OHIO STATE UNIVERSITY EXTENSION

STEM PATHWAYS
Smokejumper STEM Challenge!

The Problem

The U.S. Forest Service is seeking a parachute design that enables smokejumpers to jump in higher winds and glide to a safe landing. The parachute system needs to help reduce injuries to ankles, legs and hips during landings.

The Challenge

To design a smokejumper's parachute that has a controlled descent assuring a safe landing on the designated wildfire target.

Find a Solution

ASK: What are some possible ideas?

PLAN: Test out your ideas

CREATE: Put your ideas to the test

TEST: How well did your idea work?

IMPROVE: Review results & make changes

Things to Consider

1. What types of materials are used to make parachutes?
2. Which design material will work best to descend your smokejumper to the wildfire?
3. How will the parachute's shape and size factor into your design?
4. What aerodynamic concepts are most critical to your parachutes success?

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The U.S. smoke jumping program began in 1939 with the first fire jump made in 1940 in Idaho. Today, more than 300 smokejumpers battle wildfires from about June 1 through October in the U.S. Parachutes are also used to drop food, water and fire fighting tools to the men and women battling wildfires.

Design Materials & Supplies

Newspaper
Tissue paper
Garbage bags
Napkins
Paper Towels
Kite string
Tape
Hole Punch
Scissors
Ruler

Miniature smokejumpers (toy paratroopers 1 ½ inches to 4 inches tall). You can also use washers, clothespins or other similar items if you do not want to purchase toy figures.

SAFETY ALERT: Scissors are sharp! Adult supervision required when releasing smokejumper from elevated test sight (balcony, staircase, step ladder, etc.).

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FACILITATOR PROCESSING

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Design Set-Up and Teams

1. Table space sufficient for each person or team of persons to construct parachute
2. Indoor or outdoor testing area with elevated space to release smokejumpers from and a designated fire target. Elevated spaces could include balcony, staircase, step ladder, etc. Trash cans, hula hoops, buckets can be used to mark the fire target for the smokejumpers to land.
3. Gather parachute design materials.
4. Divide youth into 2 to 4 member teams. Challenge can also be done individually.
5. Describe the problem and challenge to the youth.
6. Explore aerodynamic concepts with youth prior to having them brainstorm designs.

TIME: 30 MINUTES

Materials and Supplies

- Newspaper
- Tissue paper
- Plastic garbage bags (stretchy & standard)
- Kite string
- Tape
- Hole Punch
- Scissors
- Ruler
- Napkins
- Paper Towels
- Ping pong ball
- Golf ball
- Cardstock
- Copy Paper
- Miniature toy figures, washers, clothespins
- Trash can, bucket or hula hoop for target
- Staircase, balcony, ladder for drop

Explore Aerodynamics

- Drop a ping pong ball and golf ball at the same time. What happens? Demonstrates gravity.
- Use a piece of cardstock and a piece of crumbled copy paper. Drop at the same time. What happens? Demonstrates drag.
- Open up the crumbled copy paper and repeat from 6.5 to 7 feet. What happens?
- Fold a piece of paper in half, but do not crease. Tape together. Release from 6.5 to 7 feet. Demonstrates lift and glide pattern.

SAFETY ALERT: Scissors are sharp! Adult supervision required when releasing smokejumper from elevated test site (balcony, staircase, ladder, etc.!

Engage the Learner

- Which material(s) do you predict will best increase lift? Which material(s) do you predict will best increase drag?
- What correlation would you expect to find between parachute size and descent? What about parachute shape and descent?
- Why would number of strings and length of strings impact the smokejumpers descent?
- How will venting of your parachute impact glide or a controlled descent?

Observations & Conclusions

Release your smokejumper from the test site.

- What type of descent was accomplished with your parachute design? *Fast or Slow, Controlled or Uncontrolled, Hit target or Missed target, Safe Landing or Broken Bones*
- What type of parachute materials worked the best? Which ones performed the poorest?
- What would you change about your design and why? *(size, shape, parachute material, length of string, weight of string, etc.).*

STEM Career Path … Aeronautical Engineer

Who else might be involved? Materials scientists, textile scientists, mechanical engineers, military, astronauts, pilots and firefighters using products.

