Regional Class Research Vessel

The Oregon Winch Trials

An engineering design challenge in which failure is your first goal

RCRV: Oregon Winch Trials

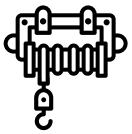
Targeted Grade Level: This lesson can be used to engage students of all grade levels

Lesson Time: The length of each component can be adjusted to suit the needs of the class or student, but we recommend a 60-90 minute work period for this lesson.

Highlighted NGSS

K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

INTRO



A **winch** is a mechanical system that's used to pull, lower, or retrieve an object attached to a synthetic rope or wire cable---otherwise known as a **tension member**. Winches are used everywhere from tow trucks to elevators to research vessels, anywhere that you would need to lift and pull heavy loads safely and efficiently. This activity challenges students to design, build, and break their own winch systems and discuss how failure can be a critical part of the engineering design process.

This activity is sponsored by the Regional Class Research Vessel (RCRV) project through the National Science Foundation.

Guiding Questions

- What are the components of a winch system?
- How are winches used on research vessels?
- What is the engineering design process?
- How can failure be meaningful and productive?

Students will...

- Be able to define the components of a winch system and identify different ways in which winches are used around their communities
- Learn more about how winches are used aboard the RCRVs and the development and testing process of oceanographic equipment
- Reflect on the importance of failure in the design process
- Practice engineering design through creation, testing, and modification
- Use digital tools to take quantitative measurements of force

PROCEDURE

Preparation

In advance of this lesson, you will need to:

- Review the Oregon Winch Trials Google Slides Presentation. Make a copy if desired and modify it for your club's needs
- Install provided batteries in the Digital Force Gauge
- Gather craft materials needed for the activity

Materials

Included in SMILE Workshop Kit

- Digital Force Gauge
- Metal S hook (for tension member trials)
- String (various materials: yarn, floss, twine, string)

Not provided by SMILE

- Cardboard tubes, cardboard pieces
- Straws, wooden dowels, chopsticks, or pencils
- Spools (various sizes)
- Duct tape, scissors, paper clips
- Markers

What is a winch?

A winch is a mechanical system that's used to pull, lower, or retrieve an object. Winches are used everywhere from tow trucks to elevators to research vessels.

Winch Hunt

Get a discussion started by asking students:

- *Can you think of any construction sites around town? Where are they? What are they building, and how are they moving materials?*
- *Have you ever seen a car being towed? What happened?*

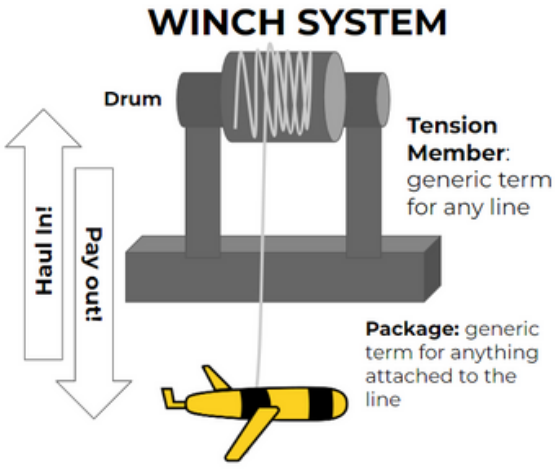
Winches on Board the RCRVs

Show students this model, or rendering, or the R/V Taani.

Ask students:

- *Can you spot a **winch** on this model of the R/V Taani?*
- *What do you think ocean scientists would use a winch for?*

Review the "fancy ship vocabulary" students will hear and use during the activity: *tension member, scientific package, pay out, haul up.*



Interested in Learning More?

- Click here for more information on the Regional Class Research Vessel (RCRV) Project
- Click here for more RCRV Activities for SMILE clubs!
- Try more free engineering design activities found in this excellent database, https://www.techlearning.com/news/best-free-engineering-lessons-and-activities

Career Corner

- MARSSAM: The OSU Marine Rock and Sediment Sampling Group is the OSU coring and dredging facility providing marine geologic sampling services for scientists aboard research vessels. Click here to watch MARSSAM Dredge Training videos!
- Did you know breaking ropes is a professional job? Watch Welcome to Right Rope!
- Be inspired to bring destruction into your artwork by this article: From Claude Monet to Banksy, Why Do Artists Destroy Their Own Work?

