Using Alternative Manufacturing to Create Better Products More Efficiently: External Fuel Tank

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Abstract

Additive manufacturing is a process that is being used more and more often today. It can be used for a variety of products and can allow for many improvements such as decrease in cost, use of less material, and increase of production. Looking at existing designs of external fuel tanks, we saw that we would be able to use the techniques of additive manufacturing to improve the product. Instead of changing the shape of the tank, which could affect its aerodynamic properties, we instead looked at ways that we could improve the use of materials and weight of the product. Through additive manufacturing, we wanted to make an already quality product even better.

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Introduction

External fuel tanks can be found on many types of military aircraft. They are important because they allow the aircraft to carry more fuel and can often be jettisoned if need be. Because these tanks serve such an important purpose and are used so often, it is crucial that they are made in the best way possible. Our group decided that we could apply the principles of additive manufacturing to help improve the design of the tank. By using this process, we intended to make the product easier to produce, more cost effective, and use less material.

Literature Review (Patent)

While looking for previously patented external fuel tanks, we found that they have had the same design for many many years. The typical conical aerodynamic shape is the shape that is best suited to be underneath an aircraft supplying it fuel. Previous fuel tanks also showed many designs for them to be dropped off of the aircraft when the fuel supply it carried has been all used up. They also showed anything from reusable ones to ones that were made of paper and glued together to hold the fuel just long enough. After searching through many different patents we decided we had enough background information in order to start designing our new and improved external fuel tanks.

Design Process

Before we started to design our improved product we needed to decide what project we were going to go choose and what part we were going to redesign. This step was the most agonizing because we were unsure of some of the prompts, but we chose to go with project 5. After choosing this project our next step was to find what exactly we wanted to remake. It was very tough to figure out what we could redesign of Lockheed Martin’s and somehow make it

better, so we thought to tackle something that was somewhat simple, so we chose to improve an external fuel tank.

To start off we did research to find how an external fuel tank is usually made and what materials are normally used in the manufacturing of a fuel tank. The conical shape that has been used since the beginning is the best choice of shape so we chose to avoid anything in that regards. Next we looked at how additive manufacturing could help us improve the fuel tank and why it would make it better. Looking at the weight and weaknesses of steel our first idea was to trim down on the amount of steel/aluminum to make it lighter so that the jet could maneuver easily, but be able to store the same amount of fuel. This was an idea that we looked to build on because it could prove to be a very beneficial improvement, but with less steel there became a problem of whether this fuel tank could handle being in the line of fire without leaking or exploding, so we needed to improve the safety of this fuel tank.

This is where we thought about using additive manufacturing. We came up with many different options as to how we could strengthen the fuel tank through the use of additive manufacturing. We talked about a couple different ideas to improve strength without adding much more weight to the fuel tank since we were trying to minimize the amount of steel used. Ideas included a solid layer of kevlar between the steel layer and the actual jet fuel, a lattice structure containing kevlar foam, and a layer of fiber-glass between the steel and the jet fuel. All three of the designs had some similarities so from there we sought out to see if there was a combination of the ideas that could be beneficial and still reduce weight and cost. Since the design of the tank is fairly simple there was not much to add, or remove from the original design, but in the end we chose to create a tank with less steel with an inner layer of lattice structure filled with kevlar foam, and included the fiberglass layer in between the kevlar foam and the actual jet fuel.

Design Result

Our final result consisted of a thin layer of steel, a lattice structure filled with kevlar foam, and a layer of S-2 fiberglass in between the lattice structure and the jet fuel. The thin layer of steel decreases the total weight, while the lattice structure and kevlar foam increases strength and damage resistance fivefold. The S-2 glass layer provides a strong heat resistant fiber that can take being exposed to jet fuel. Our design is much lighter because of the use of less steel, much stronger because of the addition of the kevlar foam. Our new design is also cheaper because using less steel means that there is less welding and manpower involved with building the fuel tank which means less cost involved in making it. Overall through the use of additive manufacturing we created a fuel tank that is stronger, lighter, and decreased the cost while improving other components of the fuel tank.

Conclusion and Summary

Our New Design for an external tank for a jet airplane will greatly improve the product and also decrease its cost of production. The new materials within our design are just as strong as the classic materials of an external tank, but they are also much lighter and and cheaper than the original design production.

References

"Safety Tank and Fuel System for Aircraft." *US2285830A*. N.p., n.d. Web. 01 May 2016. <https://patents.google.com/patent/US2285830A/en?q=fuel%2Btanks>.