ADVANCED RESTRAINT SYSTEM (ARS)

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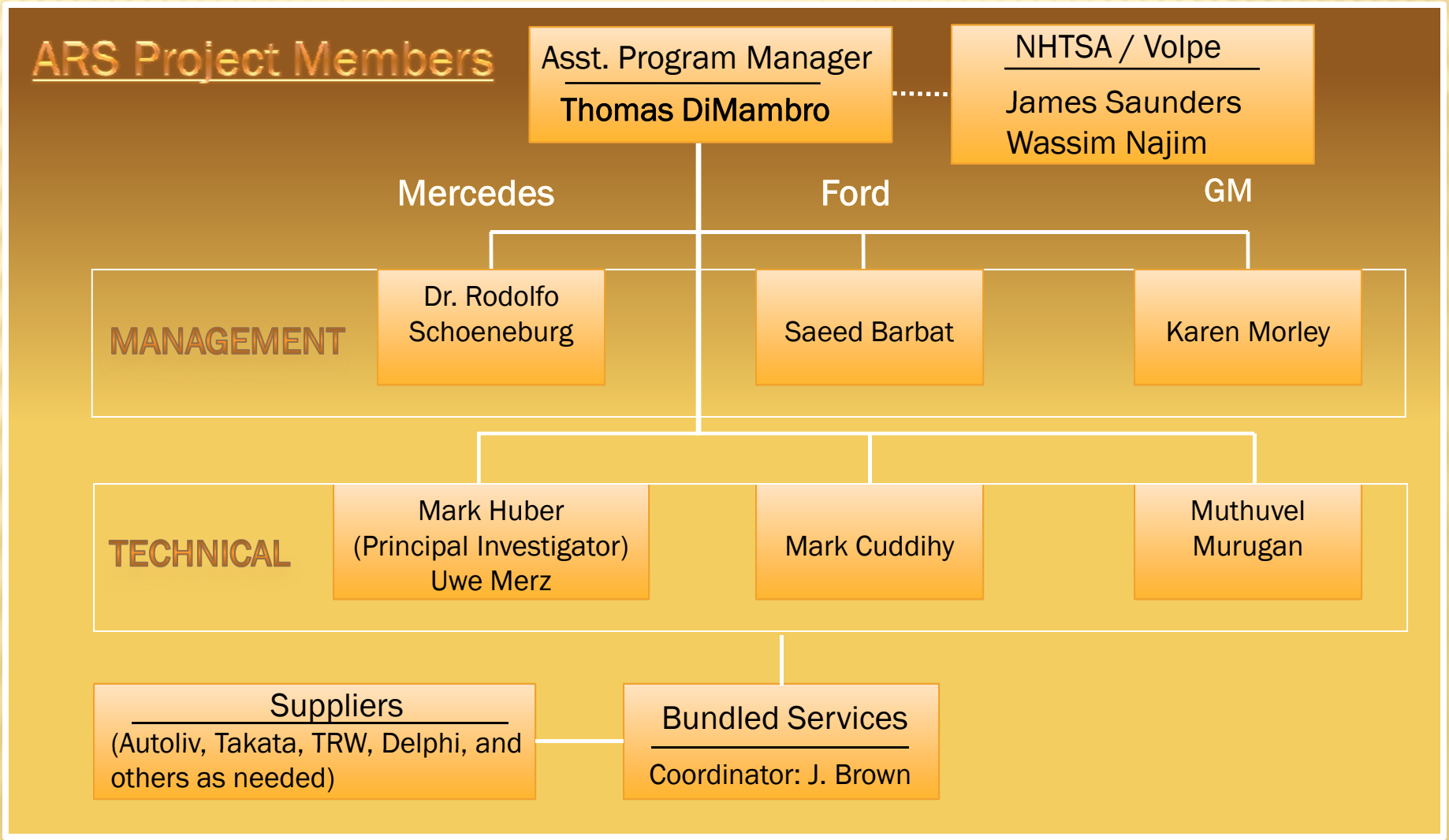
NHTSA Vehicle Safety Research

