How Vehicle Safety Advances

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How far have we come?

INSURANCE INSTITUTE FOR HIGHWAY SAFETY
Car-to-car crash test
1999 Chevrolet Bel Air
2009 Chevrolet Malibu
80 mph closing speed
50 percent overlap
CR09012
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Neuroscience & Biomechanics Research Laboratories

Departments of Biomedical Engineering & Neurosurgery
Medical College of Wisconsin
and
VA Medical Center,
Milwaukee, Wisconsin
VA Laboratories

- Biomechanical testing
  - Electro-hydraulic piston actuator
  - Drop towers
  - Pendulum
- Acceleration Servo Sled testing
- Full-scale vehicle crash testing
- Basic Neuroscience & Neurobiology
  - Tissue culture and cellular imaging
  - Histology and Immunohistochemistry
  - Stem cell biology

Laboratory Personnel

- 10 PhD Scientists; 8 engineers, 30 technologists
- Post docs, Graduate Students

Why Do Engineers Study Trauma?

- So we know what to do to prevent it!
- Human – Machine Environment
  - Vehicle crashes
  - Military equipment
  - Occupational hazards
  - Intentional/Unintentional events
- Design primary interventions
- Create secondary interventions
Background: Injury Prevention

- Feasibility of space travel
- High performance aircraft
- Motor vehicle crashes
- Understand mechanisms of injury
- Define human tolerance in high-energy environments

Federal Agencies Interested in Public Safety

- Department of Transportation
  - National Highway Traffic Safety Administration
  - Federal Aviation Administration
- Department of Defense
- National Aeronautics and Space Administration

How Vehicle Safety has Advanced

- Example 1: Creating a Federal Motor Vehicle Safety Standard
- Example 2: The CIREN program
- A new tool to study occupant protection
Example-1: Creating a Federal Motor Vehicle Safety Standard

FMVSS-214, performance requirements for protection of occupants in side impact crashes

A Success Story: Side Impact

Side Impact Safety Standards

Old Dummy

Updated Dummy
Human Tolerance Studies

- Surgically implant sensors
- Reproduce real-world scenarios in lab environment
- Determine injuries in realistic laboratory environment
- Determine engineering parameter that quantifies injury outcome

Extensive testing over 8 years

Side Impact Results: Logistic Regression TII

- MCW conducted a series of tests to derive basic human tolerance measures in side impact
- Statistical derivation of severe chest injury measure from human to Dummy

Probability of Severe Chest Injury
25% prob = 151
50% prob = 169
p-value = 0.004
US DOT Consumer Information Tests

NCAP = New Car Assessment Program

Frontal NCAP

Side NCAP

NCAP = New Car Assessment Program

Five Star ⭐⭐⭐⭐⭐ Rating System

Frontal NCAP

Side NCAP

35 mph

38.5 mph

20 mph

Side Pole NCAP Crash Test

Child Safety with Side Airbags
Example 2: The CIREN Program

Crash Injury Research and Engineering Network

CIREN Program
- Sentinel Program - Alert safety regulators of new issues.
- Detailed Data Collection – Case-by-case
- Interdisciplinary Expert Review of each case
- Catalyst for new vehicle safety research
CIREN Data Collection

- Medical Data
  - EMS treatment
  - Surgical decisions
  - Recovery process
  - Follow-up
  - 250 entries
- Engineering Data
  - Crash reconstruction
  - Physics of occupants
  - Mechanics of injury
  - Vehicle causation
  - 600 entries

Example CIREN Case

- 43 y.o. Female Driver Belted
- L1 major compression fx
- 12-FYEW-2 vs. passenger car
- Delta-V = 37 km/h
- Bucket seat
- 1 Rail engaged
Small Overlap Crashes
A CIREN Success Story

Small overlap impact (SOI)

CIREN SOI Example

73 yr old female: (63 kg, 168 cm)

Cerebral hemorrhage + contusion (AIS 4)
Transverse process fractures (AIS 2)
Occupant Kinematics – SOI Crash

Response to SOI Research Findings

- Conducts SOI vehicle crash tests
- 40 mph impact to rigid barrier
- Provides safety ratings to public

Auto Industry response:
- create new frame designs

A New Tool to Study Occupant Protection

Computational Modeling
Finite Element Computer Modeling

- Each element is individually programmed with material characteristics
- Used in other engineering disciplines
- Difficult in biological systems

Computer Modeling Studies

45-degree Oblique Impact
45-degree Oblique Impact

Computer Models of Whole Human Body

Computer Modeling Studies
Summary

• MCW is a national leader in the science of vehicle occupant safety
• Advancing basic science of trauma through interdisciplinary efforts
• Continued contribution to Motor Vehicle Safety Standards
• Continued contribution to NHTSA CIREN Program
• Advancing new computational tools for use in trauma research