Performance of Focused Research Studies

At any given time, there were typically 15 or more research studies being conducted. We highlight a few studies here to provide examples of the type of projects pursued in this category. Information on many other projects can be found in Appendix B (CenTIR Publications) and the CenTIR Product List in Appendix C.

- *Prehospital Emergency Care - How to Conduct EMS Research*

The CenTIR has sponsored the production of a supplement that was published in the April/June 2002 edition of the *Journal Prehospital Emergency Care,* Volume 6, Number 2. This supplement presents a review of the state-of-the-art associated with the conduct of EMS Research. The project enlisted the assistance of prominent EMS researchers to contribute chapters. The supplement has been distributed to over 2,000 subscribers to the journal plus it will be used as the text for the NAEMSP Association's research workshops. (See Exhibit 3 for an excerpt from the supplement including the Cover page, CenTIR Acknowledgement & Table of Contents)

- *ACN Effectiveness and Cellular Service Coverage in WNY*

This effort was performed with the Industrial Engineering Department and the Geography Department at SUNY Buffalo. The objective of this study was to examine the ability of the existing Western New York cellular analog system to support Automated Crash Notification (ACN) systems. As part of this project, measurements were made of 'received signal strength indicator' (RSSI) (i.e., cellular signal strength) by driving along Erie County roadways with instrumentation to measure RSSI as a function of GPS position. (See Figure 1). The effects of slope, elevation and foliage density on RSSI were assessed. Modeling was performed to determine optimal base station locations based on emergency needs and customer demand. The model integrated the base station location problem, the frequency of channel assignment problem and the emergency notification problem. Unifying the three problems in the same model enabled researchers to treat the tradeoffs among them, providing a higher quality solution to the cellular system design. Implications of all of this for use of ACN technology were examined.

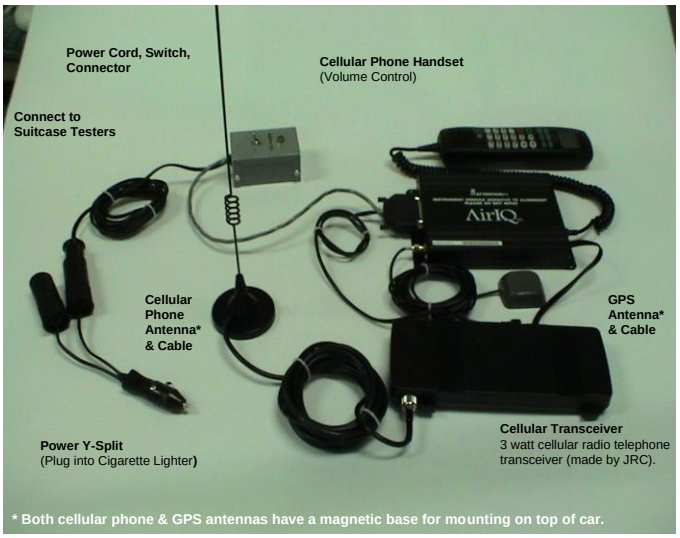

Figure 1. Equipment Developed by CenTIR to Measure Cellular Received Signal Strength Indicator.

- *Sonographic Scoring for OR Triage in Trauma (SSORTT)*

Focused Assessment with Sonography for Trauma (FAST) is a technique used by emergency physicians to rapidly identify abdominal injury in trauma patients. In this technique, ultrasound images of 3 areas (right upper quadrant, left upper quadrant, and pelvis) are obtained to assess whether free intraperitoneal or pericardial fluid is present. This rapid assessment technique is primarily used to determine the cause of shock by timely diagnosis of life-threatening hemorrhage. In making the diagnosis however, FAST only utilizes ultrasound findings without regard to patient physiologic parameters. SSORTT (Sonographic Scoring for OR Triage in Trauma) was a prospective study whose goal was to identify a set of criteria using ultrasound findings and physiologic parameters to predict the need for laparotomy (major surgery that involves opening the abdomen) in trauma patients. Patients presenting at the Erie County Medical Center underwent a FAST ultrasound exam and an ultrasound score was generated. Physiologic data was also collected on each patient. After data collection was completed, a set of criteria that predicts the need for laparotomy was determined with regression analysis. The SSORTT project successfully generated a simple scoring system that combines FAST findings with physiologic data to predict with a high specificity the need for laparotomy within minutes of ED arrival. Other potential applications of SSORTT (which is of particular interest to the CenTIR) include training of prehospital care providers to perform the FAST exam and apply the prediction model to determine appropriate mode of transport (air or ground) and appropriate receiving hospital for motor vehicle crash patients. In addition, community hospital and rural emergency physicians could use the SSORTT algorithm to make earlier decisions to transfer patients to a trauma center.