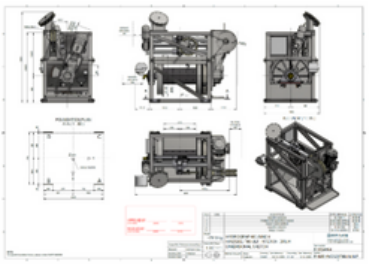
Winches on Board the RCRVs

Learn more about what winches are used for on research vessels, and the challenges and joys of working at sea

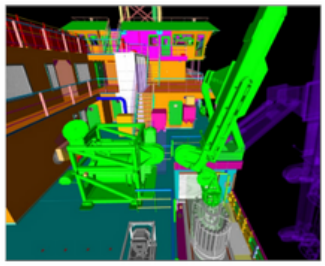
Sea Winch: Trial & Error in Ship Engineering

Recap the message of the video by following along with the slides.

From a drawing to a computer model to real life, LOTS of planning and innovation went into the design of the RCRVs' winch systems.



Detailed conceptual drawings, or schematics, of the hydrographic winch



The bright colors in this CAD model represent different types of materials

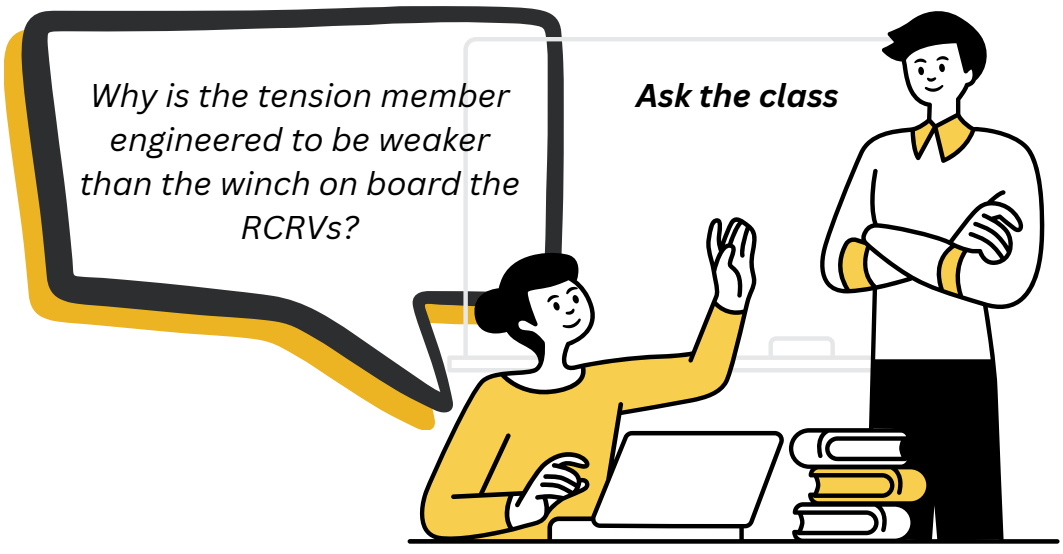
The hydrographic winch before being attached to the ship

Failure is a critical part of the design process... sometimes on purpose, sometimes by accident!