CRASH AVOIDANCE METRICS PARTNERSHIP (CAMP) ARS

- 4 year Cooperative research program
- Demonstrate restraint systems that can take advantage of pre-crash information
  - Estimate target population and predict benefits
  - Develop objective tests
  - Develop prototype systems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Bundled Services
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PROJECT OBJECTIVES

- Develop and validate minimum performance requirements and objective test procedures for advanced restraint systems
- Identify and fabricate the most promising prototype candidate advanced restraint systems to support test method development
- Support NHTSA's preliminary estimates of predicted benefits from prototype advanced restraint systems

PROJECT DELIVERABLES

- Minimum performance specifications for candidate advanced restraint safety systems
- Relative occupant performance based on current ATD technology
- Test procedures for evaluating the performance of candidate restraint systems
- Methodology for estimating preliminary system benefits
- Testing and Draft report due in December 2010

Subtask 2.7 - Develop Preliminary Functional Requirements for Pre-Crash and Restraint Components and/or Systems Based on Performance Metrics

Precrash sensors:

The system shall be capable of detection and identification of the following vehicle and object groupings:

1. All light vehicles, medium/heavy duty semi-trucks, and trailers
2. Utility poles, trees
3. Concrete pillars, walls, bridge supports
4. Guard rails
5. Sign posts

Preliminary Functional Requirements – Pre-crash Sensors

The system shall determine:

- Location of front impact on the subject vehicle (left, center, right)
- Approach angle of the subject vehicle with respect to the target vehicle or object (±5 degrees)
- Closing velocity (±2mph)
- Notification of impending impact with time-to-collision prediction (±5ms)

TASK 5: CAE STUDY – DEFINE ARS PROJECT CRASH MODES

NHTSA used the NCAC Taurus model and ARSC used a current production mid-size vehicle for study. Computer aided engineering (CAE) to determine worst case crash modes including the following:

Crash Mode No.	Description of Crash Mode
1.	30 deg. Left angle oblique wall impact (35 mph)
2.	Center pole impact (40 mph)
3.	Center pole impact (35 mph)
4.	50% overlap 15 deg. Principle Direction of Force (PDOF), rigid barrier (35 mph)
5.	40% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph
6.	50% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph
7.	65% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph
8.	80% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph
9.	50% overlap, 15 deg. PDOF, Moving Deformable Barrier (MDB)-to-car (35 mph)
10.	80% overlap, 15 deg. PDOF, MDB-to-car (35 mph)

TASK 6 – COMPONENT LEVEL DEVELOPMENT

Restraint Supplier Proposed ARS System

Element	Driver Side	Passenger Side
Seat	Mechanical seat ramp-pre-crash (reversible)	Mechanical seat ramp-pre-crash (reversible)
Steering Column	Single load level collapsible (same as baseline)	Not applicable
Seat Belt	Three point with motorized seat belt (reversible); dual retractor PT (pyro) and lap PT seat belt; variable load limiting EA seat belt (two level switchable variable load limiting).	Three point with motorized seat belt (reversible); dual retractor PT (pyro) and lap PT seat belt; variable load limiting EA seat belt (two level switchable variable load limiting).
Frontal Airbag	Dual stage programmable venting module airbag (airbag pressure tailorable by varying deployment time of inflator assembly vent)	Dual stage programmable venting module airbag (airbag pressure tailorable by varying deployment time of inflator assembly vent)
Knee Airbag	Extended coverage driver knee airbag	Extended coverage driver knee airbag
Floor Carpet Airbag	Carpet pad (crushable foam; not provided by Takata)	Carpet pad (crushable foam; not provided by Takata)
Side Curtain Airbag	Modified side curtain airbag deployed in offset crash (with extended A-pillar coverage of additional A-pillar airbag)	Not applicable

