

# **Magnesium Front End Research And Development (AMD604)**

***USAMP***

***2008 DOE Peer Review Presentation  
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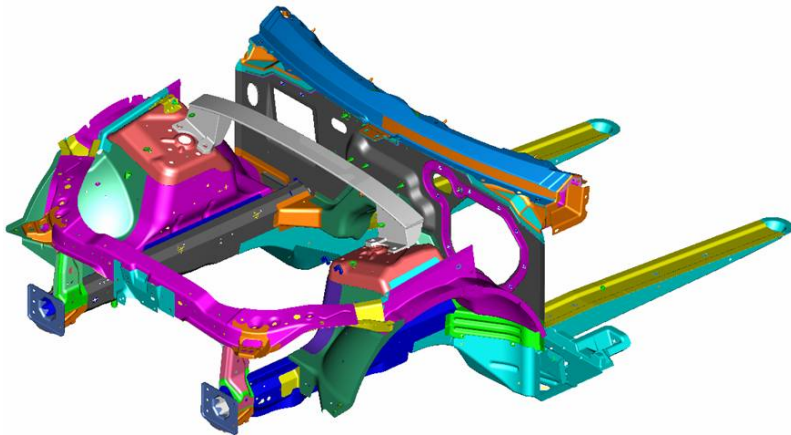
***Eric McCarty, Chrysler Corporation (Presenter)***

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## **Purpose**

Organize and deploy an international research and development project aimed at the advancement of magnesium technology by a dedicated collective of researchers toward the goal of having sufficient engineering and manufacturing capabilities to exploit the full weight-reduction potential of magnesium alloys as engineering materials for entire automotive sub-structures, thereby leading to concomitant fuel economy realizations at affordable cost, excellent vehicle performance and with due consideration for the environment.



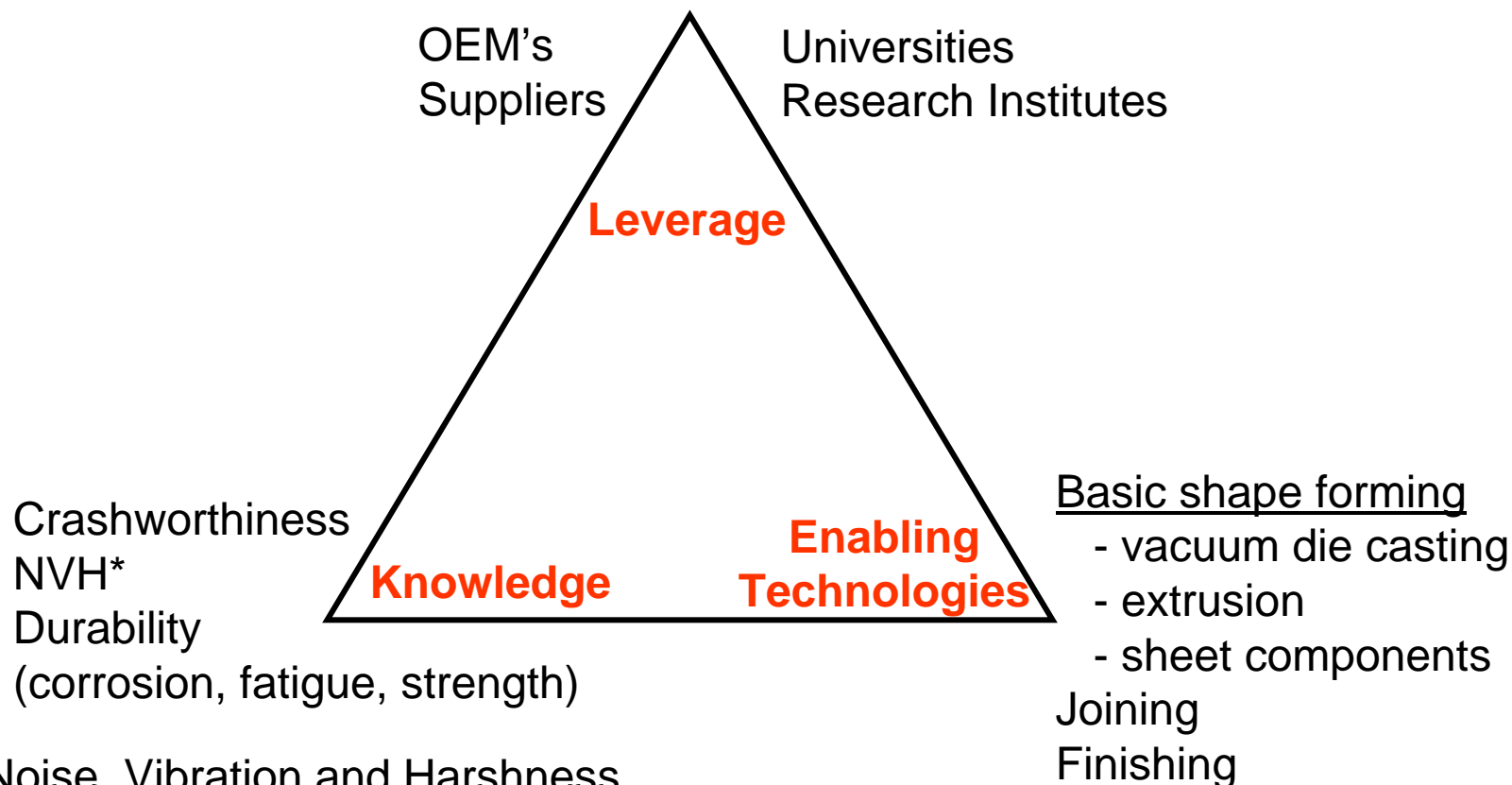
**Vision:** An automotive unibody “front-end” structure realizing a 50% weight savings relative to present steel technology, meeting all expected vehicle attributes at an affordable cost to the manufacturer.

