

Needs Assessment

Team # 7

Human Type Target System



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ABSTRACT

Lockheed Martin desires to produce a human type target system, resembling a human in size, shape, and appearance, which will react appropriately to being hit with small arms fire. This will be done via hit sensors on the target, which will be able to detect vibrations caused by a bullet being fired into the target. The target itself will be a commonly available mannequin, sold for use specifically as a small arms target. This report shall serve the purpose of clearly stating and describing the problems and needs which the project will face, and the tasks which will be accomplished by Team #7 in order to aid Lockheed Martin in producing a system as they have envisioned. Seeing as the mannequin is indeed commercially available, and the fall mechanism itself has already been invented by Lockheed Martin and is currently patent pending, Team #7 is tasked with revising the prototype and making improvements on it to bring it to a production ready state. This will include designing, at a minimum, a stand for the target, an interface plate between the target and stand, interface adapters, hit sensors, and a test stand to activate the fall mechanism. The final outcome of this project will be an operational human type target which will fall when hit with an appropriate sequence of small arms fire, including ready for manufacturing designs of the aforementioned components. This report shall serve to outline this goal and succinctly define the needs associated with this project.

1. Introduction

Lockheed Martin has begun to take action with the final goal of producing a human type target system, resembling a human in size, shape, and appearance, which will react appropriately to being hit with small arms fire. Lockheed Martin already has a patent pending on a fall mechanism which they desire to use, and the mannequins which will be used for the target are commercially available as targets for law enforcement and military applications. The mannequin comes already equipped with a hole by which it is able to be mounted to a simple 2x4. Consequently, team #7 has been tasked with designing the stand, interface plate and 2x4 adapters, and shock sensors which will allow the target to operate as desired. These will be designed in such a manner as to facilitate performance up to the standards and constraints given by Lockheed Martin concerning the final product. It will also be necessary for Team #7 to design a test stand for testing the sensor.

Since this product is to be manufactured for mass production by Lockheed Martin, the design team must consider the basic rules of design for manufacturing and design for assembly. Additionally, the team has target prices for each of the pieces. Producing in batches of 100, the cost of the interface plate is not to exceed \$50/each, the 2x4 interface adapter is not to exceed \$25/each, and the stand is not to exceed \$70/each.

Lockheed Martin will be providing an early wood-based prototype to the design team in order to facilitate their progression, as well as a starting point to see the basic utility of the fall mechanism and mannequin.

2. Project Definition

Lockheed Martin desires to produce a human type target system, resembling a human in size, shape, and appearance, which will react appropriately to being hit with small arms fire. This will be done via hit sensors on the target, which will be able to detect vibrations caused by a bullet being fired into the target.

2.1 Background Information

Military and law enforcement departments all over the world use a variety of human-like targets in order to provide effective, realistic combat training to their personnel. Aside from the shape and size provided by human-like targets, a great deal of development has been done to make them react to ballistic impacts and indicate accurate marksmanship from the shooter. Enhancing combat target training even further requires that targets not only indicate impacts, but also accurately respond to the different magnitudes of damage, further demonstrating the lethality of the firearms utilized. Currently there are a number of different products seeking to meet this level of simulation.

2.1.1 Rubber Dummies

Rubber dummies are generally 3D models of a human torso characterized by their ability to withstand a significant amount of repeated damage with their self-healing properties. Contacting bullets are allowed to pass through the material while also leaving an indication of the impact location on the outer skin. This skin can be replaced between simulations or shooting sessions to give the marksmen a clean target to only indicating his/her immediate hits [1].



Figure 1: Rubber dummy with impact indication [2].

2.1.2 Reactive Stand Targets

Other targets commonly used for law enforcement training, specifically SWAT team members, react to a certain amount of hits by falling backward slightly to simulate a neutralized target. These models are made of a self-sealing poly urethane compound that is designed to withstand anywhere from 5,000 to 10,000 live rounds. These models are also helpful for “Shoot/No Shoot” drills and can be customized to different appearances sizes. They do not, however, indicate the specific impact locations without inspecting the target up close [3].



Figure 2: Reactive dummy representation showing fall-down mechanism [3].

2.1.3 Autonomous Robot Targets

Combining the effects of the reactive fall-down targets with simulated target movement, robotic targets have been manufactured for more authentic marksmanship training. These targets also utilize self-sealing materials to prolong the target life, while also neglecting to indicate a specific impact location. To make up for this potential shortfall, the dummies are designed with integrated sensors in specific locations termed “kill zones”. These sensors, when triggered, communicate with the fall-down mechanism to cause the target to tilt backward. After a set amount of time, the target will reset to its upright position while continuing its autonomous movement for continuous target practice [4].