- *Crash Occupant and Child Seat Modeling & Visualization*

Mathematical models developed with current sophisticated three-dimensional dynamics analyses can simulate, with varying degrees of accuracy, the numerous physical processes

involved in a vehicle crash. Detailed models that forecast the dynamic response of an occupant inside a vehicle cabin during the crash provide highly informative animated video imagery depicting virtual occupant motion, interaction with restraint systems, and possible impacts with cabin-interior structures and surfaces and other occupants. Model-generated injury-indicator measures and other output enable the effects of these actions to be examined quantitatively. Modeling activity at the CenTIR has focused on child restraint systems and ambulance patient-compartment crash safety.

Child Restraint Systems: The CenTIR has developed an accurate lumped mass/finite element MADYMO model of a recent-production child restraint system (CRS). The model was exercised to study the effects of restraint belt misuse and examine CRS occupant protection performance for typical real-world vehicle crash conditions not presently addressed by Federal Motor Vehicle Safety Standard (FMVSS) 213.

Ambulance Rear Cabins: The CenTIR has also worked to develop a MADYMO model of the rear cabin (i.e., the patient-transport compartment) of a current-production Type I ambulance that was crash tested at General Dynamics. The model simulates the observed kinematics and measured effects of cabin-interior impacts experienced by instrumented dummies deployed in the ambulance crash tests.

Scientific visualization: The CenTIR also has developed the NCVM computer code, which applies virtual reality features to selected MADYMO-generated imagery. Images from sled test video used to support validation of visualization model are shown in Figure 2.

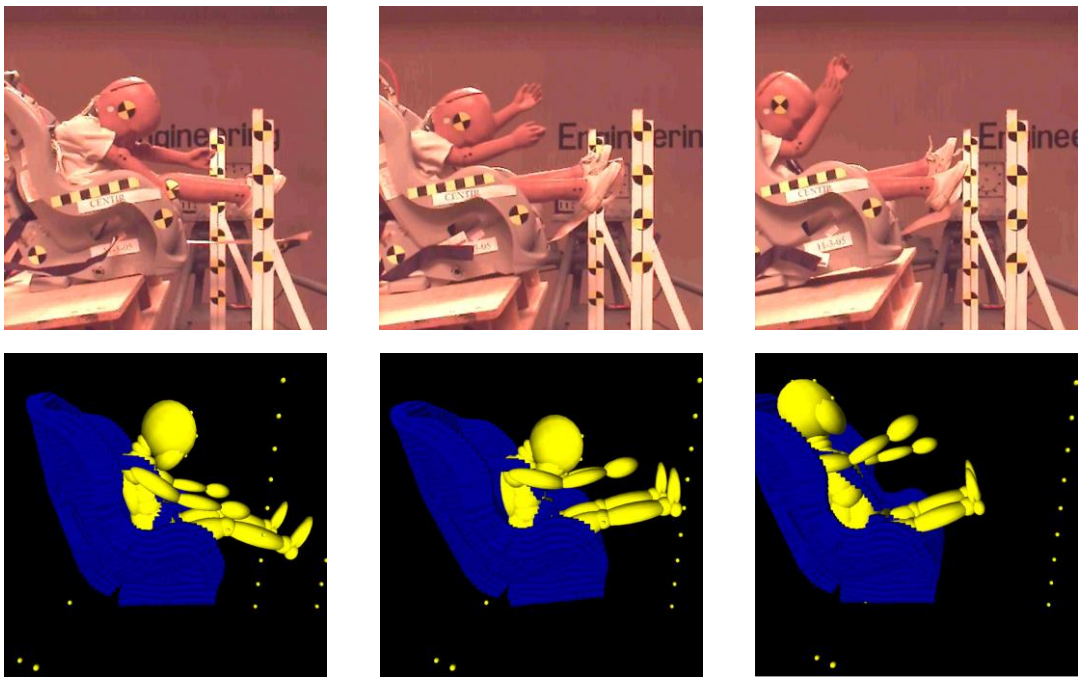

Figure 2. Images from Sled Test Video Support Validation of Visualization Model.

