An Optimized Whitewater Helmet Designed Using a Newly Developed Helmet STAR Evaluation System and 3D Printing

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Whitewater sports result in 50 deaths and thousands of head injuries every year, and the currently available helmets are insufficient. The objective of this study was to create an optimized whitewater helmet prototype designed using the newly developed Whitewater Helmet STAR Evaluation System. The 21 helmet models that were evaluated using the Whitewater STAR methodology were cut vertically and horizontally to allow for cross sectional padding analysis. A material testing system (MTS) was used to evaluate each helmet's padding stiffnesses. The padding Vinyl Nitrile (VN) 600 and VN 740 were found to have the greatest correlation with the highest performing helmets through linear regression and energy absorption analysis. Rhino 3D software was utilized to create the new model of the whitewater helmet. The helmet shell was developed as a modified ellipsoid with a length of 28.5 cm and a height of 13.0 cm above the midline. Three different materials of Accura 60, Nylon, and Accura ClearVue were selected for the helmet shell in order to test a variety of material properties. Three different prototypes were constructed in order to optimize the padding and retention of the helmet design. A custom pendulum impactor device was used to test the three different helmet prototypes in accordance with Whitewater STAR. The prototypes were impacted at 3.1 m/s and 4.9 m/s to the front, side, and rear. The final prototype produced a STAR value of 0.01 and performed 25 times better than the best currently available whitewater helmet.