MILL TEST CERTIFICATE

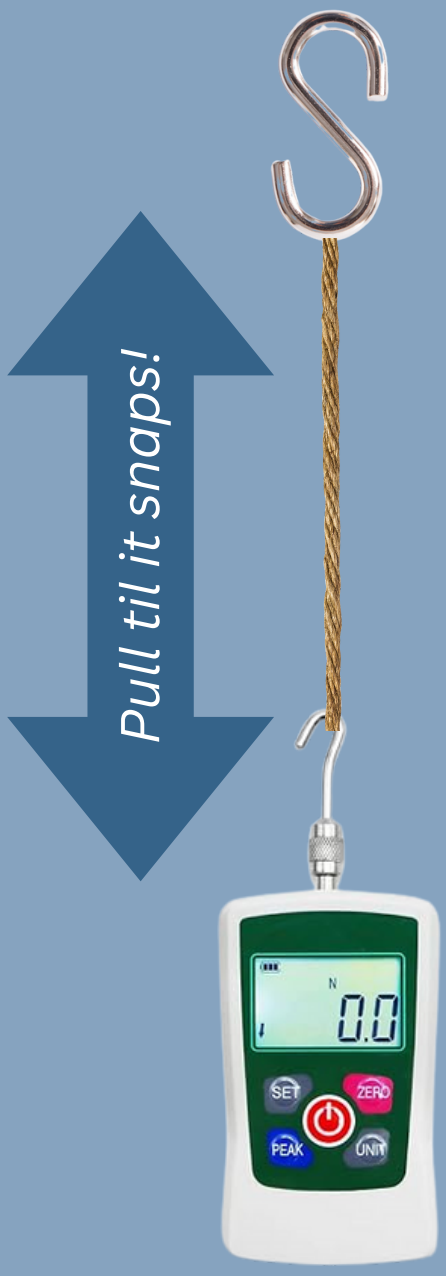
This form meets the requirements of the U.S. Department of Labor, Occupational, Safety and Health Administration Form No. 4

Left, a real test certificate from the RCRV project in which the company tested the rope until it broke. This is so they know the limits of the system and are prepared to sail safely!



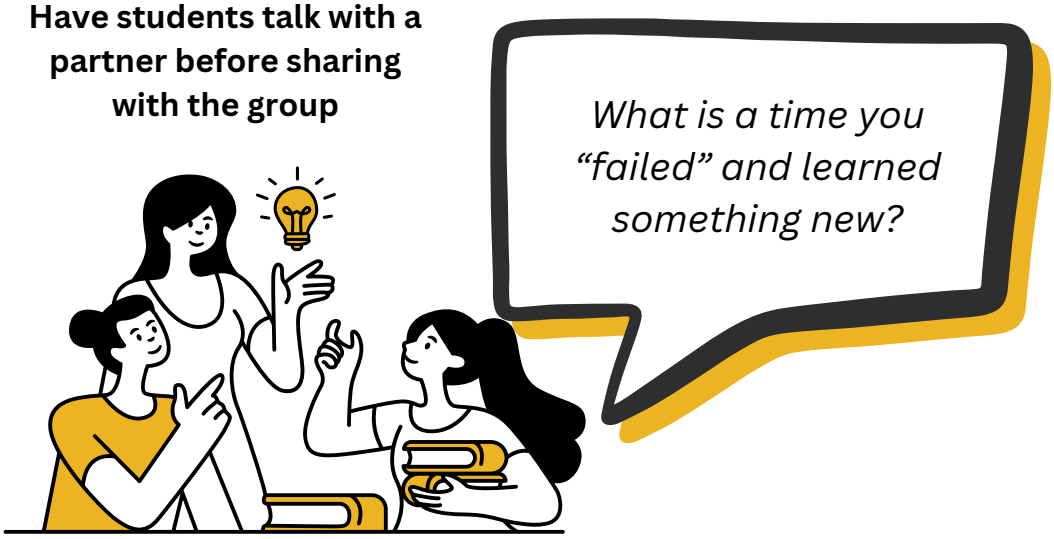
Tension Member Trials

Click for a link to a helpful instructions video
Winch Trials: Build it, Break it!



