

The Design of a Modern Pinball Machine with New Technologies: University of Virginia Themed

The Military Industrial Complex: How New Technologies Are Used To Recruit New College Graduates

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Pinball began its roots during The Great Depression. It served as a cheap form of entertainment during trying times and was based off a French game, bagatelle. Players maneuvered balls past pins into holes on the game field. The game had an individual launch balls onto the playfield and attempt to accumulate various points. Thus, the idea for pinball was born. During the 1940s, Pinball was seen as a form of gambling and was ultimately banned, even after flippers for the game were invented. It wasn't until the 1970s when the ban lifted. However, during the 1950s, Williams and other pinball companies introduced many new innovations some of which include: multiplayer, score reels, and sophisticated playfield mechanisms. Everything was electromechanical. It wasn't until the late 70s did pinball enter the genre of electronic gaming. As seen in games like the Black Knight, intricate circuit boards, digital displays, and digital sound effects changed the game of pinball to what is seen today. However, in most of these classic games, the technology used consumes tremendous amounts of power.

In Mechanical Design I, the goal of the class is to build a modern pinball machine using new technologies to create a power efficient pinball machine. Since many of the older pinball machines used power hungry solenoids, over time, the machine starts to wear down and requires maintenance every few days. However, by creating solenoids from scratch and using mechatronic systems, a modern day pinball with an old school feel can be done.

As for the sociotechnical part of the report, the impacts of the Military Industrial Complex (MIC) will be addressed. Since the end of World War II, President Dwight D. Eisenhower warned the country about the impacts of the MIC and how it would affect

the nation seen today. He emphasizes the balance of powers and how the lack of good judgment can lead to an imbalance. In his remarks, he states that “only an alert and knowledgeable” citizen can compel the meshing of military and industry. However, in today’s world, they seem to be inseparable. Many critics argue about the strength of the MIC today and how it affects higher education. With recruiters such as Lockheed Martin and Northrup Grumman at every career fair, the presence of the MIC is apparent. These companies primarily focus on military development since the government is their biggest customer. With such strong ties to the government, it makes it easier for these companies to recruit students, especially when students are promised to work on exciting projects. Even in capstone projects at the University of Virginia (UVA), the military communicates to professors about projects they want students to develop for them. However, how does the MIC relate to a modern day pinball machine?

Surprisingly, many of the technologies used in the pinball machine are also used for the military. More specifically, modern mechatronic systems, such as motors, are used in most modern technology. In some cases, some of the materials used for the pinball machine were originally developed by the government. However, outside of minor mechatronic similarities, there is no general overarching theme between the two.

UVA Themed Pinball Machine

The UVA themed pinball machine was originally created by a capstone group in 2016. Their idea was to create a modern day pinball game that incorporated state-of-

the-art technologies. They used modern day solenoids, an electromagnetic coil used to move a metal bar forward and back, to combat the heavy power usage of the original solenoids used in older machines. The newer solenoids, however, did not work because they were not powerful enough to launch the ball to the upper playfield. They also tried creating a rotating rotunda mechanism that would randomly rotate during game play. In spite of creating such a complex mechanism, it ultimately failed due to software issues. The machine never came into fruition because of failed mechanisms and lack of time.

The pinball machine has not been touched until now. With the revamping of this mechanism and knowing the lessons learned, many improvements have been made to the project. For instance, the rotating rotunda. As seen in Figure 1, the original design of the mechanism was bulky and over engineered. It weighed down the board and ended up not working as intended. So, the goal of this year's capstone was to re-engineer the rotating rotunda to make it lighter weight, smaller, and more durable.