Figure 3: Robotic dummy with integrated fall-down mechanism upon “fatal” ballistic impacts [4].

2.2 Need Statement

Lockheed Martin desires to move forward with a design for a Human Type Target (HTT) System, utilizing a commercially available mannequin and ensuring that it falls appropriately when hit. In order to bring this product to market, Team # 7 has been tasked with designing and preparing the interfacing components, sensors, and stand for manufacturing. The team needs to prepare these components for manufacturing, ensuring their durability as well as keeping their mass production costs below the given values. Finally, Team # 7 needs to test the device under the various conditions, including gunfire, to determine the suitability of the device to meet these needs and requirements.

“Lockheed Martin’s current human type target system is incomplete and requires further design for manufacturability and durability.”

2.3 Goal Statement and Objectives

“The goal of this project is to revise a prototype human type target system, that falls automatically when hit with a series of lethal shots, and take it to a production-ready-state.”

Objectives:

- Stand-to-Target Interface Plate
- Interface Adapters
- Target Stand
- Hit Sensors
- Test Stand to Activate the fall mechanism (electrical/firmware interface needed)
- Stand to be movable by 1 person
- Stand to take up no more floor space than 2ft x 2ft and mannequin
- The interface plate, adapter, and stand shall be capable of surviving no less than 1000 target drops.
- The interface plate, adapter, and stand shall be capable of being exposed to the elements
- Items above 6” from the floor shall be made of non-ricocheting material (e.g. plastic) or shall be protected in a way such that bullets will not ricochet back to the shooter (e.g. bullet guards).

2.4 Constraints

As with any project, there are a whole host of constraints which apply to the design and construction of the human type target system. The majority of these constraints have been provided to Team # 7 by Lockheed Martin. The stand must be able to be moved by one person, according to MIL-STD-1472 [Appendix A, page 147]. This same stand must not take up more than a 2ft x 2ft square of floor space for the footprint, as well as necessarily interfacing with the Lockheed Martin Target Interface Module, dimensions and sizing of which will be provided at a later date. The stand must be able to withstand direct hits from 5.56mm, 7.62mm, and airsoft ammunition without toppling, either during the hit or the sequence which involves the fall mechanism. While the 5.56mm NATO round is very small and carries relatively little energy, the 7.62 NATO round (also known as 7.62x51mm or .308) carries significantly more force. These same three rounds must trigger the fall mechanism. Seeing as an airsoft round carries so little energy, it is crucial to note that the mechanism must be very sensitive, while also rugged enough to withstand the forces of the 7.62 NATO and the rapid fire nature of the 5.56 NATO round. In the same vein as ruggedness is the lifetime criteria—the interface plate, adapter, and stand must

be able to survive at least 1000 target drops before failure. Due to the varying conditions in which the system shall be deployed, it is also crucial that all components are able to withstand various harsh environments, ranging from the heat and dryness of Saudi Arabia, to the freezing cold of Alaska, to the salt air and humidity of coastal regions across the globe. While many of the materials shall be chosen by the design team with a relatively high level of freedom, safety is still a concern. Since bullets tend to ricochet upon contact with metal, any and all components which will be more than six inches above the ground shall be made of a non-ricocheting material, such as plastic, or covered with an appropriate guard in order to ensure the safety of the operators and prohibit a bullet from ricocheting back into the shooter.

