

Engineering Tapping Systems Elementary Level Curriculum

Objective: Students will gain a conceptual understanding of the systems used by maple producers to tap trees and collect sap. Students will be able to compare and contrast different tapping systems considering the scale of a producer's maple operation.

This lesson corresponds to:

-S.3-5.ETS.1/3-5-ETS1-1 Define a simple design problem reflecting a need or want that includes specified criteria for success and constraints on materials, time or cost.

-S.3-5.ETS.2/3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Materials:

- Coloring supplies
- Paper
- Yarn/string

Background Information: For centuries maple syrup has been collected using taps in trees that have buckets hanging off of them. Maple producers would walk, drive vehicles or plow animals through their sugar bush and collect the sap that had dripped into the buckets. The types of taps and buckets have changed overtime and modernized, evolving from hollowed out wood to plastic and metal taps. The holes in trees are now made with electric drills instead of augers. There were other methods of tapping trees before the hollowed out wooden spout, Native Americans would use a wedge of wood jammed into a v-notch in the tree to guide sap into a basket.

In present day many small-scale producers still use buckets to collect sap from the trees; and during the day they will go around and collect all of the sap into a bigger container and then bring it to their sugar shack to be boiled into syrup. Large-scale producers use tubing to connect all of their taps to their sugar shack, this creates a system where sap will flow directly from the tree to the sugar shack to be processed. The use of tubing allows producers to have a larger number of taps and produce more syrup without having to go out and collect the sap all day. Tubing systems rely on either gravity or a vacuum to bring the sap down to the sugar shack. Luckily in WV many mountainsides are very steep and gravity is a strong enough force to pull all the sap into the sugar shack. When producers set up their tubing they wind multiple small lines through the maple trees, making sure the tubing touches every tree that will be tapped, the tap will later be connected to the tubing when it is time to tap. These small lines, called laterals, connect to a larger main line that runs to the sugar shack.

As tapping systems have evolved so have boiling and processing systems. Historically sap was boiled over open fires in hollowed out logs or cast-iron cauldrons. Sap was boiled until it was a thick, syrupy consistency. In present day, sap is boiled in evaporators with flat pans, this



increases the surface area and helps speed up and streamline the evaporation process. These large flat pans were improved more with a two-pan system, one for initial evaporation and the other for finishing the product, and flues, channels along the bottom of the pan, were added to increase surface area further. Many producers will also use a reverse osmosis machine, this concentrates the sugar content of the sap before it is ever boiled, to decrease the boiling time. Producers no longer wait until the syrup 'seems' ready but rather they test the sugar content of the syrup, ensuring it is between 66%-66.9% sugar, with hydrometers. Many of the modern, high-tech methods for syrup production are used by large scale producers while smaller scale operations still boil sap in pots on the stove or use a single pan evaporator.

Introduction: Ask students to think about the methods they are using to tap trees and collect sap at school (buckets and plastic taps); now would that make sense if you were tapping 3,000 trees?

- What do you think people did historically to collect syrup?
- What did they use to tap trees before plastic taps were available?

Activity 1: Creating blueprints: Students will engineer a system of collecting sap and bringing it to the sugar shack, students will draw blueprints for their systems.

Procedure 1:

1. Introduce your students to the problem: You need a way to get sap out of a tree, collect it outside the tree, and transport it to your sugar shack.
(You can be as specific or as vague as you want with your students.)
2. Working in groups, have students brainstorm a solution to this problem.
3. Have students make a blueprint of their proposed solution, sketch it out. Each blueprint should include a written explanation of the system.
4. Have the class compare and contrast the different solutions thought up with the current systems used by commercial maple producers.

Procedure 2:

1. Introduce students to the 2 most common maple sap collection systems.
 - Spouts connected directly to buckets.
 - Tubing connecting spouts all the way to the sugar shack.
2. Have the students create drawings of each system
3. Have the class compare and contrast the two systems
 - Pros and cons of each
 - At what point does it make sense to switch from buckets to tubing?
 - How much work is needed for each system?

Activity 2: Setting Up Tubing: Students will work together to set up their own tubing system.
-This activity can be done in the classroom using desks and other obstacles as trees or outside using trees.

Procedure:



1. Separate students into groups and give each group a ball of yarn or string.
2. Each group needs to string this 'tubing' up, starting at one designated tree and incorporating all of those between the starting tree and the final tree.
 - . Things to remember:
 - Tubing should run downhill, if possible, so that gravity can help transport the sap from the trees to the sugar shack
 - Tubing costs money, so the best way to run tubing is by using the least amount possible.
3. Have each group inspect the other tubing systems, compare and contrast techniques.

Resources:

"The History of Maple Syrup" Maple Valley Cooperative. Retrieved 11 January 2019.

<https://maplevalleysyrup.coop/the-history-of-maple-syrup/>

"So, When Did it All Start?" Michigan Maple Syrup Association. Retrieved 11 January 2019.

<https://web.archive.org/web/20110525093903/http://www.mi-maplesyrup.com/about/history.htm>