- *Back Seat Bullet*

This study examined whether unrestrained driver-side rear-seat passengers increase the risk of fatality of belted drivers involved in a frontal crash. Both FARS data analyses and sled tests were conducted. Variables such as point of impact, restraint use, seat position, vehicle type, occupant ages and sex, and injury severity were extracted from the Fatality Analysis Reporting System. The study determined that unrestrained motor vehicle occupant's place themselves as well as their fellow passengers at great risk of serious injury when involved in a crash. Drivers with unrestrained passengers seated directly behind them are 1.64 (95% CI 1.47-1.82) times more likely to die in a crash than drivers with restrained rear-seat passengers. These numbers are more extreme in a head-on crash where a driver is 2.27 (95% CI 1.94-2.66) times more likely to be fatally injured if the passenger seated directly behind them is unrestrained. Sled Tests using a belted dummy as driver and an unrestrained dummy in the rear seat were also successfully conducted at Veridian/General Dynamics. Adult male and child dummies were utilized as back seat unbelted occupants in separate crash tests conducted at 35 miles/hour. (A test with belted back seat occupant was performed as a control.) Both high speed video and digital data from instrumented dummies were acquired. (See images in Figure 3.)

Figure 3. Six Year Old Unbelted Child in Rear Seat Strikes Belted Driver in Sled Test.

- *Ambulance Crash Worthiness and Patient / Paramedic Safety*

The ambulance transport environment is a vehicle passenger environment for which there are no accepted national safety standards for rear compartment design and performance. The

ambulance is also a high risk vehicle exposed to a high crash injury and fatality rate per mile traveled. At the start of this project, little was known about the forces, impact mechanics and occupant kinematics of the rear patient compartment of these vehicles under crash conditions. There were no data-based crash test pulses for the rear patient compartment of ambulance vehicles. There were also no data-based crash test pulses for the components of this environment such as the occupant restraint systems for the gurney, bench seat or rear facing seat. Furthermore, there were no data to address the equipment restraint requirements for these vehicles. The objectives of this study were to conduct and analyze crash tests of ambulance vehicles under real world crash circumstances and to measure the crash dynamics of the vehicle and its occupants. Figure 4 shows the anthropometric test dummies (ATDs) within the test vehicles. One belted and one unbelted passenger/EMT are on the bench seat, one belted/secured pediatric patient is on the gurney and one belted EMT is at the head of the gurney.

The findings demonstrated life threatening safety hazards for all occupants. Also, measured crash pulses for both the vehicle and the interior components were obtained. The study indicated the urgent need for improvements to ambulance crash safety standards and designs.

Figure 4. Location of Anthropometric Test Dummies (ATDs) within the test vehicles.

- *Ultrasound Diagnostics For Detection of Occult Abdominal Injuries*

Bleeding into the abdominal cavity is a common and potentially lethal result of blunt trauma from a motor vehicle crash. It is often difficult to detect until it is too late. Since its inception, diagnostic peritoneal lavage (DPL) has provided useful information on the evaluation of blunt trauma victims. For this procedure, a lavage catheter is inserted into the abdomen. Saline is put in and drained out of the abdomen. The saline is then examined for blood and

microbes that would indicate an internal injury. Ultrasound has been shown to be capable of detecting intraperitoneal fluid *non-invasively* with a sensitivity and specificity comparable to DPL. This CenTIR-supported study, conducted at the Erie County Medical Center (WNY Level 1 Trauma Center), quantified the amount of intraperitoneal fluid that must be present for an injury to be identified by an ultrasound of the pelvis.