3. Methodology

3.1 House of Quality

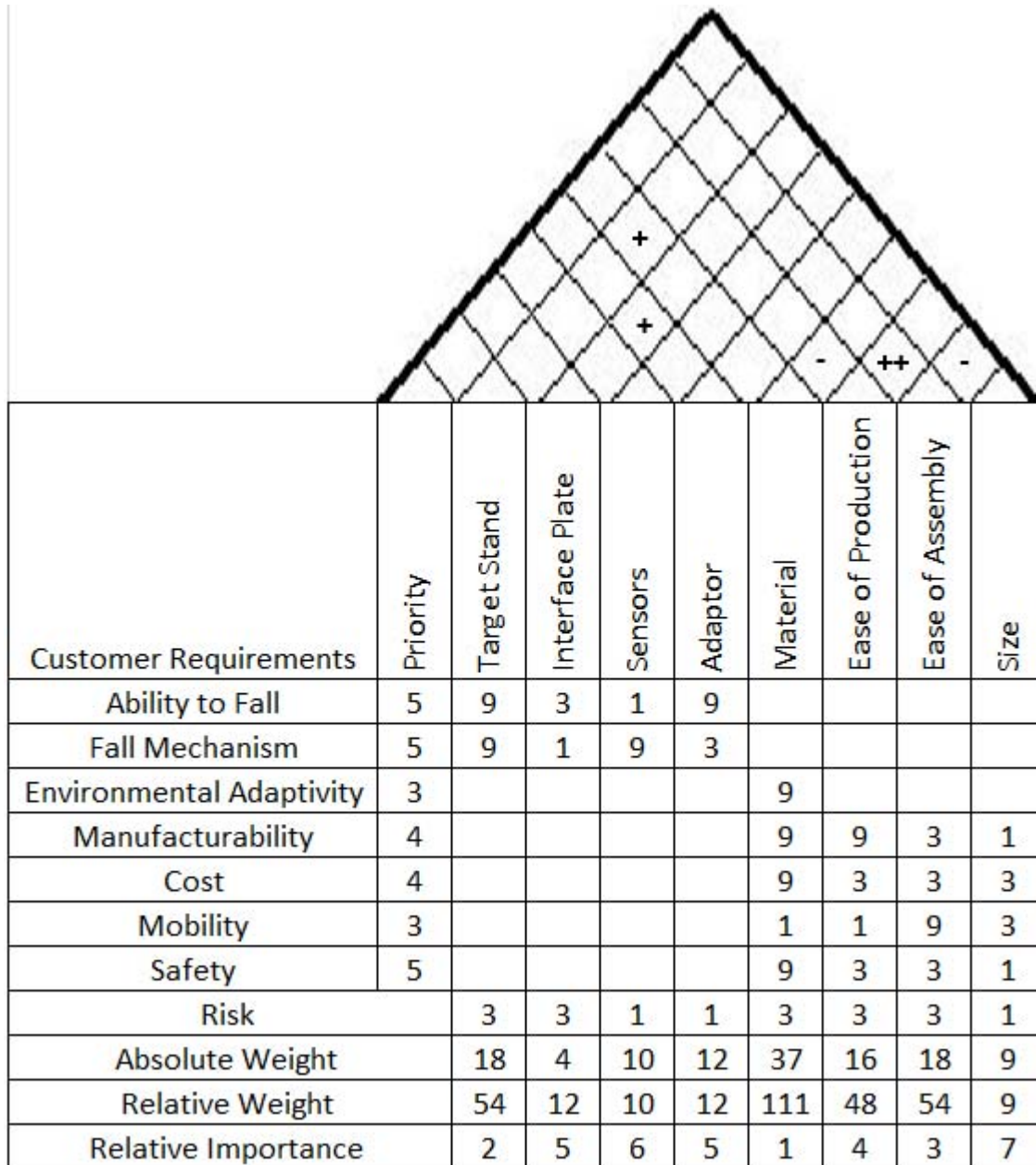


Figure 4: House of Quality representation of different project aspects and relative importance.

This House of Quality describes the relationship between the customer's needs and the design requirements, accurately ranking the most important aspects of the design. Knowing that the ability to fall using Lockheed Martin's patent pending fall mechanism is necessary, the two were given the highest priority along with safety. The rest of the customer requirements were given priority based on the emphasis the company put on them. Correlating the design requirements with the customer requirements, 9 being the highest correlation and 1 the least, relative importance could be calculated. This determined that the most important aspects to focus on in this design are the material used and the design of the target stand. While the least important aspect to focus on is the size of the stand. While all of the design aspects are important because they were specifically told to the team by Lockheed Martin, the House of Quality serves as a guide when initially brainstorming ideas. The team now will consider the material being used before the size of the stand.

4. Conclusion

Lockheed Martin is providing Team #7 with their current Human Type Target prototype. The main objectives of the team will be to finish developing the fall mechanism, standardize parts for manufacturability and cost, select durable materials to survive 1000+ falls, and select materials and components to prevent ricochets. Team #7 expects that the most challenging part of the project will include triggering the fall mechanism using a variety of projectiles and designing components that can withstand 1000+ falls. Team #7 believes that the project scope and budget are reasonable parameters to work with and also believes that the Human Type Target will be able to provide realistic training for law enforcement and the military. The team is excited to have been given the opportunity to improve on such a unique idea and is excited to begin working on the project.

References

- [1] "'RUBBER DUMMY' – Self Healing LE Training Target." *RUBBER DUMMY-Self Healing LE Shooting Target*. Web. 29 Sept. 2016. <<https://www.mrtargetonline.com/shop/rubber-dummy/>>.
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- [3] "Dummies Unlimited." *Dummies Unlimited*. N.p., n.d. Web. 29 Sept. 2016. <<http://www.dummiesunlimited.com/3d-swat-target?lightbox=c6yq>>.
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Appendix A

MIL-STD-1472F Department of Defense Design Criteria Standard, Human Engineering. Attached