INTEGRATED COMPUTATIONAL MATERIALS ENGINEERING APPROACH TO DEVELOPMENT OF LIGHTWEIGHT 3GAHSS VEHICLE ASSEMBLY

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United States Automotive Materials Partnership

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Project ID
LM080

Overview

Timeline

- Start: February 1, 2013
- End: January 31, 2017
- 0% Complete

Barriers

- **Predictive Modeling**: Integration of predictive models at all length scales
- **Cost & Performance**: Reduce cost to produce 3GAHSS and to validate performance

Budget

- Total project funding
  - $6,000,00 DOE / $2,571,253 Contractor
- Funding received in FY12: None,
- Funding for FY13: DOE $1,155,884, Contractor: $495,379

Participants

Universities/National Labs	Industry	Industry (Cont.)
Brown University	Chrysler Group LLC	U. S. Steel
Clemson University	Ford Motor Company	EDAG, Inc.
Colorado School of Mines	General Motors Company	Livermore Software Technology Corporation
Michigan State University	AK Steel Corporation	
Pacific Northwest National Lab	ArcelorMittal	**Consortias**
University of Illinois	Nucor Steel Corporation	Auto/Steel Partnership
	Severstal NA	United States Automotive Materials Partnership
	ThyssenKrupp USA	

Relevance

Vehicle Technologies Program Barriers & Challenges:

A. Cost. Prohibitively high cost of finished materials is the greatest single barrier to the market viability of advanced lightweight materials for automotive and commercial vehicle applications.

C. Performance. Low cost materials needed to achieve the performance objectives (strong, durable, easily formed and joined into assemblies and components, sufficiently well-characterized) for demanding applications may not

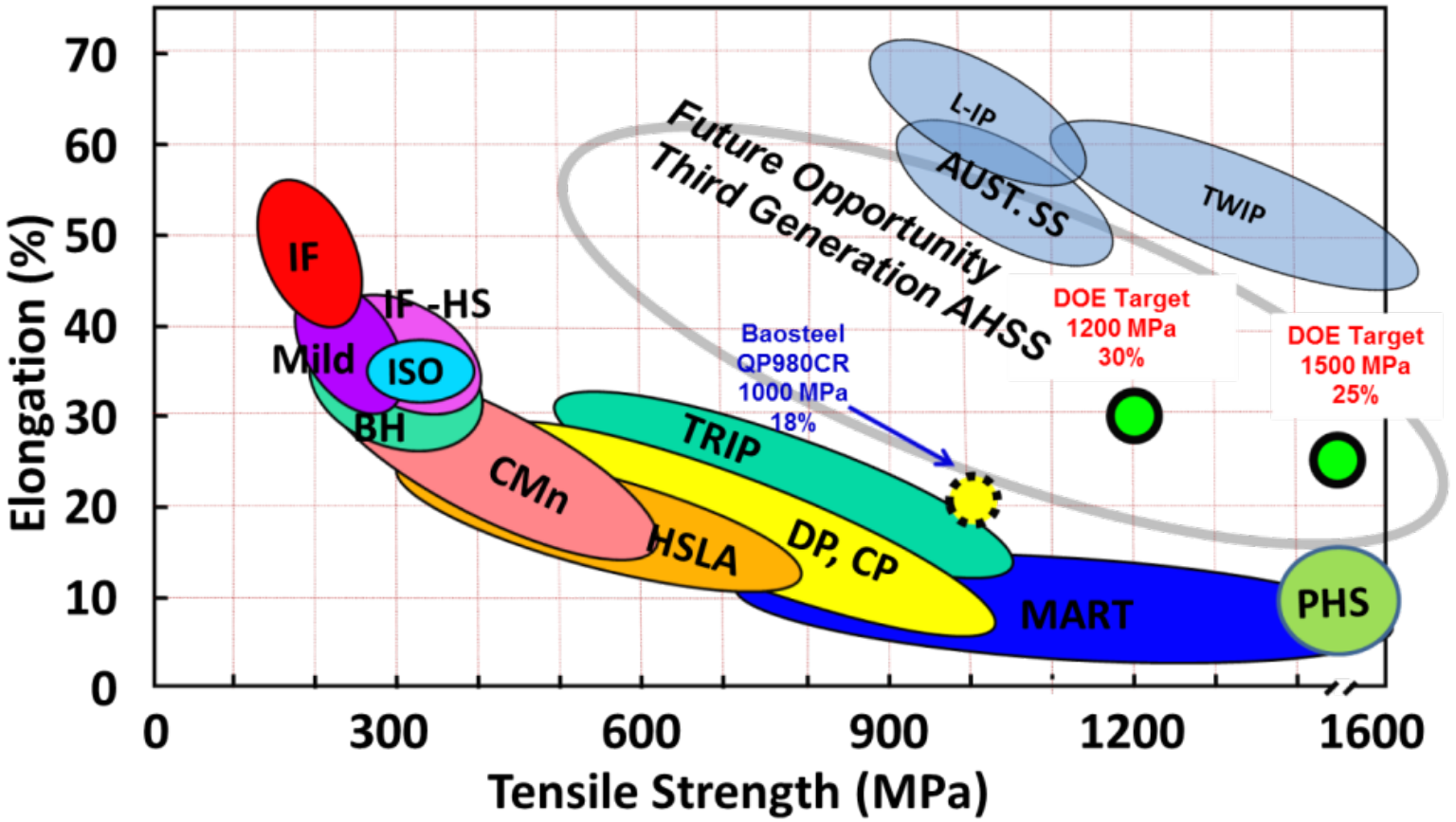
exist today.

