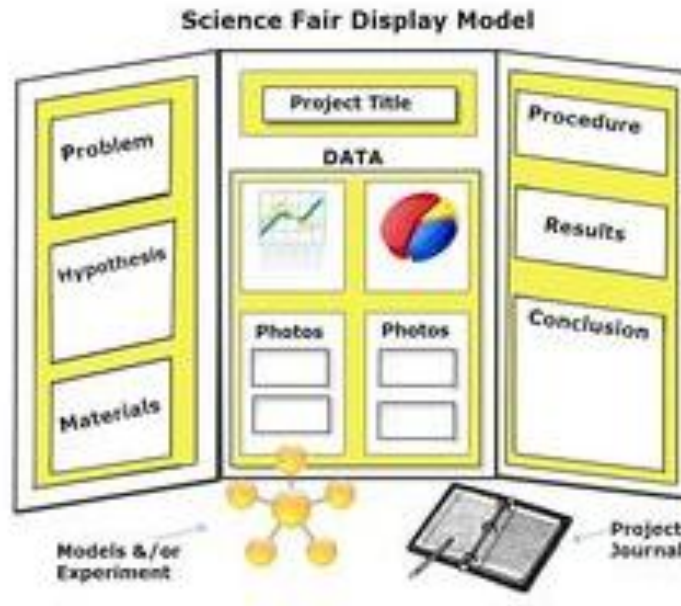


The Science Fair Board Suggestions & Restrictions



Suggestions

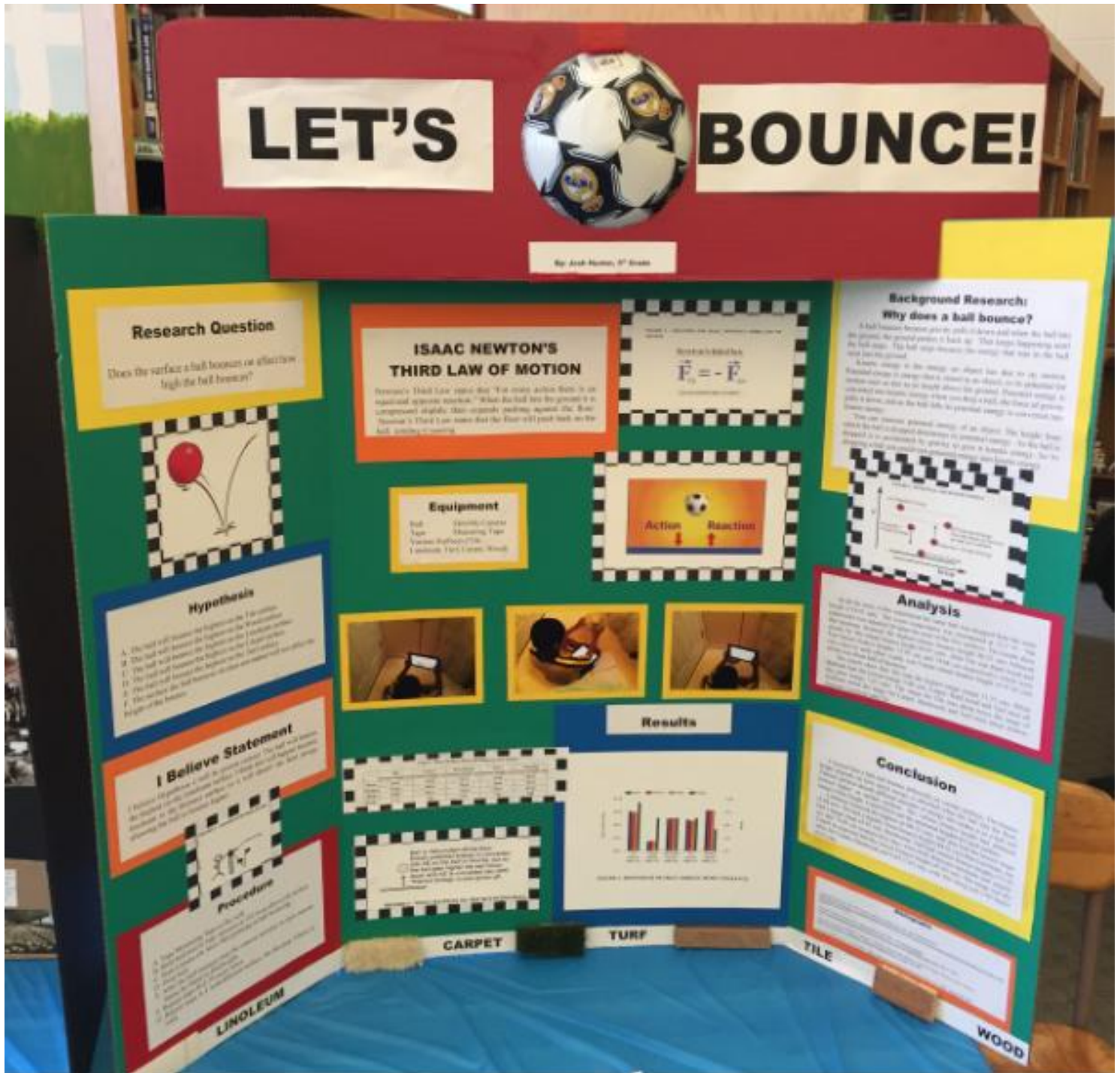
- Take pictures to display on the board or in a journal.
- Use software (Excel) to make chart, graphs and other visuals.
- If you use pictures or graphs you must cite them. If you take the pictures or make the graphs you should include “pictures/graphs taken/generated by *name* using *device/software name*. Cite **EVERYTHING**
- Make copies of your abstract to hand out and display your journal for judges.
- Must fit within a 3 foot wide space

