

SPEC-15-189

PROJECT SPECIFICATION

APPROVALS

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***Concussion
Forces and Brain
Trauma in
Competitive
Sports***

Revision History

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-	Initial Release	11/21/2014	Wyatt Moscoso
002	Revised: Experimentation Description and Requirements	01/29/2015	Wyatt Moscoso
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1 PROJECT SPECIFICATION OVERVIEW

1.1 *Executive Summary*

Most sports have a certain degree of danger associated with them, due to flying objects and bodies colliding at high speeds. Soccer and water polo are particularly dangerous for one of the most important parts of the human body; the head. Head injury in these sports may stem from contact with the goal posts, other players, the side walls (in water polo) or the ground (in soccer). However, these sports bear a unique danger to the head when compared with other competitive sports due to the nature of ball interaction. Soccer is the only competitive sport that involves and condones purposeful head contact with the ball, while water polo is one of the only sports that involves ball flight almost exclusively in a plane parallel with head altitude. As a consequence of engaging in these sports, risk of head injury, especially concussions due to such ball interactions, is dramatically increased. In 2009 alone, hospitals reported 24,184 cases of soccer head injury, and 28,716 cases of water polo head injury (American Association of Neurological Surgeons – AANS). Furthermore, head trauma in these cases can cause a plethora of disabilities. These can range from loss of motor function to complete paralysis to death in the most severe cases.

The most common of these adverse consequences include the two aforementioned modes of damage. Traumatic Brain Injury, which is defined as a blow or jolt to the head that disrupts normal function to the brain. This is the main, recordable method of brain disruption (AANS). This sort of injury is classified with a set of values known as the GADD severity index, which measures the amount of acceleration of the head as a function of its exponent. This calculation yields a single value that represents the intensity of collision, acceleration, and therefore the danger of the impact. Even more disconcerting, however, is the presence of Chronic Traumatic Encephalopathy, which occurs due to repeated sub-concussive impacts to the head, and can have long lasting effects. This is equivalent to “creep,” in engineering terms, of damage over time to the brain. After many instances of sub-concussive impacts, which seem harmless as the time, damage slowly builds to a critical level. Repeated sub-concussive impacts build up to major concussive levels. These concussions can be much more severe even if the sub-concussive impacts never reached the magnitude of a singular concussive impact (Spiotta, Bartsch, and Benzel 2011). This is a concern for many athletes, as it is hard to gauge how far along the path of CTE one is. CTE’s are quite difficult to study in a limited time span, it will not be a focus of the experiment, although it is still a serious consideration.

The existence of these serious injuries make it critical to reduce the amount of risk taken when participating in these sports. Specifically, our team is searching for methods of minimizing the amount of impact force imparted to the head by ball contact. Interestingly, there is little to no precedent for tests on ball specifications and their implications on impact forces in these two sports.

2 Experimental Description

2.1 *Experimental Context*

Soccer and Water Polo both pose unique threats to the head, as stated in the executive summary. However, in water polo especially, there is a general paucity of impact data. We hope to remedy by generating data for ball impacts over a variety of speeds and ball pressures, with the ultimate goal of maximizing safety in these two sports.

2.2 *User Characteristics*

Our experiments would benefit high level soccer and water polo players. These players face the risk of concussions on a daily basis. By lowering the force of the impacts imparted onto their heads due to more effective ball pressures and headgear, we can reduce injury rates and allow them to continue playing longer.

2.3 *Assumptions*

1. We shall assume that the Anthropomorphic Testing Dummy (ATD) being leased models the human head and neck very precisely.
2. We shall assume that the effects of wind and air drag on the ball will be negligible over the short distance that we are shooting the balls.
3. We shall assume negligible change in velocity between point at which the radar gun records a velocity and point of ball impact on head due to assumption 3.
4. We shall assume that the mass of the ball does not change with increased pressures and changes in temperature.

2.4 *Constraints*

We have constraints on the types of accelerometers we can use, and the locations they can be placed in the ATD. We have a one-week lease on the ATD, which constrains the amount of time we can test for. Our cost constraint is \$4000 for the ATD and \$800 for all other supplies.

2.5 *Dependencies*

This product's only dependency is on the availability of the ATD to be used for testing.

3 Requirements

3.1 *Functional and Performance Requirements*

Objective 1 – The primary goal of this research is to ascertain whether ball inflation pressure has a significant impact on traumatic brain injury (TBI) and chronic traumatic encephalopathy (CTE).

We shall conduct experiments using an Anthropomorphic Testing Dummy (ATD) outfitted with accelerometers to find the worst case scenario for concussions while varying ball pressure and velocity.\

Objective 2 – Test existing water polo goalie head gear in the current market.

We shall compare the data of water polo ball impacts on an unprotected head to a protected head to determine whether the head gear makes a significant impact on protecting the water polo players head.

Objective 3 – Testing the accuracy of the G-Force head-strap accelerometers.

We shall compare the data obtained from the Anthropomorphic Testing Dummy (ATD) accelerometers to that of the G-Force trackers the soccer teams are wearing during practice.

3.2 *User Requirements*

Our main goal does not have a “user requirement”. However, the requirements for headgear for these sports is that it does not affect their ability to perform well in games, while still protecting them sufficiently.

3.3 *Deleted or Deferred Requirements*

None yet.

4 Appendix

4.1 *Definitions, Acronyms, and Abbreviations*

ATD – Anthropomorphic Test Dummy

EMSSI – Exercise Medicine and Sport Sciences Initiative

4.2 *References*