D. Predictive modeling tools. Adequate predictive tools that will enable the low cost manufacturing of lightweight structures would reduce the risk of developing new materials for vehicular applications.

Project Goal:

- The goal of this project is to reduce the lead time in developing and applying lightweight third generation advanced high strength steel (3GAHSS) by integrating material models of different length scales into an Integrated Computational Materials Engineering (ICME) model.
- The ICME model will be used to predict final properties of a manufactured component thereby enabling the design of lightweight automotive components using 3GAHSS, which will in turn improve vehicle performance, mobility and fuel economy.

Relevance


Elongation (%)
70
60
50
40
30
20
10
0
0
300
600
900
1200
1600
Tensile Strength (MPa)
IF
IF -HS
Mild
ISO
BH
CMn
HSLA
TRIP
DP, CP
MART
PHS
L-IP
AUST. SS
TWIP
Future Opportunity
Third Generation AHSS
Baosteel
QP980CR
1000 MPa
18%
DOE Target
1200 MPa
30%
DOE Target
1500 MPa
25%

Relevance

Project Objectives

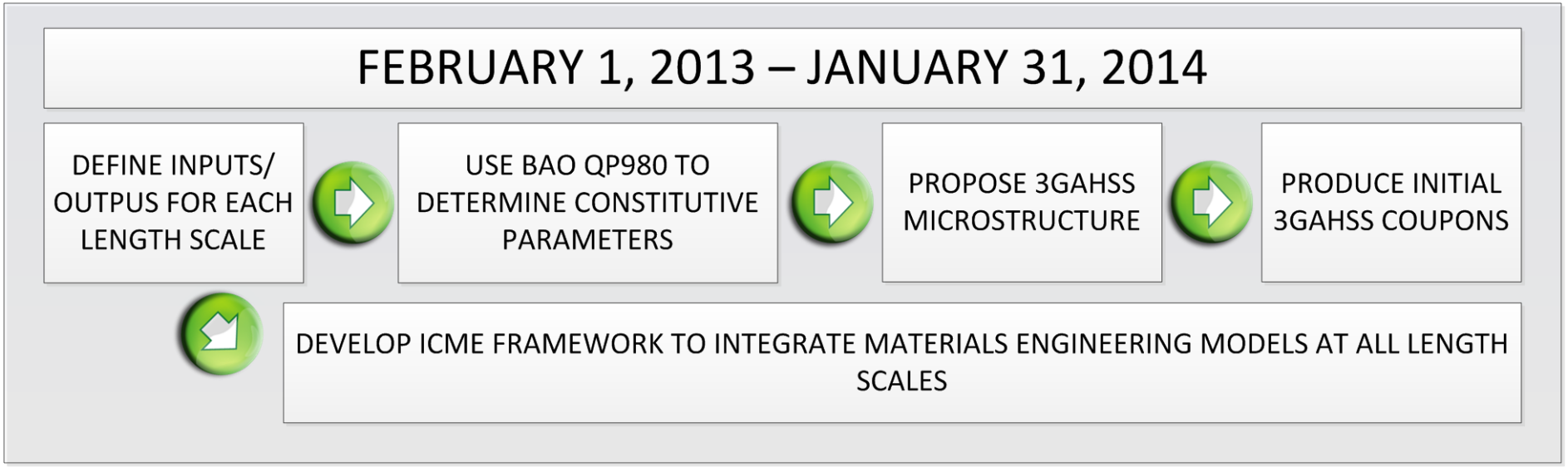
- Identify applicable material models at each length scale
- Validate material models to 15% of experimental coupon results
- Integrate the materials models into an ICME model
- Apply the ICME model to predict final properties and assembled cost for lightweight automotive assembly
- Optimize assembly design using identified 3GAHSS to be 35% lighter and no more than $3.18 cost per pound weight saved
- Validate the ICME model to 15% of experimental results

February 2013 – March 2013 Objectives

1) Launch the project
2) Establish highly functional leveraged teams
3) Establish communication channels essential to coordinate the integration of the ICME model.

