This Project
The cornstarch and water mixture is known as a non-Newtonian fluid. This means that it typically acts like a liquid, but when a force is applied it acts like a solid. The vibrations that come from the speaker are waves of force that cause the mixture to switch between solid and liquid. This results in the formation of "monsters" in the cornstarch and water mixture.

Societal Impacts
Non-Newtonian fluids are useful in everyday life. Understanding the behavior of these fluids is key to understanding many important chemical and biological processes. In fact, a whole area of study called rheology is dedicated to observing this.

Real-World Applications
In order to produce non-Newtonian fluids, it is important to understand their behavior. This is true for the production of toothpaste, paint, and many other everyday products, including ketchup! Research is also being done to create body armor containing a non-Newtonian fluid. The armor would be very flexible, but would harden up immediately when a force is applied.

Further Information
At-home instructions: http://www.stevespanglerscience.com/lab/experiments/the-force-of-sound-sick-science/
Instructions to make oobleck (cornstarch and water mixture):
http://www.scientificamerican.com/article/oobleck-bring-science-home/
More information about non-Newtonian fluids:
Liquid Curtain

This Project
A mixture of water is falling in the form of a very thin waterfall. Disturbances in this flow of water create diamond-shaped waves. (Check out the accompanying poster for cool physics explanation). Experiment to see where disturbances would cause the most waves. Where would disturbances cause the curtain to break all together? Is there anywhere the fluid could be disturbed and not make a wave?

Societal Impacts
When adding a coating onto a smooth object, disturbances in the form of waves would cause streaking, not a desired effect.

Real-World Applications
Chemical Engineers would work on things like this every day in the coating industry! For example, what’s the difference between newspaper, printer paper, and a page in a picture book? The coating! Chemical Engineers figure out ways to create coatings that are least affected by disturbances, and also create ways to prevent disturbances, such as dust, from forming in the first place. Other applications include determining optimal flow rate and thickness.
"Rainbow in a Jar"

This Project
The varying densities of the different liquids allows for layering without mixing, thereby creating a "rainbow in a jar." The liquids layered in the rainbow jar are honey, corn syrup, dish soap, water, olive oil, and rubbing alcohol, added in that order. To create the rainbow effect, food coloring was added to some of the liquids. When the liquids were added to the jar, some of them mixed together at first, but because of their differing densities, they separated from each other over a period of time.

Societal Impact
Density is a measure of a how much matter occupies a given amount of space. We use the formula \( \rho = \frac{m}{v} \) to calculate density. The symbol \( \rho \), pronounced rho, is used to describe the density of a mass divided by its volume. Liquids with a greater density, like honey and corn syrup, will sink to the bottom of the jar. If two liquids have a great difference in density, they will separate from each other! You can also use density to help identify a substance when comparing to other liquids with different densities.

Real-World Applications
Differences in density can be one method engineers use to separate liquids. Separation is a very important process to chemical engineers because they often need to remove impurities from a substance. A large enough difference in density between the substance and the impurity allows for them to be separated. Chemical engineers also use Specific Gravity (SG), which is related to density. Specific gravity of a substance is the density of a substance at a specific temperature relative to water at 4 °C. This relationship can be used to determine an unknown density of a substance.
**Chemical Engineering**

“Steady State”

**This Project**

“Steady State” is a term used by chemical engineers to describe a situation when the total amount of a substance in a container remains constant, even if there is a flow in and a flow out. For this activity, by turning valves on an apparatus the flow of water into or out of the holding tank is either increased or decreased. The goal is to match the rate of flow into the tank to the rate of flow out of the tank, which allows the process to run for a long period of time without worry of the tank overflowing. Without any measured flow rate to work with, the best way to create a system under steady state is simply trial and error.

**Societal Impact**

Chemical Engineers use the equation $\dot{m}_{in} = \dot{m}_{out}$ to describe “Steady State.” $\dot{m}$ (m dot) stands for a flow rate of mass. An example would be 100 kilograms/hour. In order for a system to be at steady state, the flow rate in must equal the flow rate out, otherwise the amount of water in the tank will increase or decrease. In the real world, achieving steady state is important in situations where a holding tank has a maximum capacity and spills need to be avoided, whether for safety, convenience or efficiency.

**Real-World Applications**

When looking at a chemical process, it is useful to know if the process is at steady state. Chemical engineers may be asked to determine the flow rate of a substance in a system. Chemical A is entering a mixer at a rate of 55 kg/h. Chemical B is also entering the same mixer at a flow rate of 35 kg/h. If that system is at steady state, the flow out must equal the flow in. Now, by using simple algebra, you can determine the flow rate out of the given system below:

\[
\begin{align*}
\dot{m}_1 &= 55kg/h \\
\dot{m}_2 &= 35kg/h \\
\dot{m}_3 &= ?
\end{align*}
\]
This Project
This project displays the effect of a **surfactant** on surface tension. The objective of this project is to:
- Design and cut out a “boat” to place on the trough
- Use a dropper to place a drop of ethanol directly behind the boat
- Try to get the boat across the trough using the least amount of ethanol drops as possible

Societal Impacts
Surface tension is a very small force found between the molecules of liquids. Although small, it’s very important! Surface tensions has a variety of functions:
- Creates natural phenomena such as floating and walking on water (for certain creatures)
- Keep our lungs inflated so we can breathe
- Enables droplets and bubbles to form
- Allows drops to stick to non-horizontal surfaces
- Manufactures a variety of products involving thin liquid layers

Real-World Applications
Ethanol is a **surfactant**, which is a compound that lowers the surface tension between two liquids. The molecules in surfactants have two sides: a water-loving side and an oil-loving side. This property is the reason surfactants make great detergents and soaps because the oil-loving side attracts grease and dirt, while the water-loving side makes the liquid easy to wash away. Surface tension is also the reason that water cannot permeate certain objects, such as an umbrella in the rain.

Further Information
- **RIT Chemical Engineering**: [https://www.rit.edu/kgcoe/chemical](https://www.rit.edu/kgcoe/chemical)
- Learning more about surface tension: [http://hyperphysics.phy-astr.gsu.edu/Hbase/surten.html](http://hyperphysics.phy-astr.gsu.edu/Hbase/surten.html)