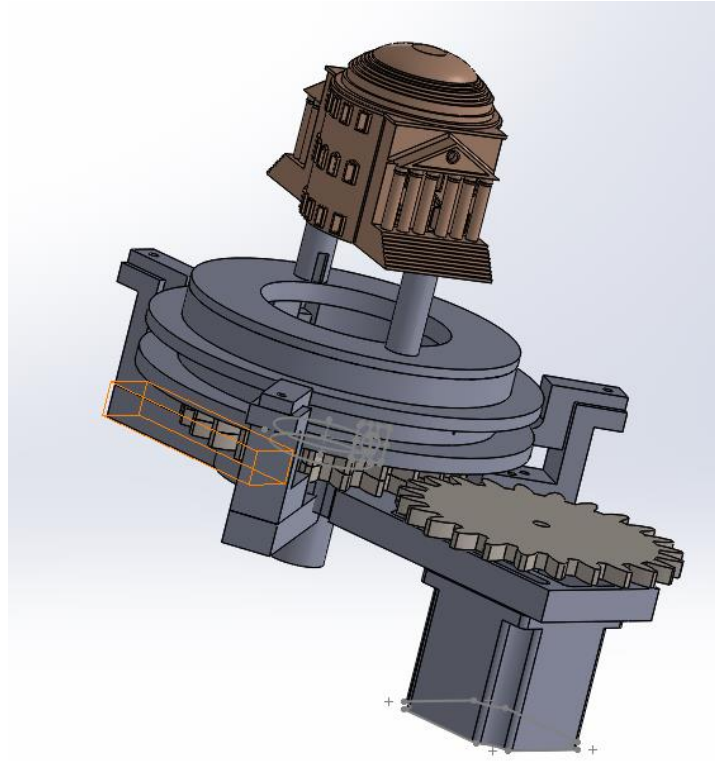


Figure 1 2016 Rotating Rotunda

The idea for the new and improved design uses similar concepts to the original, as seen in Figure 2. However, some significant changes were made. For instance, a rotating slip ring was used, which allows the rotunda to spin while preventing the wires from tangling. The new design also includes a permanent magnet in the center of the rotunda. This permanent magnet acts as a “ball trap” and will hold the ball for a certain amount of time before releasing it back to the playfield. It does this by using a linear actuator, which takes a rotating motion and turns it to a linear motion. As the ball is trapped, the linear actuator activates and lowers the permanent magnet down, which causes the ball to release. This design also uses a stepper motor with an encoder. This allows us to know the position of the rotunda at all times. Since stepper motors do not provide feedback, meaning there is no way of telling the position of motor, the encoder

becomes essential to the programming aspect of the system. The encoder makes it possible to read the position of the stepper. This allows for the rotunda to spin to any position during the game and even allows for trick shots at any point.

