Virtual Design Review 3 – Prototype

T101 Helmet Project

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This project objective is to identify the most effective methods to reduce brain acceleration following an impact sustained by an athlete. By conducting testing, the team seeks to deepen the understanding of concussion mechanics and gain insight into how energy is distributed within the helmet and the brain during an impact.

The project is composed of two key subsystems. The first is the auxetic material, designed to significantly reduce both rotational and linear accelerations. The second is an advanced impact sensor that alerts coaches and staff when a player is at risk of a concussion. Unlike most current sensors, which primarily measure linear acceleration, this sensor also considers rotational impacts—widely regarded as the primary contributors to concussions. These rotational forces can be effectively analyzed using the Head Injury Criterion (HIC), providing a more in depth approach to concussion prevention and detection.

The team has selected a Flexible 80A Formlabs material to create an auxetic foam consisting of hourglass-shaped layers. This material is cut into hexagon-like tiles, allowing it to wrap easily around the head. The foam is being integrated into a ski mask and the interior of the helmet, with impact testing underway to determine how effectively it reduces acceleration. The material is applied to the front, back, left, and right sides of the head.

The current sensor setup includes a load cell to measure the force of impacts. An accelerometer is used to calculate acceleration changes across all three axes, derive the Head Injury Criterion (HIC) value, and measure the linear force applied during impacts based on the mass of the helmet.

The next steps for the sensor involve testing and optimizing the device to make it wireless and compact enough to fit comfortably within the helmet. Future tests include impact drop tests, impact pendulum tests, and potentially brain FEM modeling.

The upcoming experimental steps include establishing controlled conditions, collecting acceleration data, evaluating the material's performance, and comparing the results with baseline measurements. The team will also analyze acceleration data to identify patterns and outliers based on the material's placement in different positions.

Moving forward, the team is looking out for potential problems. The first problem being the possibility of the material design underperforming in the drop test and not reducing the acceleration to its expected goal. It is required that the material can still perform up to the targets and standards even if the design needs to be altered in size or area. Another problem could occur with the load cell. The sensor should not move during testing, and this could lead to inaccurate and unreliable outputs during the testing phase. This would diminish the results and cause the final data to be skewed. Other factors such as environmental conditions that the foam and sensor can be utilized in and the reality of the social acceptance of the ski mask are also being considered. With several challenges ahead the team is aware and taking account of each.