# **Barriers**

- Absence of a substantial magnesium production and processing industry within the U.S. capable of supporting the envisioned design and manufacturing initiatives.
  
- Knowledge-based limitations:
  - Crashworthiness of predominantly cast Mg structures
  - Durability of Mg structures in fatigue, overload and corrosion
  - Performance characteristics of Mg-intensive structures (e.g. NVH, structural modes, stiffness)
  
- Technology-based limitations:
  - Defect-free, high-strength, weldable castings
  - Limited formability of Mg sheet and extrusions (hcp metal)
  - Mg joining technologies not developed for automotive structures
  - Low-cost corrosion protection; environmentally-assisted fracture
  
- Resource Limitations: Limits on funding to outside agencies for Crashworthiness, joining (self-pierce rivets), extrusion, corrosion, large-casting development.

# Approach

First-of-its-kind international cooperative project  
engaging the best minds in science and technology  
of magnesium from U.S., Canada and China



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# Approach – 1. Partitioning of Projects

## Design

**AMD603  
MFE  
Design and  
Development**

- Unibody
- Body/Frame  
(USAMP  
Proprietary)



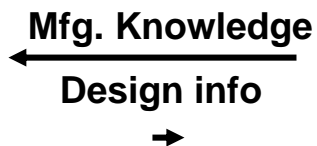
## International Efforts

**AMD604  
MFE  
R&D**

- Knowledge-base  
tasks
- Enabling  
technologies

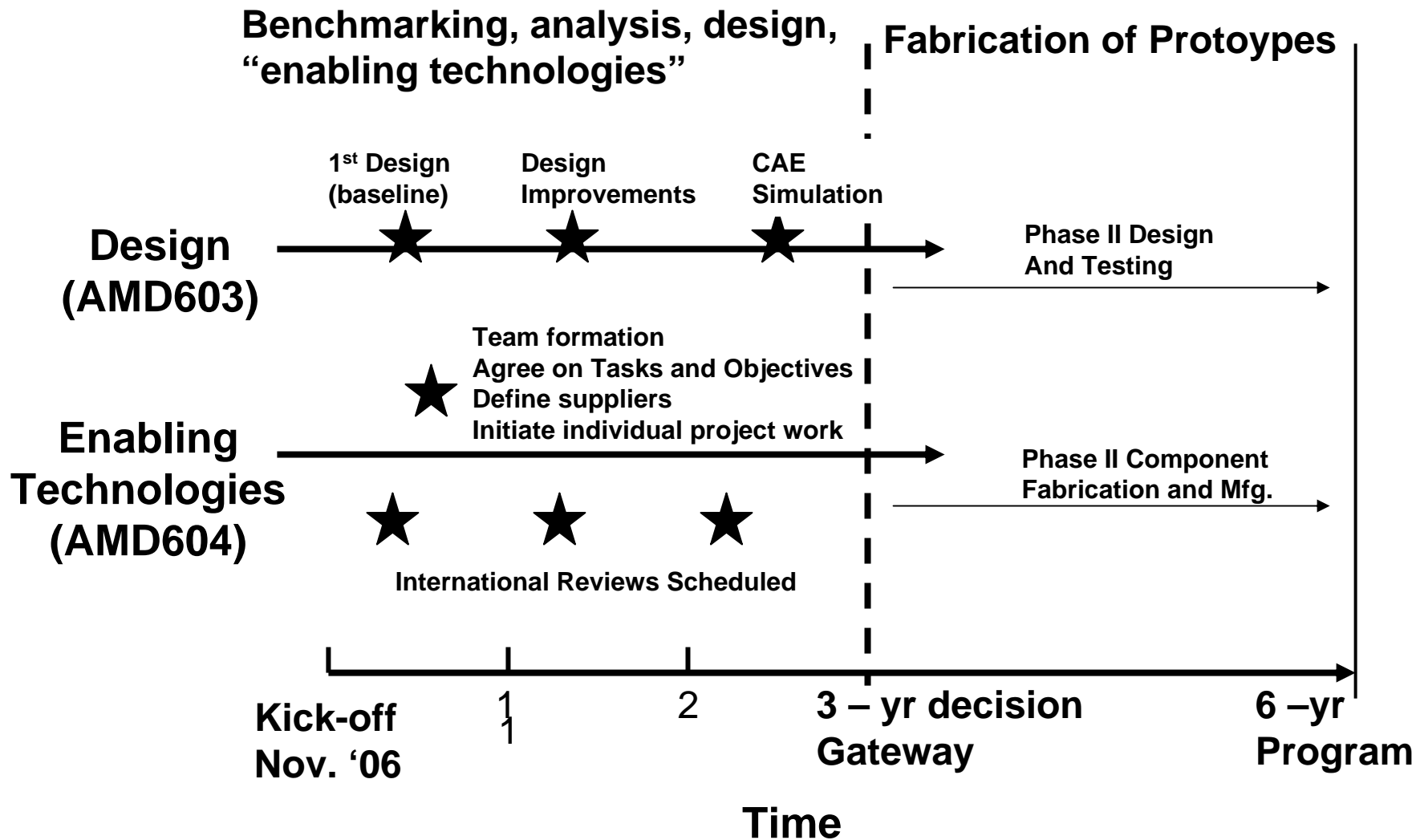
**Integrated  
Computational  
Materials  
Engineering  
“ICME”**

**AMD702  
(Mississippi State)  
AMD703  
(USAMP)**



A “diode” of information  
flow

# Approach – 2. Timing and Gateways



## ***Performance Measures and Accomplishments***

- Launch of US, Canada, and China program components in 2006.
- First international meeting and review at Orlando, FL, March 1-2, 2007.
- Agreement on broad program objectives, work plans and management/reporting structure.
- Concurrence by individual Task Teams on objectives and work plans.
- USAMP 1<sup>st</sup> year accomplishments by Task Area:
  - **Crashworthiness:** high strain rate measurements on typical Mg materials of interest distributed by rate regime capabilities in 3 countries. Designed exemplary crush rail prototype to characterize materials and manufacturing methods.
  - **NVH** – Assignments to 3 countries based on capabilities for acoustic frequency measurement ranges; fabrication of prototypes.
  - **Fatigue:** Selection of appropriate specimen geometries and first materials of choice for initial measurements.



