# “Sound Cells” Experiment

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## 1. Introduction

The purpose of this assignment was to capture a fluid phenomenon in an artistic fashion in a team setting for the third time. This assignment was submitted to the Flow Visualization course, MCEN 5151, led by Professor Jean Hertzberg. This experiment was carried out with the assistance of Abduljalil Almashama, Abdullah Alsaffar, and Salah Ammar. The goal of this experiment was to observe and capture the effects of sound waves and the patterns that would develop from the wave propagation through water.

## 2. Discussion of Flow

Sound waves are something that are all around us but are not commonly recognized. We mostly notice the loud noises of construction or the chants at a sports game. Sound waves are all around us and can be closely related to waves present in fluids, such as the ocean. Both sound waves and fluid waves have a frequency and amplitude of the wave. To understand sound waves, they can be propogated into a fluid, such as water.

If the sound source is loud enough, wave patterns will form on the surface of the water [1]. These wave patterns are known as Faraday waves. These waves have been studied for their patterns and mathematically explained based on the frequency of the waves as well as their affect in certain fluids.

The mathematics of these Faraday waves are rather complicated and therefore for the purpose of this report, will only be discussed conceptually. The patterns can be predicted based on the frequency of the sound source, the fluid that the sound propagates through, and the depth of the fluid to name a few factors. Researchers from the Eindhoven University of Technology in The Netherlands have been able to predict and visually represent the patterns formed from different frequencies in water, as seen in *Figure 1* [2].

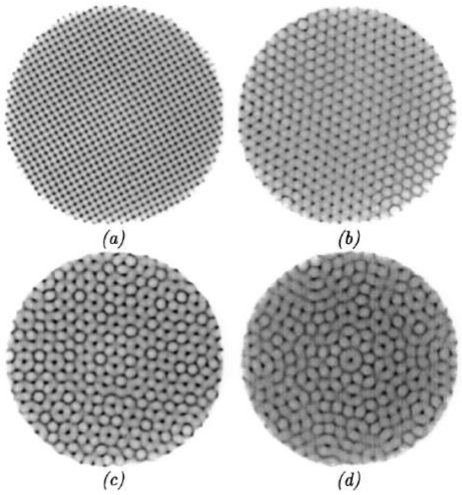


**Figure 1**. Faraday Wave Patterns [2]

## 3. Visualization Technique

For this experiment a beaker approximately three inches in diameter was filled with approximately one and a half inches of clear tap water. The water was then placed on top of a waterproof Bluetooth speaker. A tone generator was used to generate a 110 Hz sinusoidal sound wave. The beaker was slightly held by one of the teammates to prevent the beaker from falling over as the vibration of the speaker moved the beaker. It is important to note that the teammate holding the beaker did not hold the beaker tightly as this was noticed to dampen the vibrations necessary to create patterns on the waters surface. A headlamp was used to light the experiment from the side of the glass and a maximum of 350 lumens from the headlamp was used. The setup can be seen below in *Figure 2*.

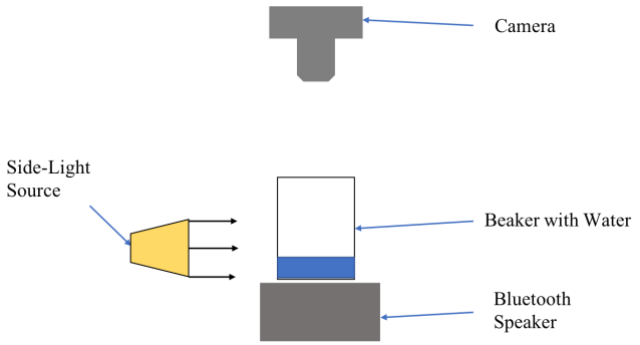


**Figure 2**. Side View of Setup

## 4. Photographic Technique

A Canon Rebel T3i EOS 600D DSLR camera was used for photographing the vibrations from the sound and water interaction. A 55-200 mm lens was used and zoomed in to achieve a FOV of approximately three inches. The distance from the camera and the glass experiment container was approximately two feet normal to the top of the beaker. The raw image is 5184 x 3456 (HxW) pixels, *Figure 3*.

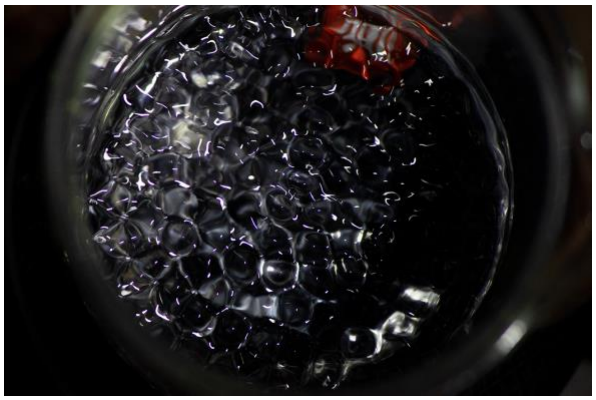

**Figure 3**. Raw Unedited Image

The final edited image is 1300 x 865 (HxW) pixels, *Figure 4*.

**Figure 4**. Final Edited Image

The camera settings were as follows: ISO: 1600, Shutter Speed: 1/800, Aperture: f/6.3, Focal Length: 250 mm.

The edits were done use Adobe Photoshop CC 2019. The negative function was used to reverse the colors of the original image and then the Black and White Function was used to ensure that the color parts of the image were not distracting to the fluid phenomenon.

## 5. Discussion

I believe that the final image works well as an attempt to show Faraday Waves. The speaker setup was not as good as it could have been. I believe in the future it would be very beneficial to use a larger dimension speaker. The fluid could then be placed within the speaker head and better Faraday Waves could be captured due to the fact that the intensity of the sound would be greater.

Additionally, I think to capute the Faraday Waves better the fluid color and lighting could be played with to produce the best image. Perhaps a black fluid with slightly over-head lighting would help show the patterns in the fluid. Overall the final image does show Faraday Waves in an artistic fashion, one that may be considered modernistic.

References:

[1] The American Physical Society, 1997, “Analytic Stability Theory for Faraday Waves and the Observation of the Harmonic Surface Response”, PHYSI CAL REVIEW LETTERS, Volume 78, Number 12

[2] The American Physical Society, 1997, “Nonlinear Pattern Formation of Faraday Waves”, PHYSICAL REVIEW LETTERS, Volume 78, Number 21