Characteristics of the Injury Environment in Far-side Crashes

K. Digges, P. Mohan, B. Alonso

G.W. University

C. Gabler

Va Tech
Outline

• The Joint US/Australian Far-side Research Project
• Progress to Define the Crash Environment
Joint US/Australian Project – Research Objectives

• To obtain a more detailed understanding of far-side crashes, injuries, and injury mechanisms
• To develop suitable test devices, procedures, and injury criteria
• To assess the benefits for a range of generic countermeasures to reduce far-side trauma
• To make all results publicly available
Joint US/Australian Project - Participants

- Monash University (lead agency)
- GW University
- Autoliv, AB
- Holden Australia
- Medical College of Wisconsin
- University of Miami School of Medicine
- Va. Tech & Wake Forrest
- Ford USA
- Wayne State University
- Australian Ministry of Transport
Project Funding & Timing

• Funding from
  – Australian Research Council
  – Ford USA
  – Holden, Australia
  – Autoliv, AB
  – In kind funding from all participants

• Research to be completed during 2007
Present Focus

• Far-side Planar Crashes
• No Rollover or Ejection
• Belted Occupants

• Annual Target US Population
  – With 76% Belt Use –
  – 2,224 MAIS 3+ and Fatal Injuries (MAIS 3+F)
Far-side Rollover – 208 Test Cart
The Target Population

• Target population –
  – Annual number of severe and fatal injuries that might be addressed by a countermeasure

• How well injuries are mitigated will depend on the countermeasure (and the vehicle test requirements)

• Data source – NASS/CDS 1993-2003 - annualized
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% Due to Far Side: 33% (Far-side Target)
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| % Due to Far Side        | 33%    | 52%  | 42%    |

214 Target

Far-side Target

17,194
The First Step

- What is the crash environment for far-side belted front seat occupants in planar crashes?

- Harm distribution published by Gabler SAE 2005-01-0287

- Selected MAIS 3+F distributions to follow
Far-side Crash Severity – Delta-V

- Exposed Occupants
- MAIS3+F Injured

MAIS 3+F Median Delta-V – 28 kph
CDC Zones for Small Car

First 6 zones – 168 mm each

CDC 3.5
Far-side Crash Severity – Damage

Exposed Occupants

MAIS3+F Injured

MAIS+F Median CDC Extent = 3.6
Other Crash Factors

• Crash Direction:
  – 60% of MAIS 3+ at 60 degrees
  – 24% of MAIS 3+ at 90 degrees

• Body Region Injured:
  – 42% of MAIS 3+F Harm is to the Head
  – 41% of MAIS 3+F Harm is to the Trunk

• CCD Extent of Damage – 3.6

• Delta-V - 28 kph
Research Questions

• Which crash tests represent the far-side injury environment?
• What dummies are suitable for evaluating countermeasures?

• Evaluate available crash tests & apply computer models
  – FEM models of vehicle structure
  – MADYMO models of dummies
NHTSA 214 Barrier Side Test
Vehicles Tested in Side Impact by IIHS – with IIHS Barrier

Honda Accord
Nissan Altima
Toyota Camry
Subaru Forester
Mitsubishi Galant
Saturn L series
Chevy Malibu
Mazda 6
Volvo S40
Saab 9-3
Hyundai Sonata
Dodge Stratus

The crash pulse averaged for the 11 cars is displayed in the next slide.
Extent of Damage in IIHS Side Impact Tests

Max Exterior Crush
Level-3 Middle Door

Average Delta-V – 23.6 KPH
Average max Crush – CDC – 2.2

Average of 10 IIHS Tests
FEM Simulations of 60° & 90° Crashes

1500 Pickup Into Taurus

50% risk of MAIS 3+F
Delta-V ~ 28 kph
CDC ~ 3.6

90 deg  60 deg
FEM Simulations Delta-V 28 kph
Crush Profile at Window Sill

Max Exterior Crush
Level-4 Windowsill 2001 Ford Taurus

Vehicle Mid-Plane

Pickup at 60°
Pickup at 90°

IRD Coord (US-NCP Protocol) (mm)

Exterior Door Panel Motion (mm)

Door Inner
Door Outer

A-Pillar
B-Pillar
C-Pillar

CDC 1
CDC 2
CDC 3
CDC 4
CDC 5

US-LNCAP
IIHS
Pickup Truck @ 60 deg
"Pickup Truck @ 90 deg"
FEM Simulations Delta-V 28 kph
Crush Profile at Window Sill

Max Exterior Crush
Level-4 Windowsill 2001 Ford Taurus

- A-Pillar
- B-Pillar
- C-Pillar

Vehicle Mid-Plane

Pickup at 60°

Pickup at 90°

CD 1
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Door Inner
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US-LNCAP
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A-Pillar
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Pickup at 60°
Pickup at 90°

Door Inner
Door Outer

CDC 1
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CDC 5

US-LNCAP
IIHS
Pickup Truck @ 60 deg
"Pickup Truck @ 90 deg"
Observations

- Damage pattern produced by IIHS Barrier blends 60° and 90° pickup impacts
- Damage pattern produced by NHTSA barrier produces less front door damage at the same crash severity
- Crash test for far-side crashes should be at higher delta-V than 23.8 kph used by IIHS
- IIHS barrier appears to be the best test device
MADYMO Models of Dummies

- Select the human facet model as baseline
- Validate human facet against human tests
- Examine performance of MADYMO dummies and compare with human facet model
Cadaver vs. Human MADYMO

0 ms
Cadaver vs. Human MADYMO

135 ms

81 cm (32 in)
Cadaver vs. Human MADYMO

160 ms

97 cm (38 in)
MADYMO Human Model with 3.6 CDC Intrusion Displayed
Hybrid III Dummy vs Human Model

Side impact dummies were no better
Conclusions

Crash configuration for 50% far-side MAIS 3+F belted occupants in planar crashes
  – Delta-V -28 kph
  – Extent of Damage – 3.6 CDC
  – Crash direction 60° (60%)

• IIHS barrier at higher delta-V is best available test device
• MADYMO human facet model is good evaluation device
• Improved dummy needed
Conclusions

• Target MAIS 3+F population for far-side belted planar crashes - 2,244
• Target MAIS 3+F population for all far-side crashes - 17,194
• Target MAIS 3+F population for all near-side planar crashes - 14,625
Acknowledgement

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• C. Gabler; Va.Tech
• J. Augenstein; Miami Medical College
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Questions