CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)
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Project Number
S0310

Project Title
SmartVest: Redesigning and Revolutionizing the Bulletproof Vest

Abstract

Objectives/Goals
The purpose of my project was to seek a performance improvement over current body armor by using more economical materials in a novel way, changing the orientation and contour of armor tiles, to make a lighter, more comfortable, less expensive, and active bullet-proof vest.

Methods/Materials
Clear acrylic plastic, 1.25 inch thick, was chosen as the armor material. 18 tiles, 4 x 4 square inch, were mounted in six wooden carriers, each holding 3 tiles. The tiles in each carrier were shot with a 9-mm FMJ bullet, one shot per tile. Each carrier was placed at a different angle to the shooter, in 15 deg. increments. Damage to the acrylic tiles was assessed at qualitative and quantitative levels.
Using the results from firing at various angles from obliquity, a theoretical armor was created to induce ricochet and increase performance. The contour of the strike face was modified and resulted to a thinner armor. This increased the effective thickness of material experienced by the projectile, compared to that when the "tile" is oriented as normal. An increase in the angle of obliquity, theta, yields a greater areal density, pA, and mass efficiency, Em, resulting in better ballistic performance.

Results
It was shown that the optimum angle of obliquity was 45 deg. It further revealed that the performance of the acrylic increased exponentially as the angle of incidence was increased. In fact, at 45 deg, its performance exceeded that of ceramic, the material currently used by the US military.
The theoretical armor ensured that any bullet striking the armor would impact obliquely at or near 45 deg. By conducting a zebra analysis, it was shown that a projectile could never impact the armor obliquely. As a result, the proposed design with a modified surface contour is shown to actively induce deflection and effectively increase performance over the standard issued armor to defeat the projectile without increasing weight.

Conclusions/Discussion
With the surface modifications to the current bulletproof vest, I demonstrated that angling non-ceramic armor tiles 45 deg. led to increased performance of the armor without adding extra weight. In addition, the use of lighter materials increases comfort and mobility for the wearer.

Summary Statement
By exploiting the surface of the armor face, I demonstrated that angling non-ceramic armor tiles 45 deg. led to increased performance of a now lighter, cheaper, comfortable, economic, and more effective armor.

Help Received
Dr. Donald A. Shockey guided me through the project; Deputy Steve Lopez tested the plates; Mr. Stuart Calhoon gave access to saws and drills