Development of Surrogate Child Restraints for Airbag System Testing

Overview of Research and Development Program

NHTSA Public Meeting

November 2001

Biosciences Division
University of Michigan
Transportation Research Institute

Background

FMVSS 208 Test Requirements

- FMVSS 208 (May 2000) requires that passenger-side frontal airbags either:
  - deploy without exceeding injury criteria for child dummies (low-risk deployment), or
  - suppress deployment when tested with a range of production child restraints
- FMVSS 208 specifies testing with 23 production child restraints intended to span a wide range of designs

Background

FMVSS 208 Test Requirements

Airbag system must suppress deployment of frontal airbag on passenger side (with "airbag off" telltale indication) for:

- full forward, middle, and full-rear seat positions
- with and without seatbelt
- with and without LATCH, if available
- with belt tensions up to 30 lb

Airbag must not suppress with small adult female Hybrid III in front, middle, and rear seat positions

Background

Industry Issues

- Arbitrary list of child restraints (many others sold in U.S.)
- Too many restraints & test conditions
- Child restraint availability throughout development and testing
- Moving target -- NHTSA to update list periodically

Background

Alliance Alternative

Develop a set of surrogate child restraints for use in static testing of suppression systems

RFP	July 2000
UMTRI Proposal	August 2000
Project Began	January 2001
Work Actually Started	March 2001

Objectives

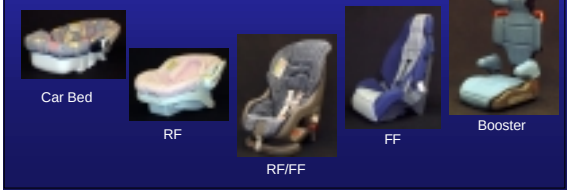
UMTRI Work Plan

1. Test and Characterize Commercial Child Restraints (90% completed)
2. Develop Surrogate Child Restraint (SCR) Design and Performance Specifications (underway)
3. Develop Engineering Drawings and Fabricate Prototypes (with FTSS)
4. Evaluate SCR Prototypes (with FTSS)
5. Develop and Document SCR Test procedures

Progress

Obtaining Child Restraints

- 21 of 23 seats on NHTSA list have been obtained from retail stores or manufacturers (GM has volunteered to loan the other two for testing)
- 4 additional seats obtained to represent current trends (including LATCH)



Car Bed | RF | RF/FF | FF | Booster

Progress

Child Restraint Characterization

- Feature categorization
- Mass and CG location
- Digitize basic geometry

Progress

Digitized Geometry

- Captures essential shape and features
- Extract dimensions of interest
- Align data with in-seat measurements via reference points

Progress

Test Mockup

- Front-seat vehicle mockup
- Two vehicle seats
- One standard seat modeled on FMVSS 213 buck
- Taurus ELR belt
- Adjustable seat position and belt anchorage locations
- Belt tension adjuster and load cell

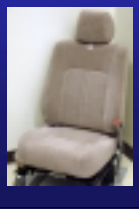
Standard Seat

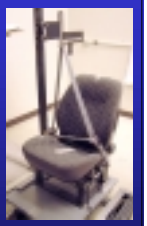
Progress

Test Mockup

Xsensor Pressure Distribution Measurement System

Vehicle Seats





Progress

Develop Test Matrix

- Testing all possible combinations of seat position (belt angle), belt tension, restraint configuration (e.g., forward/rear facing), etc. --> too many trials
- Simplifications:
  - two lap belt angles: 13 and 75 degrees wrt vertical; torso belt angle did not affect CRS position and orientation substantially in pilot testing
  - one ATD per CRS (largest)
  - three vehicle seats
  - three lap belt tensions: 0, 15, 30 lb

630 trials

Progress

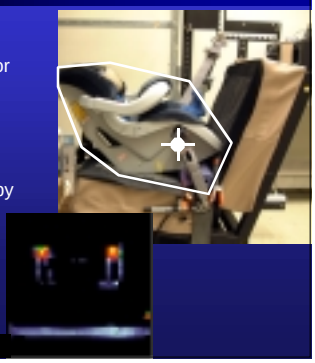
Lap Belt Angle and Tension

- Outboard lap belt angles achieved by moving seat and anchorage

Progress

Test Data

1. Positions, orientations, and occupied volume for child restraints for a range of belt tensions and angles
2. Seat cushion pressure distributions produced by belted and unbelted restraints

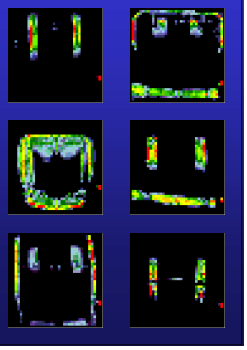


Progress

Mockup Data

Preliminary Observations

- Effects of belt tension and angle on restraint position and orientation are small compared to differences among restraints
- Seat surface pressure data vary widely -- no "typical" pressure distribution
- Belt tension affects pressure distribution, but differences are small compared to differences among restraints



Progress

Data Analysis — Next Steps

- Complete mockup testing and CRS measurements – this month
- Examine influences of vehicle seat type, belt angle, and belt tension on restraint position and orientation —> design targets
- Establish position and orientation targets (CRS on vehicle seat) for each restraint category.
- Establish CRS surrogate geometry requirements: overall size, belt paths, harness mounting, etc.

Work Plan

Surrogate Design Targets

1. Number of surrogates (current plan):

   (1) F/R infant + convertible,
   (2) low/high-back booster

   - removable components
2. Surrogates will represent average characteristics for each category
3. Surrogates will be appropriate for technologies that sense weight, seat surface pressure distribution, and spatial dimensions

Work Plan

Surrogate Design

Current plan:

- select "typical" restraints in each category
- reverse-engineer the basic features of the selected restraints (FARO Arm -> simple CAD model)
- adjust model dimensions to match targets derived from measurements of all seats in category (height, width, etc.)
- preliminary design models to FTSS
- design for mass and center of mass of CRS + occupant (heavier CRS surrogate gives greater design and application flexibility, don't need to use real ATD)

Work Plan

Surrogate Design Concept

One “cradle” component that will represent

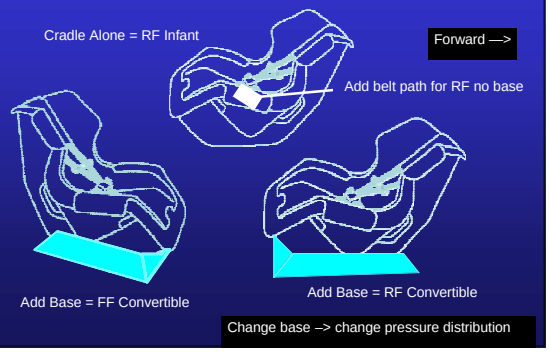
- RF infant, no-base/base
- Convertible, no-base/base

Hypothesis:

The small differences in cradle size between RF infant and convertible can be accounted for by different mounting locations on base

Work Plan

Surrogate Design Concept



Work Plan

Outcomes

1. Design specs for surrogates and drawing package (with FTSS)
2. One set of prototype surrogates (with FTSS)
3. Technical report from UMTRI
4. Database from UMTRI measurements and testing
5. Draft test procedures for using surrogates

Work Plan

Schedule

Pilot testing and complete test matrix	Aug 2001
Complete testing with all seats	Nov 2001
Design specs and models to FTSS	Jan-Feb 02
Evaluate prototypes from FTSS	Mar-Apr 2002
Final deliverables	May 2002