

UVA Pinball Machine 2.0

Impact of Industrial Facilities Among Residents in Cancer Alley

A Thesis Prospectus

In STS 4500

Presented to

The Faculty of the

School of Engineering and Applied Science

University of Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Mechanical Engineering

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November 3, 2023

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Introduction

Pinball has been a popular game for over a century. It started as a tabletop game consisting of a ball and multiple pins it would bounce off. By the early 1900s, pinball machines became “electro-mechanical;” they were powered through wires, solenoids, and relays(Littman, n.d.). During the 1980s, Pinball machines were very popular, and they became even more sophisticated and complicated with the use of circuit board technology(Littman, n.d.). Even though the game has declined in popularity within the 21st century, new pinball machines are still in development today. However, these new machines are still manufactured with similar techniques to their retro predecessors. The goal of the technical topic is to reinvent the pinball machine and rethink the mechanisms behind any of its features by using modern technological advancements. In 2016, another capstone group attempted to create a UVA pinball machine. Unfortunately, the group wasn’t able to finish a working game. Picking up where they left off, the UVA pinball machine will be optimized and, hopefully, completed with modern mechatronics updates.

In Louisiana, USA, there is a stretch along the Mississippi River between Baton Rouge to New Orleans that is home to over 150 petrochemical plants, petroleum processors, and other industrial plants(Allen, 2006). These plants along the river release substantial amounts of pollution into the environment every year. The state of Louisiana alone “produces 16,000 pounds of hazardous waste per capita” (Singer, 2011) annually, and the area between Baton Rouge and New Orleans is responsible for a significant chunk of this. There are many different adverse health effects witnessed by those living within proximity to petroleum refineries, but one in particular is the increased risk of cancer. As a result, this region along the Mississippi River has been dubbed “Cancer Alley” and the “Chemical Corridor” because of the residents’ personal

experiences living in the area for generations. There is a long history behind the area of Cancer Alley that led to the residents in the area being predominantly black and low-income (Terrell & Julien, 2022). For generations, these communities claim they witness higher than normal rates of cancer and poor health, and many residents cite the petrochemical plants' pollution as the root of their problems (Singer, 2011).

It is hard to pinpoint a connection between the mechanical engineering that goes into a UVA-themed pinball machine, and the environmental racism along the Cancer Alley stretch. However, lessons learned from pinball could, perhaps, be applied to the manufacturing processes within petroleum refinements. The pinball machine project seeks to take old mechanical systems and make them modern while still delivering stimulating gameplay and a reliable machine. Even though modern machines work well, there are innovative ways to continue to update them to increase efficiency and durability. Many of the solutions proposed to help the people within Cancer Alley are social and regulatory at heart. Since the petroleum industry is so successful there are few and far between mechanical solutions proposed to limit emissions. However, engineers should constantly strive to improve preexisting systems; even if they work, modern technology and developments should be considered.

UVA Pinball 2.0

In 2016, another capstone group decided to make a UVA-themed pinball machine. Although they worked very hard, they were not able to complete a fully functional and polished game. Picking up where this team left off, this capstone project aims to complete a working pinball machine. Some elements are being conserved from the Pinball 1.0 team, while others are being completely reworked.

On the surface, pinball seems like a very simple game. In reality, the mechanisms that run the game have many parts, and it's a complicated system. Without going into too much detail about every mechanism that goes into a pinball machine, the most important mechanical features include drop targets, pop bumpers, ball traps, slingshots, and flippers. Drop targets are often square and lie along the edge of the pinball playing field. People advance in the game by knocking certain targets down. Pop Bumpers have a metal ring that pops down when the ball rolls next to it, causing the ball to shoot out from it radially. Ball traps will trap the balls, and save them for later in the game, or transport the ball to get spit out somewhere else. Slingshots will push the ball out whenever the ball bumps against it. Lastly, the flippers are the most iconic part; they are the part that the user controls to knock the ball around and keep it from falling out of the playing field. Even though all these elements have different goals and can be designed differently by different manufacturers, they all are powered by the same mechanism: solenoids.

Solenoids are simply a coil of wire. When current is run through the wire, it produces an electromagnetic field. The inside of the spool of wire is a metal core, which can slide in or out of the coil depending on its shape. In general terms, it's able to translate electrical energy into linear motion. It can do this with great force, making it easy to knock the metal pinball around. Although solenoids have run pinball machines for decades, they have a significant flaw. They take a lot of power in proportion to their motion. Activating a solenoid comes with a voltage spike which can be dangerous to other parts connected within the pinball machines. Also, because of the high amounts of current, it is not uncommon for the wire coils to overheat and become unusable.

The updated pinball machine will be made as efficient and durable as possible. This requires innovative thinking and implementing modern technology to make a game that's fun to

play, and easy to maintain. For some components, such as the flippers, the force and simplicity of the solenoid cannot be beaten. However, they can be optimized. By making custom coils, the most efficient solenoids can be manufactured for each part's specific needs; heat and current sensors plan to be incorporated into the windings as a way to monitor coil performance and act as a safeguard against overheating. For areas where solenoids are not necessarily needed, motors, linear actuators, and electromagnets will be used to move, stop, and direct the ball around the playing field.

Continuing the mission of the UVA Pinball 1.0 team, this project aims to create a fun and durable game incorporated with modern advancements. Even though some things have been done one way for over 30 years, doesn't mean it's the best way to do it. Engineers should constantly be thinking critically about ways to improve already functioning systems – especially if there are new technological advancements that can be implemented cleverly to resolve the same task.

