EML 4501 - Senior Design I

Technology Study Memo - Safety

Julian Tabascio

1.0 Introduction to Safety

Safety is a top priority in developing and implementing any engineering project, including the design and construction of the UCF Athletics T-Shirt Cannon. This memo emphasizes key safety considerations throughout the design and research process. While specific propulsion methods and design details will be determined through rigorous research, proactive identification and assessment of potential safety risks guide the team towards a secure and reliable outcome.

In the absence of specific propulsion mechanisms, a safety-first approach is crucial, given the unpredictable nature of compressed air or any other potential propulsion methods. This involves a comprehensive safety strategy to ensure the well-being of operators and bystanders, as well as safeguarding the structural integrity of the cannon.

The memo delves into general safety practices for the project's conception and developmental phases, covering material selection, operator safety, user training, emergency shutdown mechanisms (Lock-out/Tag-out), and regulatory compliance. These considerations create a framework for a robust safety approach to the project. As the project progresses, these principles will be refined and adapted to the chosen propulsion method and design, aiming to integrate a culture of safety, while aligning with regulatory standards and best engineering practices, ensuring project success without compromising well-being.

1.1 Material Selection

Material selection is a pivotal factor for ensuring the safety, reliability, and longevity of an engineering project. The chosen materials for all parts of the cannon must withstand the forces generated during T-shirt propulsion, ensuring structural integrity and preventing failures that could lead to accidents.

Given the repetitive nature of launching T-shirts at sporting events, durable materials must be used to reduce premature wear and extend the overall lifespan of the T-shirt cannon. Key considerations for selecting the T-shirt Cannon's materials include:

- Strength and Stiffness - Materials must possess sufficient strength and stiffness for launching T-shirts to avoid rapid unplanned disassembly of the launcher.
- Chemical Compatibility - Materials must resist corrosion and degradation, ensuring long-term reliability.
- Thermal Performance - Materials must withstand temperature fluctuations without compromising mechanical properties, as the launcher will be used in various environmental conditions.
- Cost-Effectiveness - Strike a balance between quality and budget to keep the cannon economically viable. [1]

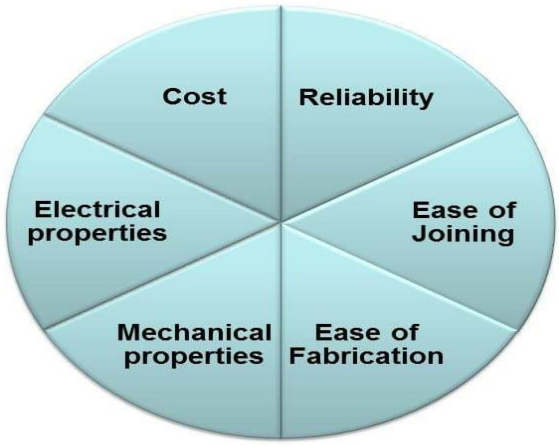

Figure 1: Material Pie Chart illustrates key considerations to be taken into account when selecting materials. [1.1]

1.2 Operator Safety & User Training

Emphasizing operator and user training is fundamental in industrial and operational environments. Prioritizing operator safety not only protects individuals but also ensures the efficiency and success of the intricate processes of repetitively launching T-shirts.

As an operator of any device that stores energy, proper safety protocols must be abided by to reduce risk of accidents, the following statements must be followed to operate the device.

- Personal Protective Equipment (PPE) - Proper eye protection, hearing protection, gloves, and footwear should be worn to protect the operator in an emergency situation.
- Know your surroundings - Never point the cannon in the direction of anyone in close proximity. Never keep the cannon loaded while transporting to avoid accidental firing.
- Read the safety brochure - A required safety brochure will be read by anyone wanting to operate this device, this brochure will encompass good safety practices and outlines the main functions and important how-tos relating to the device.

- Only allow trained individuals to operate the device - It is important to only let individuals who are trained on the mechanics and functions of this device operate it to prevent negligent usage. [2]
- Only allow trained individuals to troubleshoot or repair the device - When dealing with large amounts of stored energy, only a qualified and properly trained individual should troubleshoot or repair the launcher.

Figure 2: Operator Safety Training [2.1]

1.3 Emergency Shut-Off Mechanism/Lock-out Tag-out

An ESD (Emergency Shut-Down) device, is a system used in hazardous areas to prevent situations that could have catastrophic effects. They are designed to minimize the consequences of emergency situations, such as injury to personnel or damage to equipment, by preventing things such as: leaks, escape of hydrocarbons, fire outbreaks, and explosions. [3]

During the design phase of this project, an ESD will be implemented into the design to make the device safer. Since this device stores energy, regardless of the propulsion method, it is important to think about what can be done in the event that a component does not work as it is intended to.

