the bag of potatoes up all of the steps to mimic hiking upwards	Participants were able to safely carry the bag of potatoes up all of the 5 steps to mimic hiking upwards	
	Participants were unable to safely carry the bag of potatoes through the overhanging forest/tunnel	Participants were able to safely carry the bag of potatoes through the overhanging forest/tunnel	
Device Safety	**0**	**2**	
	The Wilderness Rescue Device breaks or becomes unusable	The Wilderness Rescue Device remains intact and can be used again	
	The bag of potatoes is not secured to the Wilderness Rescue Device	The bag of potatoes is secured to the Wilderness Rescue Device	
	The bag of potatoes is not able to be safely carried (it is damaged or falls off due to the functionality of the Wilderness Rescue Device)	The bag of potatoes is able to be safely carried (it is not damaged and does not fall off due to the functionality of the Wilderness Rescue Device)	
Allotted Time	**0**	**2**	**/30**
	Assembling the Wilderness Rescue Device and placing the bag of potatoes on the prototype took longer than the 5 minutes allotted	Assembling the Wilderness Rescue Device and placing the bag of potatoes on the prototype took 5 minutes or less	
	The stairs portion of the obstacle course took longer than 2 minutes to complete	**1**	
		The stairs portion of the obstacle course took 2 minutes or less to complete.	
	The flat surface portion of the obstacle course took longer than 1 minute to complete	**0.5**	
		The flat surface portion of the obstacle course took 1 minute or less to complete.	
	The 'tunnel' portion of the obstacle course took longer than 1 minute to complete	The 'tunnel' portion of the obstacle course took 1 minute or less to complete	
Total			**/100**

VIRTUAL EVENT – RUBRIC AND ADDITIONAL REQUIREMENTS

ADDITIONAL REQUIREMENTS (SPECIFIC TO VIRTUAL EVENT)

- Provide evidence of a plan and problem-solving by completing the Engineering Design Process Chart provided with this package.
- The budget sheet provided must be completed and submitted with the rest of the challenge documents and video. The budget only applies to materials that need to be purchased and your electronic components. This does not apply to materials that are reused or recycled in your prototype - these materials can be added to your budget at a cost of $0.00.

VIDEO SUBMISSION REQUIREMENTS

Once you have completed your device and set-up your testing environment an adult member of your household or your classroom teacher should begin to record as you:

- Describe your design and the materials you used. Please ensure you:
    - note the reusable or recyclable materials
    - address how the prototype should be assembled and disassembled
    - show evidence of the physical footprint of your prototype when it is disassembled/packed together
        - Ensure measurements of the dimension are included.
        - Show evidence of your device's weight
- Identify/show your bag of potatoes
    - Show evidence of your bag of potatoes being 10lb
- Explain **1** problem that occurred while creating your device and how you solved this problem. Any other problems can be included in the Engineering Design Process Chart.
- Begin testing your prototype by assembling it and securing your bag of potatoes in 5 minutes or less
    - A timer must be included in the video so that judges will be able to tell how long it takes to assemble your prototype and secure your bag of potatoes to the prototype
- Demonstrate you and your prototype safely completing the 3 tasks in your obstacle course:
    - Carrying the bag of potatoes for 10 meters on flat ground
        - You will need to measure the area and show evidence that the bag of potatoes will be carried a minimum of 10 meters
    - Carrying the bag of potatoes up and down a flight of at least 5 steps of stairs to mimic hiking across rocky terrain
        - Your entire stretcher must pass over a minimum of 5 steps.

    - Carrying the bag of potatoes underneath a height of 1.5 meters and within a width of 2 meters and a length of 2 meters (to mimic walking through dense low hanging forest or a tunnel)
        - To design a tunnel or low hanging obstacle, consider taping string across a hallway to indicate the height, width and length of the tunnel to crawl under. **The width of this part of the obstacle course should not exceed 2m and the obstacle will need to have a minimum length of 2 meters**
            - You will need to measure the area and show evidence that the testing environment follows the requirements of the challenge
- After the obstacle course has been completed you will need to show your bag of potatoes to provide evidence that no potatoes were damaged during the testing
- Your video should be no longer than **10 minutes**.
    - You may edit your video if you wish, to combine your presentation and testing of your prototype, but there should be no edits or cuts in the footage showing your prototype completing each challenge.
    - You can film the different parts of the testing process (the assembly of your prototype and each task in the obstacle course) separately and combine them to make your video, but you cannot have edits/cuts in each of those clips.
    - **We will only be evaluating the first 10 minutes of your submission and anything after the 10-minute mark will not be counted in the assessment.**

SUBMISSION ITEMS

Your entire submission should include the following items:

1. Your 5-minute video submission
2. A completed Engineering Design Process Chart
3. A completed budget sheet
4. You may include photos of your Wilderness Rescue Device and Testing Environment fitting the requirements (e.g., correct weight and dimensions) OR include that in your video.

More information about how to submit these items will be shared in April 2022.

