Traumatic Brain Injury
Reducing Army Combat Helmet

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Background

- Former U.S. Army soldier, now a UConn nursing student, suggested improvements to combat helmets after serving in Iraq.
- Current helmets provide ballistic protection, but limited head trauma protection
- The *New England Journal of Medicine* reported a study where over 15% of soldiers in Iraq suffered from Traumatic Brain Injuries (TBIs)
- TBIs are defined as sudden trauma to the brain that causes a varying extent of damages
- TBIs are mainly caused by Improvised Explosive Devices (IEDs), vehicle accidents, and falls.
  - Limited TBIs resulted from bullets, shrapnel, and fragments
Room for improvement is greatly needed to make helmet capable of protecting against these injuries:
- Padding system
- More supportive/better fit
- Facial protection
Project Description

- Design a new helmet and padding system that provides facial protection and reduces the risks of TBI's
Subunits

- Outer Shell
- Expanded Polystyrene Layer
- Retention Padding
- Suspension System
- Chin Guard
Chin Guard

- Wear to protect face
- Lift up and lock when not needed
- Made of Kevlar and has pads for comfort/fit
Outer Shell

- Ideally, same current manufacturing process would be used to create the outer shell
- Shape will be similar to ACH
  - Slightly larger
  - More protection
- Made of Kevlar using a composite kit
  - Mold for shell was made based on the shape of the ACH
Outer Shell

- 3 prototypes
  - Necessary for testing
  - 1 Triangle design, 2 Pinwheel design
Padding/ Impact Protection System

- Expanded Polystyrene (EPS) Layer
  - For impact protection
  - Currently used in bicycle and motorcycle helmets
  - Replaceable

- Retention Padding
  - Removable for comfort and fit
  - Same pads as used in ACH
- EPS layer
  - Cut from 14” cubes with heated wire
  - Molded using sandpaper
  - Final thickness is 3/10”
Padding/ Suspension System

- In order to prepare for testing
  - Velcro circles added so padding can stick
  - Suspension system added
    - Same as used in ACH
    - Required 4 holes to be drilled
Testing

- Head form with internal accelerometer attached to helmet
- Dropped at different heights to correspond to desired final velocities
Results

- Results compare acceleration (G Force) felt during impact velocity
- Helmets without EPS appear to increase in G Force exponentially while helmets with EPS increase less drastically
Results

- Comparing ACH with pads to Prototype with pads
- Both the ACH and Prototype exhibit similar trends when only pads are used
Results

- Comparing prototype with pads to prototype with pads and EPS
- 54% decrease at 15 ft/s (with pads and EPS)
- 33% decrease at 12 ft/s (with pads and EPS)
Results

- EPS Degradation
  - Shows that EPS is truly the variable that reduces G Force
  - EPS begins to degrade after several hits and the results show higher accelerations
  - Military replaces helmets after one major impact so this is not a hindrance
Brain Injury Reduction

- We know that the prototype decreases impact forces
  - How does this affect brain injury reduction?
- Brain injury diagnosis is observational
  - Glasgow Coma Scale classifies Mild, Moderate, or Severe injury based on victim’s verbal, motor, and eye reactions to stimuli
- Comparison of qualitative results with quantitative data is difficult and unclassified
Brain Injury Reduction

- There is no real effective way to say that “x amount of forces reduced produces a y increase in the GCI.”
- The relationship is much more complicated than a simple one-to-one relationship, such as “an x percentage of forces reduces an x percentage of brain injuries”
  - when a force impacts a helmet even at a single point, it sends a wave of energy throughout the entire head that emanates from the point
Brain Injury Reduction

- We can look at medical definitions of brain injuries to determine their causes
  - Countercoup effect
    - Causes the brain to hit the skull and rock back and forth
      - Caused by inertia, which is largely tied into the initial impact

- Although there are no studies to mathematically equate force reduction to brain injury reduction, such a large decrease in impact force will logically decrease brain injury probability by a statistically significant margin
Budget

- ACH donated
- Motocross Helmet donated
- Shell mold & components $880.69
- Padding/suspension system donated
- Foam cutting supplies $130.58
- EPS Foam Pack $122.12
- Miscellaneous supplies $81.21
- Testing cost $600
- Total $1800

Cost of product: $420
Conclusion

The results show that the combination of EPS and the retention padding system reduces G Force significantly compared to the previous helmet model resulting in reduction of TBI risk.

The helmet:

- Provides a stable, comfortable, and secure fit
- Provides facial protection
- Is suitable for fast action situations
Reflection

- Future changes:
  - Have a specific, machine-manufactured EPS shell and chin guard made for precise fitting rather than shaping by hand
  - Design EPS differently so neck guard can move
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Questions?