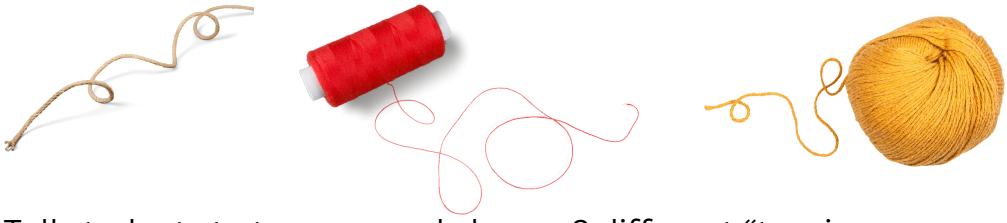
Productive Failure Discussion

Have students talk with a partner before sharing with the group



TRIAL 1: Tension Member Trials

Remember, a tension member is the general term used to refer to ANY rope or cable that's used in a winch. On the ship, this could be made of steel or rope. It could be a "dumb" cable that just acts as a connection, or it could be a "smart" cable that has fiber optics and can transmit information. For research vessels, there is actually a dedicated facility that tests tension members by breaking them. They can also repair lines that have been damaged.

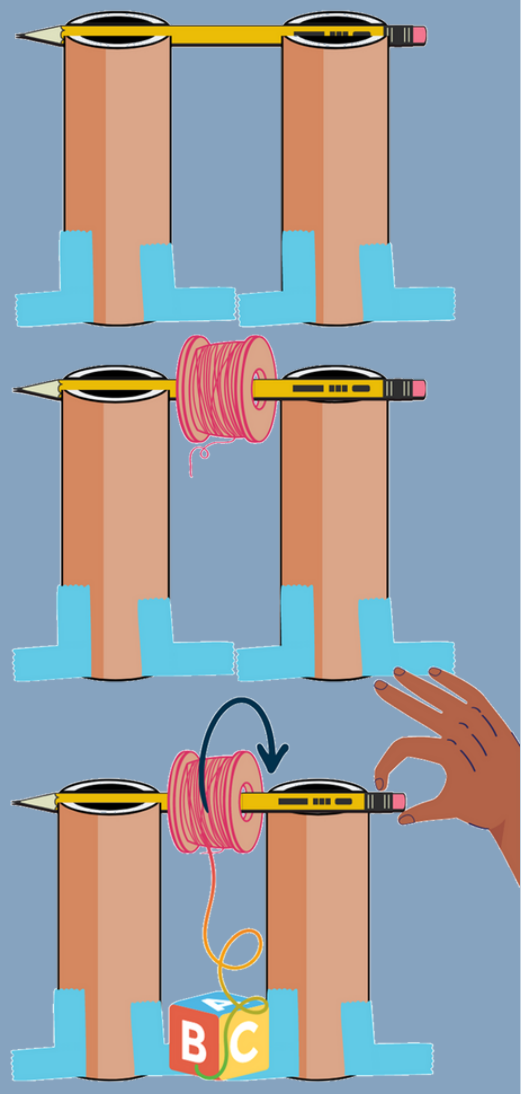


Tell students to team up and choose 3 different "tension members" (strings) to test.

- Have one student hold the digital force gauge and screw the metal hook on to the top.
- After turning it on, they should push ZERO and then PEAK so the device is set to record the maximum force, or the point at which the string breaks.
- Tie each end of the string into a loop.

- Have one student hold the digital force gauge and the other hold an S hook (to avoid hurting their fingers). Attached the loops of string to each hook.
- Then, it's time for a tug-of-war!
- Have students test 3 materials and record the peak force at which each of them breaks.

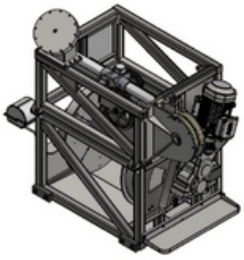
Cardboard Winch Trials



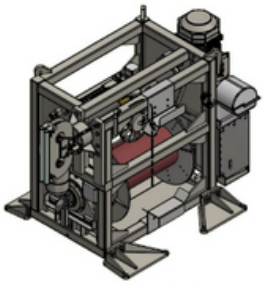
TRIAL 2: Cardboard Winch Prototyping

The RCRVs have 3 winch systems: the oceanographic winch, the hydrographic winch, and the portable winch. These are traction winches that are able to lift extremely heavy loads by removing pressure from the winding part of the mechanism.