## ***Performance Measures and Accomplishments (cont.)***

- **Corrosion and Surface Treatment:** Focus on galvanic attack at fasteners, pre-treat for adhesive bond and protection packages for automotive paint lines and field exposure.
- **Extrusion:** Selection of alloys and initial structural targets (bumper beam and crush rails); design of tooling for test structure.
- **Sheet:** Coordinated sheet manufacturing and deformation studies with AMD602 Project. Received initial sheet materials from suppliers in US and China.
- **Casting:** Obtained first high-vacuum die cast Mg component pieces for evaluation and analysis.
- **Joining:** Established subteams on threaded fasteners, self-piercing rivets, adhesive bonding and welding processes. Conducted initial adhesive bond measurements on baseline materials and impact of corrosion on joint strength.

## ***Technology Transfer***

**Knowledge sharing** with 40 official and potential partnering organizations  
Including companies, universities and professional societies.

**A Conduit** for best information and practices from China and Canada.

**Design** – Cosma Engineering

**Crashworthiness** – University of Dayton Research Inst.

**NVH** – IAC Corporation

**Fatigue** – Mississippi State, Westmoreland Labs.

**Corrosion** – Henkel Corp., PPG, MetoKote, Ohio State, Univ. of Mich.  
Keronite, Magni Ind., MacDermid, Atotech, Chemetall

**Extrusion** – Timminco Corp., Lehigh Univ., SFTC

**Sheet** – Magnesium Elektron N.A.

**Casting** – Contech Corp., Gibbs Die Casting, NADCA, U.S. Magnesium

**Joining** – Dow Automotive, Kamax, ATF, Henrob

**ICME** – (AMD703) – Northwestern Univ., Univ. of Mich., TMS, ThermoCalc.

## ***Activities for Next Fiscal Year***

- International review Meeting in Hangzhou, PRC, April 2-4.
- Ongoing work of Task 1-8 Committees and Participants in accordance with work plans and objectives.
- Completion of requisite DOE reports and documentation.
- Next U.S. Team review – late Oct. 2008.
- Incorporation of 2<sup>nd</sup> iteration design elements from AMD603.

## ***Summary***

- **There is a large opportunity for magnesium structural sub-assemblies to effect vehicle weight reduction and improve fuel economy at reasonable cost, provided a number of fundamental technical barriers are overcome.**
- **A separate design project (AMD603) was launched to both request technical needs from the Task areas, but also to provide direction for incorporation of the enabling technologies into actual designs.**
- **A strong international collaboration of Mg researchers and technologists has been organized and launched.**
- **Objectives and targets have been identified both by country and by technical Task area and agreed to by participants.**
- **Country and Task area work began in CY 2007 and initial results of Task teams are beginning to emerge.**

## ***Presentations and Publications***

1. A. Luo, E. Nyberg, K. Sadayappan and W. Shi, “Magnesium Front End Research & Development - A Canada-China-USA Collaborative Project”, TMS Annual Meeting, Orlando, FL, USA, February 25 – March 1, 2007.
2. A. Luo, R. McCune, R. Beals, S. Logan, E. McCarty, J. Allison, M. Maj, D. Wagner, T. Lee, R. Osborne, L. Ouimet, J. Quinn and R. Verma, “The USAMP Magnesium Front End Program - Design and Enabling Technology Development”, International Magnesium Association Magnesium in Automotive Seminar, Livonia, MI, USA, March 28, 2007..
3. A. Luo, R. McCune, R. Beals, S. Logan, E. McCarty, J. Allison, M. Maj, D. Wagner, T. Lee, R. Osborne, L. Ouimet, J. Quinn and R. Verma, “Magnesium Front End Development - USAMP Activities”, Society of Automotive Engineers (SAE) 2007 Congress, Detroit, Michigan, USA, April 16-19, 2007.