Restrictions

- No abstract on the board
- No pictures of human faces
- No food or liquids including: candy, water, packets containing sugar, yeast, candy, etc. (you can empty them and use them).
- No live organisms
- No chemicals/biological agents (including water)
- For further questions contact MSEF Region V director
sciencefair.msstate@gmail.com

Examples

Board A



QUESTION

Which starch will generate the most electricity?

HYPOTHESIS

I believe the Yam will generate the most electricity because of it's size.

PROCEDURE

1. Gather all materials
2. Peel a bit starch-in flat surface
3. Place galvanized screw in starch
4. Insert copper in starch one inch from screw
5. Using voltage meter, attach black cable (negative) to the galvanized screw
6. Attach red cable (positive) to the copper wire
7. Read and record voltage from the meter
8. Repeat with additional starches

WHICH STARCH WILL GENERATE THE MOST ELECTRICITY

BY DANIEL CHRISTENSEN

MATERIALS

DIAGRAM

VARIABLES

RESPONDING

1. Amount of voltage in each starch

MANIPULATED

None

DATA GRAPH

Starch	Voltage
Sweet Potato	0.4
Yam	0.6
Yukon Gold	0.8
Red Potato	0.7
Russet Potato	0.9

RESULTS

Yukon Gold Potato had the highest voltage and the most electricity

CONCLUSION

I concluded from this experiment that the Yukon Gold Potato conducted the most voltage.

DISCUSSION

I would be interested in trying this experiment with Yukon Gold Potatoes that range in size, to see if they would each have a different voltage.

Filtration of Microplastics in Aqueous Environments Using Ultrasonic Acoustics

Background

Microplastics (MPs) are a growing environmental concern due to its effects on sensitive ecosystems and water contamination. Studies have shown MPs can pose chemical, biological, and microbial hazards once introduced through effluent discharge. Consequently, it is imperative that communities take initiative to reduce the amount of MPs being introduced into the sewage system.

Current approaches used to treat MPs at wastewater treatment plants (WWTPs) are effective at filtering the polymer beads but become unreliable and inconsistent for beads below a certain threshold size. As a result, MPs of sizes on the order of magnitude of microns often escape into the natural water ways, calling for the development of an efficient and effective method to filter the smaller elusive MPs.

Objective & Hypothesis

The objective of this project is to develop an effective, efficient, and feasible MP filtration system by applying an ultrasonic acoustic (UA) pressure field to contaminated water samples.

The hypothesis of this study was that the MPs suspended in contaminated water samples could be manipulated and displaced while under the influence of an UA field, moving them towards the micron filter and therefore resulting in cleaner water.

Experimental Design

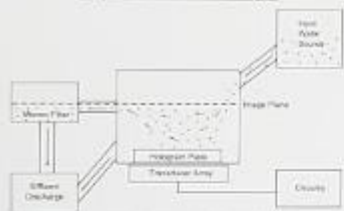


Figure 1) Water contaminated with suspended MP particles will flow and pass through the apparatus where an UA pressure field will displace the MPs in a controlled manner towards the micron filter and the clean water can flow out of the apparatus with ease.



Figure 2) Arduino-based control system generates signals at 5 V_{pp}, 40 kHz, which are sent to the motor drive board that in turn controls the transducer array. A DC-DC boost module is used to transform the low DC voltage to 24V and supply the array.



Figure 4) 3D printed hologram plate which structure is determined by a hologram generation and optimization algorithm is used to manipulate the MPs, small differences in thickness create delay in wave propagation, creating a distortion pattern and guiding the MP particles to experience movement.