Who benefits? Military, skydivers, astronauts, smokejumpers, and humanitarian relief drops of food, medical supplies, airplane travelers, etc.

What other issues are aeronautical engineers helping to solve? Design test and manufacture safe aircraft and spaceships, missiles, rockets and satellites, inspect and test aerospace equipment, troubleshoot problems encountered on all types of aircraft.

Refer to Career Focus Card for more details.

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STEM PATHWAYS

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Did You Know? The first emergency use of a parachute was from an exploding hot air balloon. Modern parachutes deployed at high speeds and high altitudes started in the 1930's by the military. Parachutes help humans land safely, drop supplies and slow the descent of the Space Shuttle. What do you think the future holds for this medieval invention?

SCIENCE
Physicist

How can we improve the safety and landing for humans? How can we use what we know to design a parachute to safely land a distressed plane?

- The earth's gravity makes falling objects accelerate.
- After about 5 seconds, you reach a falling speed where the air resistance (pushing you upward) balances with gravity (pushing you downward). This is known as terminal velocity and is about 55 meters per second or 125 mph for a skydiver (smokejumper).
- The force on a parachute requires it to be made of strong materials. Canvas and silk have been replaced by lightweight synthetic materials like nylon and Kevlar used in bullet-proof clothing.

TECHNOLOGY
Pilot

What altitude will the person be jumping from the aircraft?

- Smokejumpers deploy from the plane at 1,500 feet above the ground. Wind direction and speed must be accounted for to enable the jumpers to reach the targeted spot.
- Recreational skydivers jump from 12,500 to 18,000 feet. Skydivers reach 115 mph in free-falls from 12,500 feet.
- When jumping at high altitudes (30,000), a GPS device and use of way points and terrain features help navigate military jumpers to target locations.

ENGINEERING
Aeronautical

How does parachute attachment to the falling object (person or thing) impact performance?

- The descent rate is dependent upon the drag force that the parachute develops. These characteristics impact drag force: surface area, glide pattern, air flow around the canopy, shape of the canopy, permeability of the fabric (tightness of weave), descent velocity, length of lines.

MATH
Parachute Rigger

How does the way a parachute is packed effect performance?

- Parachutes are inspected and tested to ensure safety and regulations are met.
- Both strength and permeability of the parachute's fabric are conducted. As permeability increases, the parachute will open more slowly and flight performance will deteriorate.
- Wing loading is easily calculated by dividing the total suspended weight in pounds by the parachute's surface area in square feet.

$$\frac{190 \text{ lbs.}}{210 \text{ sq.ft.}} = 0.9 \text{ lb./sq.ft.}$$

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AERONAUTICAL ENGINEER

Finding Solutions For...

- Design, manufacture and test aircraft, spacecraft, missiles, satellites, drones, parachutes and other aerospace products.
- Develop new technologies in aviation and defense systems.
- Redesign aircraft to increase fuel efficiency and decrease noise pollution.
- Low-orbit and beyond-earth-orbit for human and robotic space travel.

Job Forecast Looks Like...

- **Median Income:** 107,830
- **Job Outlook:** 2% decline from 2014 to 2024.
- **Job Environment:** Full time often with extended hours to meet project deadlines. Utilize sophisticated computer equipment and software design tools, modeling and simulations for tests, evaluations and training.
- **Expected Growth Areas:** Unmanned aerial vehicles domestic uses in search and rescue of people lost in large area and putting out forest fires, etc.

Skill Set Needed...

High School Courses:
Math – Calculus, Trigonometry, Statistics
Science – Physics
Specialized – Computer science, technical writing

Critical-thinking and problem solving: identify design elements to meet requirements and formulate alternatives
Business: knowledge of commercial law and standard business practices

Education and Training Required...

- **Entry Level Jobs:** Require Bachelor's degree
- **Additional Training and Certifications:** Many careers also require advance training and passage of the Fundamentals of Engineering exam and/or Professional Engineering exam.

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Source: U.S. Department of Labor, Occupational Outlook Handbook, 2015-2016 Edition, bls.gov/ooh