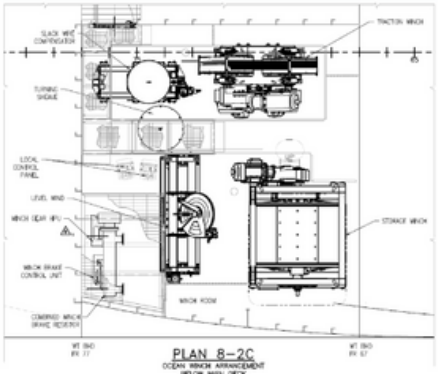
- Oceanographic "Ocean" Winch
- Hydrographic "Hydro" Winch
- Portable Winch



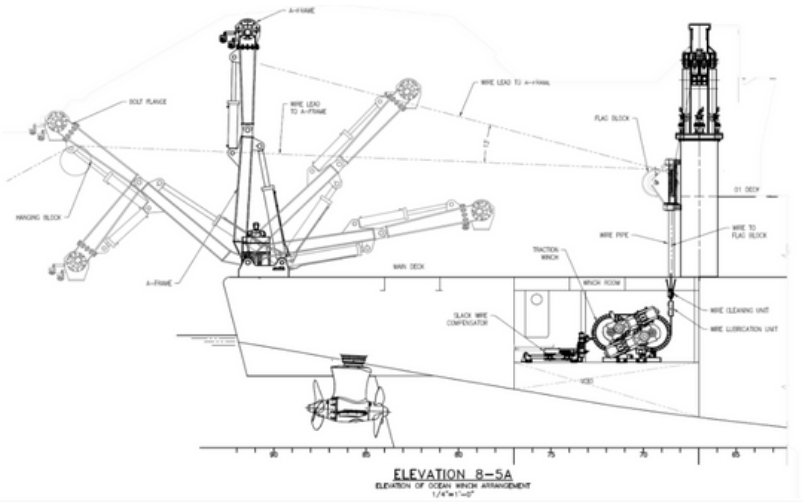
Hydrographic Winch



Portable Winch



Oceanographic Winch



Your students will build a simplified version of a winch today– a hand-crank model– using cardboard prototyping. This step might seem like arts and crafts, but this is a technique even professional engineers use when they are first brainstorming what a design might look like. By creating 3D mockups of new designs out of cheap paper or cardboard, they can try something out without wasting expensive materials!

A hand-crank winch will need a stand, a rotating drum, and a hand crank. There are many different ways to put these components together! Use cardboard pieces, straws, chopsticks, pencils, duct tape, and other craft materials to construct your first prototype. Then, use the digital force gauge again to record the peak force it takes to BREAK IT!

References

- Build a Hand Crank Winch a YouTube video by Volusia Kids Read
- How Winches Work an article for How Stuff Work

This lesson draws on many elements from the **engineering design process**. Use the figure below as a reference for this and other engineering activities.

This lesson was created with the support of the National Science Foundation, an independent federal agency that promotes the progress of science though awarding grants to projects driven by curiosity and discovery.

NSF funding enables the construction of all 3 RCRVs as well as development of educational materials to engage students with ocean sciences, engineering, and data management.

Reflection: Did we meet the challenge criteria?

Once students have finished Trial 1 and Trial 2, it's time to put it all together. Follow along with this slide to evaluate:

- **Remember, your challenge was to build a winch that is stronger than the tension member.**
- **Did this happen on the first try?**
- **If so, try rebuilding and making both components stronger.**
- **If not, make some adjustments. Will you need a weaker tension member, or a stronger winch?**

Teaching Tips:

- Though it seems counterintuitive, encourage students to select a WEAKER tension member for their model
- Repeat the **"iterate"** process with students as many times as you like.
- Rely on the quantitative tools (the digital force gauge) as much or as little as you want. If your group has limited time, build functional winches and skip the destruction step!

Extension: We love to see you fail

We hope that through this activity, students are excited to fail. Share these exciting moments with others by taking photos or videos during the process. Use program like Stop Motion, Canva, or TikTok to edit the video into something entertaining and educational!