RUBRIC (SPECIFIC TO VIRTUAL EVENT)

Category	Points Awarded				Score
Problem Solving	**0**	**5**	**10**	**15**	
Engineering Design Process Chart (EDPC)	EDPC was blank or illegible	EDPC was partially filled out and was lacking in detail	The EDPC was completed, but lacked details for each category	All of the EDPC was filled out in a clear and detailed manner	**/20**
Problem Explanation	**0**	**2.5**	**5**		
	A problem was not mentioned in the video or the explanation was unclear	A problem was clearly mentioned, but no solution was given	A problem and solution were clearly explained in the video		
Budget	**0**	**2.5**	**5**		
Did participant(s) stay within their **$50 CAD** budget for their prototype?	No, the participant(s) either did not hand in a budget sheet, exceeded the $50 limit, or provided a document that was not legible.	The participant(s) is/are within budget; however, their budget sheet is not representative of all materials used for the prototype.	Yes, the budget sheet is representative of the materials used for the prototype and is equal to, or under, the $50 limit.		**/5**
Communication	**0**	**2.5**	**5**		
Communication *(Participants communicated with one another while completing the obstacles (or with the person assisting them) by providing instructions and guidance OR they provided reassurance to the injured hiker)*	No communication occurred during the challenge, or the communication was very unclear	Some communication was evident during the challenge and mostly clear	Communication during the challenge was ongoing and clear/understandable		**/5**
Creativity	**0**	**5**			
Design	Design is a basic stretcher	Wilderness Rescue Device exceeds expectations in design and differs from a basic stretcher			**/10**

Identifiable	**0**		**5**	
	Prototype lacks characteristics that would make it identifiable to Search and Rescue Teams		Prototype incorporates an element(s) that would be easily identifiable to Search and Rescue Teams.	
Device Design	**0**		**5**	
Dimensions – **Footprint** (40x 30 x 10 cm)	Footprint of wilderness rescue device exceeds any of the 3 dimensions when **packaged/stored** together		The footprint of the wilderness rescue device meets or is smaller than the required dimensions for when the prototype is **stored/packaged** together	**/20**
Dimensions - **Weight** Maximum of 10 lbs.	**0**	**2.5**	**5**	
	The Wilderness Rescue Device weighs more than 10 lbs.	The Wilderness Rescue Device weighs 5-10 lbs.	The Wilderness Rescue Device weighs less than 5 lbs.	
Materials - Wilderness Rescue Device	Device incorporated pre-assembled components	n/a	Device had no pre-assembled pieces	
	Device used no reusable/ recyclable materials	Device used 1-2 reusable/recyclable materials	Device was constructed of at least 3 different reusable/recyclable materials	
Device Functionality	**0**		**5**	
Obstacles	Participants were unable to safely carry the bag of potatoes 10 meters on a flat surface		Participants were able to safely carry the bag of potatoes 10 meters or more	**/30**
	Participants were unable to safely carry the bag of potatoes down all of the steps to mimic hiking downwards		Participants were able to safely carry the bag of potatoes down all of the 5 steps to mimic hiking downwards	
	Participants were unable to safely carry the bag of potatoes up all of the steps to mimic hiking upwards		Participants were able to safely carry the bag of potatoes up all of the 5 steps to mimic hiking upwards	
	Participants were unable to safely carry the bag of potatoes through the overhanging forest/tunnel		Participants were able to safely carry the bag of potatoes through the overhanging forest/tunnel	

Ability to Carry	**0**	**2**	
	The Wilderness Rescue Device breaks or becomes unusable	The Wilderness Rescue Device remains intact and can be used again	
	The bag of potatoes is not secured to the Wilderness Rescue Device	The bag of potatoes is secured to the Wilderness Rescue Device	
	The bag of potatoes is not able to be safely carried (it is damaged or falls off due to the functionality of the Wilderness Rescue Device)	The bag of potatoes is able to be safely carried (it is not damaged and does not fall off due to the functionality of the Wilderness Rescue Device)	
Allotted Time	**0**	**2**	
	Assembling the Wilderness Rescue Device and placing the bag of potatoes on the prototype took longer than the 5 minutes allotted	Assembling the Wilderness Rescue Device and placing the bag of potatoes on the prototype took 5 minutes or less	
	The stairs portion of the obstacle course took longer than 2 minutes to complete	**1**	
		The stairs portion of the obstacle course took 2 minutes or less to complete.	
	The flat surface portion of the obstacle course took longer than 1 minute to complete	**0.5**	
		The flat surface portion of the obstacle course took 1 minute or less to complete.	
	The 'tunnel' portion of the obstacle course took longer than 1 minute to complete	The 'tunnel' portion of the obstacle course took 1 minute or less to complete	
Testing Environment	**0**	**2.5**	
Flat surface	The flat surface portion of the challenge was less than 10 meters long	The flat surface portion of the challenge was a minimum of 10 meters long	
Steps	The stairs portion of the challenge had fewer than 5 steps	The stairs portion of the challenge had a minimum of 5 steps	**/10**
Low hanging forest or tunnel (height)	The height of this portion of the challenge exceeded 1.5 meters	**2**	
		The height of this portion of the challenge was a maximum of 1.5 meters	
		1.5	

	The width of the path was more than 2 meters	The width of the path was a maximum of 2 meters	
	The length of the path was less than 2 meters long	The length of the path was at least 2 meters long	
Total			**/100**