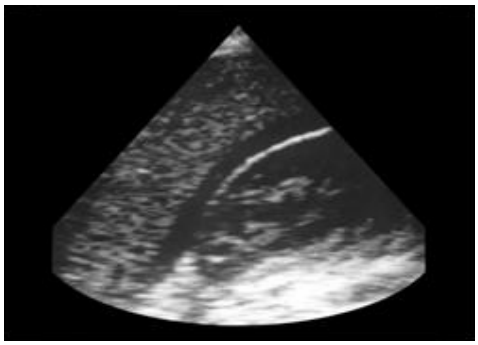

Figure 5. Ultrasound Image

- *Use of ADAMS in Air Medical Coverage and Access to Trauma Care Studies*

The ADAMS database (previously described in Sec. 2.2.6) has been used to support a number of research studies. The first looked at air medical coverage of geographic areas and populations in the US within 10, 20 and 30 minute flight from the nearest air medical rotor wing base. Coverage of the US roadway system was also examined and quantified for US DOT. ADAMS has also been used in collaborative research studies including a study with the University of Pennsylvania and Johns Hopkins University Bloomberg School of Public Health. This study, published in Journal of the American Medical Association in 2005, looked at "Access to Trauma Care" which examined where populations in the country had timely access to a Level 1, 2 or 3 trauma center. A similar study is currently underway at Harborview Medical Center looking at access to Burn Centers. ADAMS is updated each year and an Atlas containing state & national maps showing air medical Rotor Wing (RW) coverage in the U.S. has been published and distributed at the national Air Medical Transport Conference (AMTC) each September since 2003.

- *Utility of Geocoded FARS Data*

The CenTIR was given access to geo-coded FARS data for 2001 through 2004 (courtesy of NCSA at NHTSA) and proceeded to explore how viewing FARS data in a map context might support and enhance FARS data analyses. One such study used information contained in the geocoded FARS dataset to identify intersections across the country which had multiple fatal crash occurrences. The left side of Figure 6 shows a national map with these locations. Another study looked at using information contained in the geocoded FARS dataset in conjunction with high resolution orthoimagery (see right side of Figure 6) to investigate the geospatial patterns of fatal motorcycle crashes. The intent was to determine if newly available analysis tools can be used to gain additional insight in crash causation and potential crash mitigation strategies. Specifically illustrated in this study were locations involving single vehicles (motorcycles) that

collided with guard rails on curved roadways with 55 mile an hour posted speed limits and which resulted in fatalities. Geocoded FARS data has also been combined and mapped with other recently developed, geocoded databases, such as air medical base locations, trauma center locations, etc. to further expand the type of research analyses which might be performed with FARS.

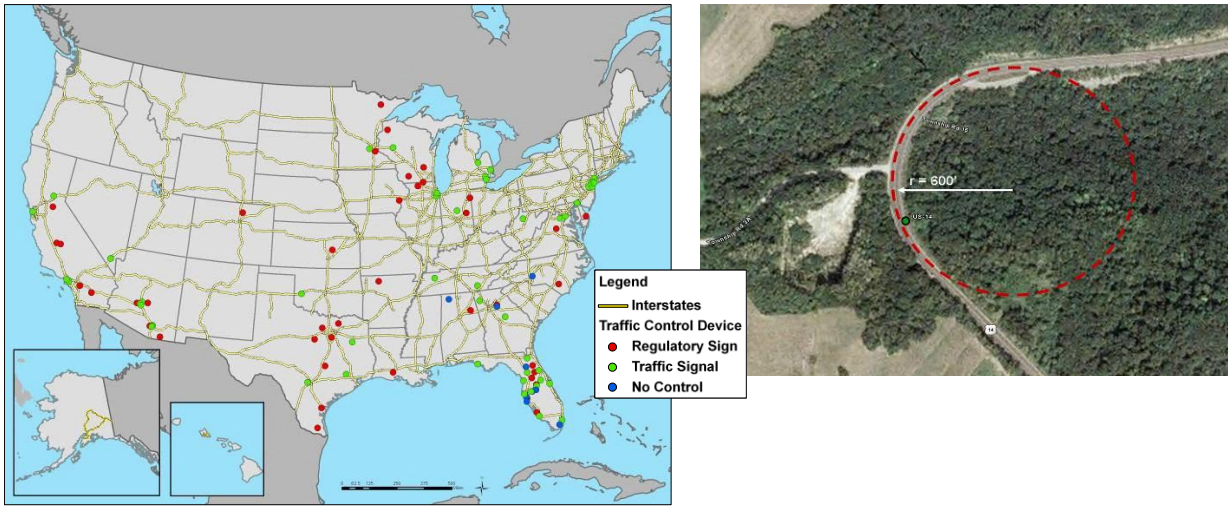

Figure 6. National Map Showing 101 Intersections With at Least 3 Fatal Crashes from 2001-2004; Orthoimage Used to Calculate Radius of Curvature of Roadway Where Fatal Motorcycle Crash Occurred.