In the event of an emergency, the designed ESD will cut all electrical power to the device (and/or energy stored) until the switch is reset. [4]

Another type of ESD to be implemented would be Lockout/Tagout, or LOTO. This form of ESD ensures that dangerous equipment is properly shut off and not able to be restarted again prior to completion of transport, maintenance, or repair work. This safety measure could involve the use of a key and lock mechanism that would disable the device until the proper authorized personnel returns to the device to unlock it. This measure prevents unauthorized and uneducated users from being able to operate the device while it may be unattended. [5]

Figure 3: Lockout / Tagout [5.1]

1.4 Regulatory Compliance

As part of a university project, it is imperative to continue the design of this project while ensuring regulatory compliance. While we begin to seriously consider options for this project, it is important to adhere to UCF's safety standards, ethical considerations, and academic protocols to promote a reliable and successful outcome of our t-shirt cannon within the university environment. As part of this project, the team will:

- Review University Policies - Read university policies and guidelines relating to student projects involving engineering.
- Safety Documentation - Ensure project documentation, including safety protocols, aligns with university standards.
- Academic Supervision - Collaborate with academic advisor to ensure the project aligns with educational objectives and adheres to requirements.
- Use of Campus Facilities - Confirm compliance with regulations regarding using the campus facilities for testing and demonstrations, and obtaining approval if needed.

The team will abide by OSHA safety standards regarding "Control of Hazardous Energy." The OSHA website states the top LOTO citations; consequently, our team is dedicated to abiding by these principles to effectively eliminate preventable accidents.

1. **1910.147(c)(4)** —"Energy control procedure." **730 violations**
2. **1910.147(c)(7)** —"Training and communication." **491 violations**
3. **1910.147(c)(6)** —"Periodic inspection." **362 violations**
4. **1910.147(c)(1)** —Energy control program: **265 violations**
5. **1910.147(c)(5)** —Application of control: **231 violations** [6]

1.5 Conclusion

To conclude, the safety considerations outlined in this technology study memo express the team's commitment to prioritizing the well-being of both operators and bystanders throughout the design and construction phases of the T-shirt Cannon. Key takeaways include: considering material safety when designing the prototype, implementing a safety and instruction program to educate potential operators on effective device usage, utilizing an ESD device to mitigate potential consequences of

technical failures, and adhering to regulations to avoid fines or consequences related to the project. As the project progresses, a dynamic commitment to regulatory standards and continuous updates to potential safety protocols will contribute to making our device the safest and the best overall. This team emphasizes a commitment to both innovation and responsible engineering practices within the university environment.

Citations

[1] "The Influence of Material Selection on Engineering Inspections and Longevity." *Utilities One*, 3 Sept. 2023, utilitiesone.com/the-influence-of-material-selection-on-engineering-inspections-and-longevity.

[1.1] *Material Pie Chart*. (n.d.). https://www.imetllc.com/wp-content/uploads/2014/10/Selection-criteria.jpg

[2] Rausch, Barb. "6 Safety Tips Every New Engineer Should Know " Patti Engineering." *Patti Engineering*, 12 Oct. 2023, www.pattiengineering.com/blog/6-safety-tips-every-new-engineer-should-know/.

[2.1] *Operator Safety Training*. (n.d.). https://cdn.dealerspike.com/imglib/v1/800x600/imglib/Assets/Blog/ee/d0/eed0b134-a2c9-433a-ade0-e57e80952e1b.JPG

[3] Admin, VM. "What Is an Emergency Shutdown System?" *CCSDualSnap*, 20 Aug. 2020, www.ccsdualsnap.com/what-is-an-emergency-shutdown-system/.

[4] “Control of Hazardous Energy (Lockout/Tagout) - Overview.” *Occupational Safety and Health Administration*, www.osha.gov/control-hazardous-energy. Accessed 4 Feb. 2024.

[5] “Lockout–Tagout.” *Wikipedia*, Wikimedia Foundation, 13 Jan. 2024, en.wikipedia.org/wiki/Lockout%E2%80%93tagout.

[5.1] *Lock-out Tag-out*. (n.d.). https://trdsf.com/cdn/shop/articles/tradesafe-circuit-breaker-lockout-with-padlock-hasp-and-tag_38872257-4965-49c5-aed5-8e16c86cd9e7.png?v=1680182541

[6] Nlyman. “OSHA’s Top 10 List of Most Frequently Cited Standards: Control of Hazardous Energy (Lockout/Tagout).” *VelocityEHS*, 10 Jan. 2024, www.ehs.com/2024/01/oshas-top-10-list-of-most-frequently-cited-standards-control-of-hazardous-energy-lockout-tagout/.