Type of Plastic	Source Concentration (g/L)	Average Particle Diameter (mm)	Average Filtration Efficiency	t-statistic	p-value
Polyethylene (PE)	10 g/L	0.5	0.45	-0.34	0.6931
		0.1	0.48	-0.26	0.6026
	15 g/L	0.5	0.50	-0.23	0.5910
		0.1	0.53	-0.16	0.3636
Polypropylene (PP)	10 g/L	0.5	0.53	-0.16	0.5636
		0.1	0.58	-0.340	0.516
	15 g/L	0.5	0.59	-0.14	0.5557
		0.1	0.57	-0.321	0.5084

Table 1) Comparison of experimental efficiency in filtering MPs. Data sample size related to a two-way ANOVA with two groups of particles of 0.5mm and 0.1mm and two experimental groups. Results were insignificant at an alpha level of 0.1 for all comparisons.

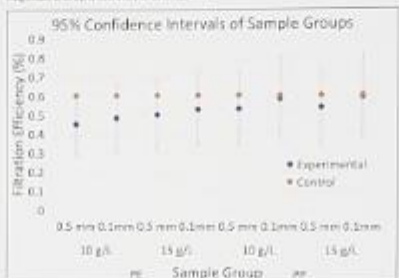


Figure 5) Manual estimator for filtration efficiencies. 2 intervals were calculated at a 95% confidence interval. Results show that after intervals capture the control efficiency value of 90%.

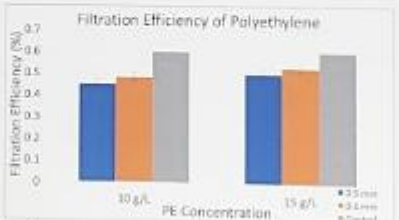
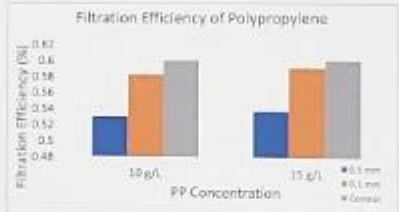


Figure 6) Average of filtration values for UA method. Data represents variation of flow rate and sample PP particles size. The data shows a correlation between the UA method and the reference data.

Discussion

- Compared to other methods of UA fields, the hologram plate approach is simple and more flexible. Phased arrays require complex electronics to maintain acoustic traps, coils and tubes devices are more difficult to maintain and produce a unique acoustic field.
- Performing an approximate yearly operation and maintenance cost analysis shows that the UA method is estimated to have a rate of \$64,000 while the most common disc filter method has an average cost of about \$100,000. The transducer array is assumed to contain 40 speakers operating at 20 W each and 24 hours a day.
- Suspended particles at different depths responded differently to the acoustic field. MPs near the bottom of the apparatus had trouble responding to the acoustic field due to the weight of the water above it. MPs near the surface followed a small spiral path upward and was then subject to the distortion pattern that guided them towards the filter.
- Turbulent forces produced from the water flow occasionally disturbed the MPs that were trapped in the distortion patterns, resulting in escaped particles that flowed out with the filtered water.
- Using larger and a greater number of ultrasonic speakers can scale the acoustic field proportionally and result in a macrofiltration system.
- The implementation of a more efficient MP filtration system to wastewater effluent could slow the accumulating trend of MPs in the environment and various industries.



Figure 8) A. M. M. et al. Applied Physics Letters 2017

Conclusions

- The observed results show that MPs has the potential to be manipulated by a UA field, but there was not enough data to show that the method produced a statistically significant difference. The limitations of the current project include the number of speakers in the transducer array, the turbulence created by the water flow, and the precision of the 3D-hologram plate.
- Yearly cost analysis shows that implementation of the UA method in WWTPs could potentially reduce overall financial budgets in operational and maintenance costs. Furthermore, the nature of maintenance (3D-printed materials and replaceable transducer units) could also lower costs.

Future Research

- To optimize the filtration efficiency, the system should be able to counter fluctuations and control the flow rate of the influent and effluent for the purpose of maintain a steady water level surface at the image plane of the acoustic field where the displacement distortion pattern is most effective.
- Before implementing an UA filtration system, studies should be conducted with field samples from various natural sources of water to observe whether an UA field would affect native microscopic organisms and local ecosystems.
- Implementation of an UA field in WWTPs would be more appealing if an acoustic monitoring system was also available for data collection to observe the effectiveness of the filtration method.

*All tables, flow diagrams, and graphs are made to the project. All values of the speaker set up MP return to the project.