Health Disparities Among Black Communities Within Cancer Alley

For this STS topic, I plan to explore the rates of cancer within the area colloquially known as “Cancer Alley” or the “Chemical Corridor.” Many studies have already proven that cancer risks are higher in this area, but there are contradictory studies about whether pollution is causing higher rates of cancer within the area. “Concerns about Louisiana’s pollution burden have been dismissed by state regulators and politicians, who maintain that there is no evidence of adverse health outcomes”(Terrell & Julien, 2022); unfortunately these statements are true. There is little to no evidence because there is very little research done within the area in the first place.

To understand the situation within Cancer Alley, it is important to understand the historical context that allowed for industry to grow around black communities. In the 19th century, land along this area of the Mississippi was owned by American white settlers; it consisted of multiple narrow plantations bordering the river growing successful cash crops with African enslavement(Kang, 2021). Kang argues that, here, the land was associated with generating economic output as “the plantation was shaped by the settler’s insistence on turning land into value”(2021, pg. 108) After the Civil War, smaller plantations were split up and land grants were awarded to newly freed slaves and their families while larger plantations remained in the hand of white owners (Allen, 2006). When petrochemical production and chemical industries started to move into the area, they bought out the larger plots of land with the surrounding areas being black-owned communities. By the 1930s, petroleum processing was booming. Many new plants were drawn to the South because of “low wages, a nonunion labor force, and regulatory freedom”(Allen, 2006, pg. 114). The Mississippi provided the natural resources like “oil, natural gas salt, water, and sulfur” (Allen, 2006, pg. 114)that the plants needed. Today, over 150 plants from various industries lie within the area. Many of the surrounding communities are still predominantly black, with some of their residents “living on the same land their families had received from the Freedmen’s Bureau after the Civil War”(Allen, 2006, pg. 115).

The “petroleum industry” is a very broad term that comprises a whole set of stages ranging from extraction of crude oil to its sale. Throughout the life cycle of production, there are many sources of emissions, but the processes that account for the greatest amounts of pollution include production and refining(Adebisi, 2022); plants of these types occur abundantly within the Cancer Alley region. Common air pollutants released from refineries include Volatile Organic compounds, Ozone, Nitrogen dioxide, Sulfur Dioxide, Lead, and Air Particulate Matter.

All of these are associated with adverse health effects and many are considered carcinogenic (Adebiyi, 2022). There have been studies conducted globally that seek to quantify the health impacts on those within proximity to petrochemical plants. In 2020, a study was conducted researching multiple places such as Louisiana, Taiwan, Spain, Italy, and the United Kingdom; the authors found that, through multiple other studies, “positive associations have been found between mortality/incidence of other cancers”(Domingo et al., 2020). Increased rates of cancer within areas that surround oil refineries are not an anomaly that is being reported within the lower Mississippi delta; it has been observed across the globe.

Communities within the Chemical Corridor believe that the petrochemical plants are killing them. Many communities have already organized and taken political action to fight back against pollution (Meaders, 2021). I plan to analyze this topic specifically by quantifying cancer risk and rates. If politicians need “hard evidence” to intervene or adjust environmental regulations, I want to explore the hard evidence that may prove this problem exists.

Evidence will be collected mainly through research. I plan to look for studies that focus specifically on cancer rates within this region of Louisiana; cancer risk will also be considered, but many sources already seem to prove an elevated risk for cancer within Cancer Alley exists. I plan to pay special attention to the methods of the studies: how data was gathered, the demographics of the people studied, and what the authors were looking for. This will guide how I interpret the evidence found, and whether or not it seems to answer the question I’m looking for. For example, one study from 2022 found that a higher estimated risk from air pollution was linked to higher instances of cancer (Terrell & Julien) within the most impoverished Louisiana neighborhoods. However, they cited that this could be linked to the fact that these communities are more vulnerable to negative health outcomes because they may forgo treatment due to high

costs of medical care, or their area might have less quality care(Terrell & Julien, 2022). On the other hand, another study found that cancer rates (specifically lung cancer), were not higher for those living in proximity to petrochemical plants in Cancer Alley, but it was mentioned that the study population was mostly white males(Simonsen et al., 2010). While these sources offer answers to my topic questions, their findings have room for questioning and are still open to interpretation. If I'm not able to find a comprehensive answer to my question, I would at least like to investigate what makes finding a quantifiable solution so hard, and why so many studies offer contradictory findings.

Conclusion

Cancer Alley, Louisiana is characterized by the many industrial facilities that lie along the banks of the Mississippi River. Black communities that live within proximity to industrial plants have claimed that the pollution from the plants has increased rates of cancer within the community. When looking at society as a whole, it is important to address instances of environmental racism and justice. Simply put, environmental racism is when “environmental policies, practices, or directives that differentially affect or disadvantage (whether intentionally or unintentionally) individuals, groups, or communities based on race or colour”(Bullard, 2002). Throughout the United States, many different groups of people have been subjected to environmental racism. It's important to understand how many aspects of our history and culture, have propagated to today to cause issues for groups today. Through my future research, I want to see if proximity to petrochemical plants in the Cancer Alley region leads to higher rates of cancer. This topic is highly debated, and there is not much research behind it. So if I can't find an

answer to my primary question, I'd like to investigate why that is, and what makes this such a difficult topic to research.

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