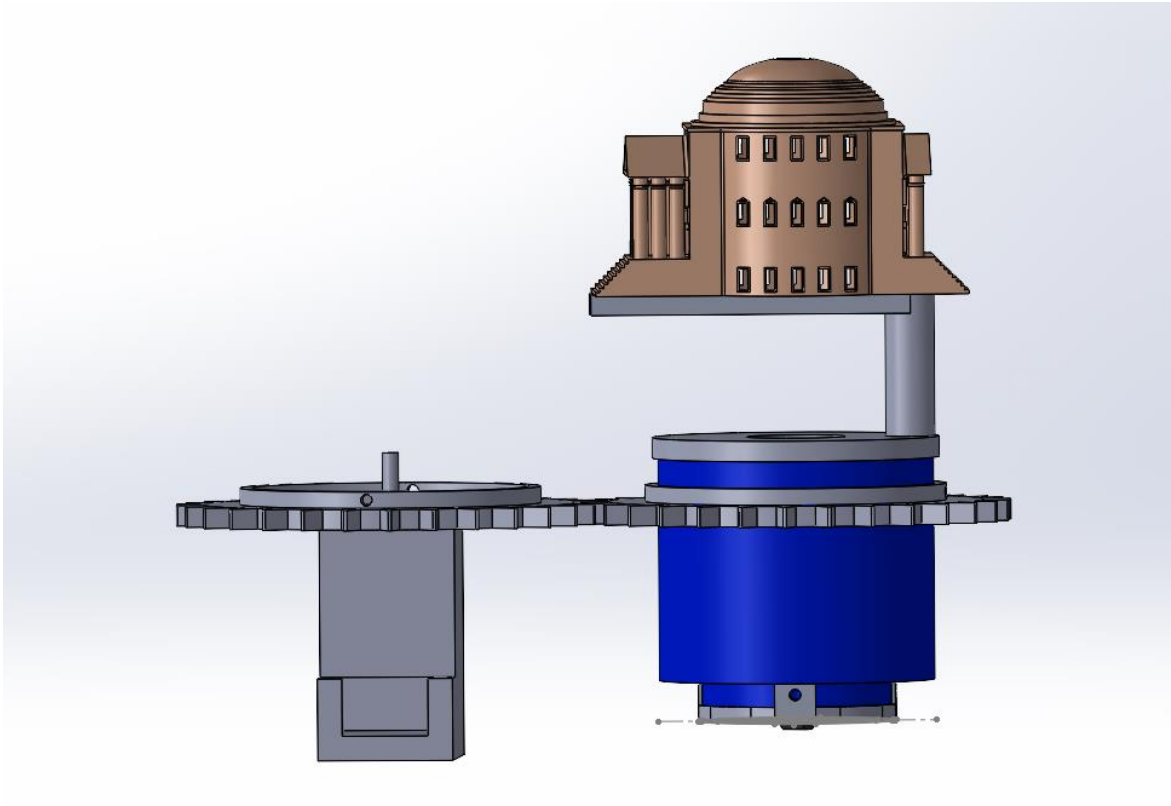


Figure 2 2023 Rotating Rotunda

Updates to this system allowed for not only a working game but also for a closer UVA community. This idea transcends UVA engineering and serves as a token for school pride. It adds to the traditions of the university while also paying homage to retro gaming.

The Military Industrial Complex: How It Bleeds Into Academia

My STS research question is: how the military uses new technology to recruit new college graduates to further the military industrial complex. I'm working on the topic

of military recruitment tactics and the military-industrial complex because I want to figure out how the military uses technology to recruit new college graduates to continue the growth of the MIC. This is important because new technology in recruiting can lead students to believe their work will be used for good instead of something destructive, and we should understand these tactics to process how they affect the MIC.

Dwight D. Eisenhower's farewell address hits on so many key aspects of the MIC. In his speech, he makes an emphasis on the balance of powers and how the lack of good judgement can lead to imbalances. In the conversation of the evolution of the MIC, it's interesting to see how these imbalances show in the wars following WWII. Especially when looking at the US's presence in foreign affairs, these imbalances are extremely prevalent. An example of this is the Israeli Palestinian conflict. The US involvement in this issue could lead to the misplaced power Eisenhower was talking about. He warns the American people of the dangers of the MIC and how the "potential for the disastrous rise of misplaced power exists and will persist." He also notes that "only an alert and knowledgeable" citizen can compel the meshing of industry and military. This led to many critiques of the MIC later down the road.

One critic of the MIC, Henry Giroux, talks about how militarization, corporatism, and political fundamentalism "bears down on every aspect of individual and collective experience" and have shaped how we view higher education (Macrine 2008). These aspects are extremely prevalent in the engineering school experience, especially for mechanical and aerospace students. Even in capstone projects, military personnel ask

students to develop prototypes for projects the military hopes to use in the future. Capstone also serves to teach students “real” engineering in the sense of prepping students to handle corporate America. Giroux also talks about how there is no more open-minded thinking in schools and how the lack of critical thinking has been an attack on democracy. He even points out how post 9-11 American education has become increasingly militarized and policed (Macrine 2008). Many individuals nowadays are arguing to take out critical race theory and ban the knowledge of literature, which adds to his point of over policing. This further proves Eisenhower’s speech in the sense that nowadays most citizens aren’t aware of the MIC, which has led to its rapid growth. It’s become so intertwined in most American’s way of life that it’s no longer recognized as a problem. Eisenhower’s speech serves as a warning of the MIC and is essential to the understanding of its development.

