The Future Is Here:
Using State-of-the-Art Technology to Investigate and Test Off-Highway Events

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I. Introduction and Background

Much of the world has focused its attention the last 40 years or so on developing on-highway products and ensuring these vehicles are safe and reliable to consumers. This has resulted in significant and sometimes amazing advancements such as the seat belt, crumple zones, air bags, smart seat systems, and advanced warning systems. We are even witnessing the introduction of “driverless” vehicles for on-highway applications. In its purest form technology is the embodiment of human intelligence and creativity.

For many reasons, off-highway and recreational markets have, at least at times, lagged with respect to the implementation of many of the “advancements” used in on-highway products. This is not because off-highway accidents do not occur or occupant protection in such events is not important. Off-highway incidents are, however, different in many respects. These differences, at least in part, explain the apparent disparity in the application of technical advancements in vehicle and occupant safety systems. Many off-highway applications require the vehicles/equipment to routinely be in environments and situations that would make many on-highway safety systems moot, if not becoming possible safety concerns themselves. Off-highway applications do not take place in smooth, predictable, well-planned areas. There may or may not be a “road,” or a paved surface of any sort. There usually is not another vehicle involved, but often there are other large objects that may contribute to an event. The relative “speed” of many off-highway events is lower in most utility and work related events, but can be similar (or even higher) in recreational environments.

Despite the inherent differences in off-highway vehicles/equipment and the accident events they are involved in, the approach to investigating such events and testing such products is not dramatically different than that used for on-highway products. In fact, the investigation of off-highway events and the analysis and testing associated with evaluating these instances has, in many ways, allowed this industry to “catch up” with on-highway accident investigation and product testing.

S-E-A has been testing such equipment/vehicles for many years, including directly for many manufacturers in pre-market and post-market evaluations, litigation cases, as well as part of the third party test centers for various government entities. During this process S-E-A has worked with industry to develop test methods and has designed and developed a number of unique test devices to enable this testing. S-E-A now has steering controllers and brake/throttle robots for use on vehicles with steering wheels or handlebars (such as ATVs). S-E-A also has designed and developed an indoor sled system and a roll simulator to evaluate occupant kinematics and protective devices for these types of vehicles.

II. Using Technology to Collect and Preserve Evidence

Investigating an event involving an off-highway vehicle such as a Multipurpose Off-Highway Utility Vehicle (MOHUV) or a Recreational Off-highway Vehicle (ROV) starts with collecting and evaluating the evidence available. Using 3D laser scanners and even aerial drones, a remote or changing environment can be documented (via measurements, photographs and video) accurately and quickly. This allows in-field assessment and evaluation, unprecedented virtual inspections by interested parties at a later date, and preservation of the evidence. The vehicle, and the damage sustained during the event, can also be documented using such
laser scan technology. The data collected can then be used to determine the best method for analyzing the event whether that is calculations, computer simulations, physical simulations, or full vehicle testing.

III. Using Technology to Analyze and Test Evidence

Vehicle impact and dynamics computer simulation methods have become increasing complex and have, at the same time, found greater validation in off-highway environments. The best of these software applications allows for the three-dimensional evaluation of the physical and testimonial evidence while systematically changing various input and/or control parameters. Even when such an approach cannot rule out all other scenarios, often the range of valid solutions provides the investigator/researcher with valuable insight to the relationships between various inputs and outputs for a particular off-highway vehicle and environment combination.

These software simulation solutions can be used on their own for evaluation purposes or in conjunction with physical simulation and/or full vehicle testing. Alternatively physical simulations or full vehicle tests can be performed alone to analyze incident specific data or to evaluate vehicle performance under specific conditions. Physical testing, however, often has been met with reluctance since there is an inherent cost in supplying the test components and the likelihood of damage being sustained to such. The other issue has classically been concerns regarding repeatability of tests and the limits that must be placed on tests when human volunteer involvement is required at least as a test driver. Partially to aide these concerns, physical simulations and human surrogates are used to provide repeatable and controllable tests with less potential for damage and under circumstances not reasonable for human volunteers. Still, certain vehicle dynamics data can only be obtained through full vehicle testing, and the data from full vehicle tests is often necessary to provide validation to a physical simulation's input/output relationships under certain conditions.

An example of this can be seen in how S-E-A has developed and is utilizing autonomous vehicle testing equipment and methods to perform single vehicle tests (both on-highway and off-highway vehicles) in paved and off-road environments. This includes steering controllers and brake and throttle robots specifically designed to provide repeatable and reliable testing without the use, or potential harm, of human volunteers while removing the inherent variability of such operators. These systems have been used for conducting vehicle-to-vehicle crash tests of on-highway vehicles, single on-highway vehicle dynamics testing, MOHUV and ROV vehicle dynamics and roll-over testing, and most recently all-terrain vehicle (ATV) vehicle dynamics testing.

At S-E-A, for example, an indoor acceleration/deceleration track is used, along with specific vehicle/occupant compartment bucks to aid manufacturers, regulatory bodies, and forensic engineers in their evaluation of such vehicle-occupant systems. Specifically, S-E-A's Roll Simulator allows for selectable yaw positioning while controlling lateral speed and acceleration, and roll dynamics. Various combinations of occupant protection and restraint components have been compared parametrically on ROVs using this device.

IV. Conclusion

Whether flying a drone over a remote accident site, completing a detailed 3D laser scan of the damage sustained to the ROPS of an ROV during an accident event, or performing physical testing of such equipment, deploying the right technology for the task can be a game changer. Before a product goes to market, or after years of reliable use, the behavior of an off-highway vehicle and the performance of its occupant protection systems can be evaluated using a variety of technologically advanced systems.
V. References/Citations


