Investigation into the Injury Severity of Unmanned Aerial System (UAS) Impacts on Non-Participating Public

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A series of injury criteria were collected for automotive and aviation industry regulation at the beginning of virtual & physical ATD testing. These focused on head & neck injuries and were used to assess injury potential of impact variations. Impact speeds and orientations possible for the sUAS in an impact event were varied in virtual testing of ATD impacts. These variations identified the injury severity at different speeds and helped to identify the worst case orientations. Variations on how the sUAS could impact from the top, side, forward, side, back, and angled directions were virtually tested. Impact speeds ranged from 10 to 71 ft/s. Physical testing of the H-III took the most critical orientations identified for each impact direction and tested the full speed range to confirm injury severity.

These critical cases and ranges of speeds were then also virtually tested with the THUMS HBM. Additional injury criteria were used to further evaluate skull fracture and head injury in general. Specifically, these criteria examined injuries for AIS1+ concussion, 30% chance of an AIS2+ skull fracture, and 30% chance of an AIS3+ head & neck injury. With the more biofidelic FE model, properties like skull bone strain could also be evaluated and compared to literature for fracture limits. These simulations identified which of the critical cases for the ATD were also critical for the HBM.

Finally, physical PMHS testing was conducted at the Injury Biomechanics Research Lab at OSU. A similarly wide range of impact speeds & orientations were planned for PMHS testing and a subject would no longer be useful for testing if too high of injuries were sustained. This is where the virtual & physical ATD and THUMS data became critical to sequence the PMHS tests. A tetrahedron accelerometer package was used to obtain head c.g. acceleration and strain gages were placed at key locations around the skull to identify peaks in strain rate when a bone fracture occurred. The PMHS were x-ray scanned and examined by necropsy after a severe injury was physically observed or indicated by the sensors.

Results & Discussion

THUMS. While the magnitude of the this load sensor was always less than what was read by the ATD, the impulse compared well.

Conclusions

The advantages of virtual testing proved helpful in running a large number of variations, also providing an estimate for worst case scenario. This was critical in both forms of physical testing where the physical ATD results compared well and the PMHS subject suffered a similar fracture as the THUMS simulation. This virtual comparison also shows the benefit of THUMS in injury analysis, offering a more realistic biofidelic response.