In addition to increased militarized education, Giroux argues that patriotic correctness, consumerism, and militarization have become the most powerful forces shaping education. This is seen in many classes here at UVA. Engineers are taught to be completely unbiased machines that pump out new technological advancements. They’re taught to be innovators of the future, where each product is meant to be consumed.

Giroux further talks about how academia “struggles as a democratic public sphere” because of the aforementioned factors. This rings true because it happens every day at the university. Students are constantly approached by military recruiters through career fairs or classes. Because of crippling student debt, many of their hands

are forced to take careers that are less involved in public service. Giroux hits on this topic and argues that students are “indentured” by this debt. This becomes the perfect recipe to incentivize students to take jobs within the military or corporate. It seems as if school serves as a breeding ground for corporate guinea pigs that fill the needs of the military.

This problem will be analyzed through interviews from new college graduates and students who have either interned or want to intern with defense companies. By looking at first hand accounts, I’m able to understand a general theme of not only why students work at these companies but also how they were recruited into their position. In these interviews, I will ask how the defense companies enticed these students to work for them, what projects or new technologies does the company work on that interested the student, and was this position a last resort for a post college career. This information will further my understanding of the effects the MIC has on new college graduates, and how it intersects in academia.

Conclusion

The MIC has had a chokehold on the American way of life for decades. From the brands we consume to the education students hold, the MIC has its foot in every door. It continues to overpolice higher education and holds students and professors in powerless positions. The lack of awareness of the MIC has made its presence stronger than ever before. If individuals do not know about the problem, then the problem does not exist. If the problem does not exist, then there is no need to worry about military

involvement in politics. This allows defense companies to profit off of wars the US should not be involved in and allows for the continued use of taxpayer's money in military advancement. However, because of the strong presence defense contractors have within engineering schools, many students feel that this was their best option for their future careers. Since war is profitable, jobs within defense seem stable. Thus proving Eisenhower's warning.

References:

- Adams, W. (1968). The Military-Industrial Complex and the New Industrial State.
Source: The American Economic Review, 58(2), 652–665.
- Dunlap, C. J. (2011). The Military-Industrial Complex. *Daedalus, 140(3), 135–147.*
https://doi.org/10.1162/daed_a_00104
- Ewafa. (2015). Eisenhower Farewell Address (Best Quality) - “Military Industrial Complex” WARNING. In *YouTube*.
<https://www.youtube.com/watch?v=OyBNmecVtdU>
- Fallows, J. (2002). The Military-Industrial Complex. *Foreign Policy, 133, 46.*
<https://doi.org/10.2307/3183556>
- Hartung, W. D., & Freeman, B. (2023, May 9). *The Military Industrial Complex Is More Powerful Than Ever*. *Www.thenation.com*.
<https://www.thenation.com/article/world/military-industrial-complex-defense/>
- Houghton, H. G. (2020). *Voluntold: Tactics in U.S. Army Enlisted Recruitment*.
<https://open.bu.edu/handle/2144/41540>
- Macrine, S. (2008). The university in chains: confronting the military-industrial-academic complex. *Choice Reviews Online, 46(01), 46-057646-0576.*
<https://doi.org/10.5860/choice.46-0576>
- Ottosen, R. (2009). Targeting the Player Computer Games as Propaganda for the Military-Industrial Complex. *Nordicom Review, 30, 35–51.*
- Pfaff, W. (2010). Manufacturing Insecurity: How Militarism Endangers America.
Manufacturing Insecurity How Militarism Endangers America, 89(6), 133–140.

Sackett, P. R., Mavor, A. S., & National Research Council (U.S.). Committee On The Youth Population And Military Recruitment. (2003). *Attitudes, aptitudes, and aspirations of American youth : implications for military recruiting*. National Academy Press.