TASK 8 – TESTING PLAN

- Up to12 full-scale crash tests
- Up to 49 sled tests
- Vehicle-to-Object will be evaluated using CAE & 2 full scale tests
- Vehicle-to-Vehicle will be evaluated using CAE, sled tests & full vehicle tests
- Completed by August 2010

TASK 9 –BENEFIT ESTIMATES

- Joint effort between NHTSA/Volpe/ARSC
  - Include multiple body regions
  - High and low speed categories
  - 3 occupant sizes
  - 2 crash types
    - Vehicle to vehicle
    - Vehicle to object
  - Draft report December 2010

NHTSA'S ARS

FRONTAL CRASH PROTECTION

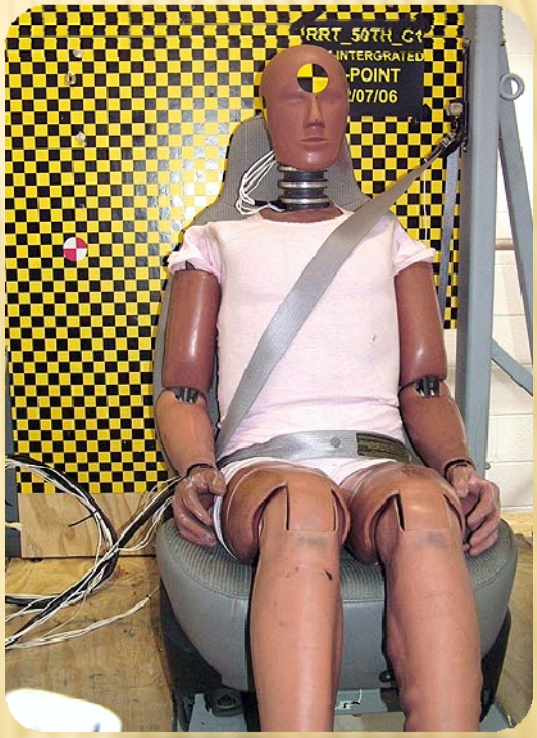
- Rollover restraints research has been underway for several years
  - ESV 2007 (07-0279)
  - ESV 2009 (09-0483)
- Examine the performance of selected ARS in frontal sled tests

TEST CONDITIONS

- 35 mph NCAP pulse for a mid-size car
- 2 dummies side-by-side
  - Hybrid III 50th percentile male
  - THOR 50th percentile male
- Head, neck, chest, pelvis instrumentation
- Head, knee excursion through video analysis
- Use of vehicle seats on sled buck
- Test matrix - TBD

RESTRAINTS USED

- Non-Integrated Three-Point Seat
  - Standard fleet representative three-point restraint attaching to a B-pillar frame element of the vehicle.



RESTRAINTS USED

- Retractor Pretensioner
  - uses a pyrotechnic discharge to remove the slack from a seat belt when triggered by a sensor. A force around 1500 Newtons is experienced at the shoulder belt when the retractor is fired.
- Buckle Pretensioner
  - pyrotechnic device incorporated in the buckle and is fired to remove the slack near the pelvic region. A force around 500 Newtons is observed at the lap belt when the buckle is fired.

RESTRAINTS USED (CONT.)

- Motorized Retractor
  - Electric pre-pretensioner, is a reusable device designed to remove slack from the seat belt system. The force rating is generally much lower than the pyrotechnic devices (~140 N). The reusability of the device allows implementation much earlier when the possibility of a crash is sensed, but the crash is not yet imminent.

RESTRAINTS USED (CONT.)

- Four-Point Seat Belt
  - Belts across both shoulders and buckles at the center of the lap.

Two pyrotechnic pretensioners are utilized on each side of the restraint's lower retractors. This is a prototype device being evaluated by suppliers and OEMs for improved restraint performance in both frontal and side crash protection.

TESTING SCHEDULE

- Testing Summer / Fall 2010
- Results to be presented at SAE Gov/Industry meeting or ESV