The FIRST Frame: Personalized Front Impact Reduction SysTem for Bicycles

Stothers, Duncan

Serious injuries and fatalities among cyclists are a problem of global concern. Nationwide studies on cyclist fatality have demonstrated that 92% of cycling fatalities involve a collision with a motor vehicle, 57% of which are ‘head on’ in nature. During front-end collisions, a standard bicycle frame throws the rider forward (pitch-over), the mechanism by which cycler injury occurs. The FIRST Frame, aims to enhance rider safety by redirecting impact energies, enabling the rider to remain seated on impact while reducing peak and average acceleration. The functionality employs a front fork compression design with an oblique disc and spring mechanism. Computer-aided design and simulation software was employed. Linear increasing resistance and elliptical non-linear increasing resistance mechanisms were created, simulated, refined, 3D printed, and mathematically modelled. Parts were milled in metal then crash tested using high-speed cameras and accelerometers versus a control. Comparison of the control bike to the test bikes showed that at 4.26 m/s the control rider pitched over 70.0% of the time compared with 10.0% and 0% for the straight and elliptical designs. Forward angulation of the rider was reduced by 64.1% and 85.4% for the straight and elliptical designs respectively. Rear wheel elevation, rider elevation, and bike angulation showed similar results. The test bikes reduced forward acceleration by up to 64.5% and 69.1% for the straight and elliptical designs. The FIRST frame can reduce the mechanisms leading to injury from head on collisions and can be personalized for individuals, thereby enhancing this increasingly popular form of green transportation.

Awards Won:
Second Award of $2,000
Arconic Foundation: USAID Global Development Innovation award of $10,000
Society for Experimental Mechanics, Inc.: Second Award of $1000 for excellence in Behavioral and Social Sciences