FY13 Milestones

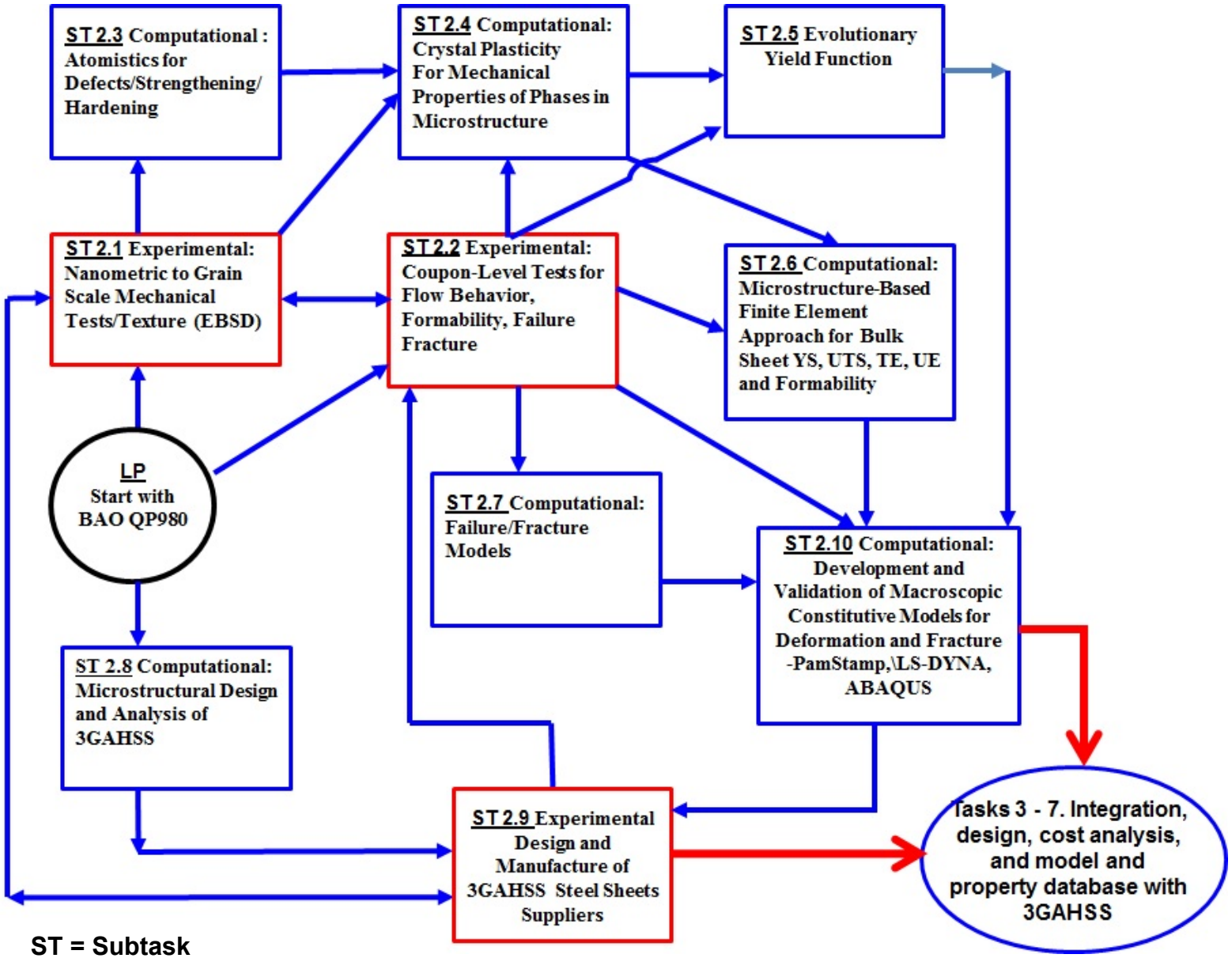
Month / Year	Description	Status
Feb-13	Launch Project	Complete
Mar-13	Kick-Off Meeting	Complete
Mar-13	Establish Project Teams	In Process
Oct-13	Propose 3GAHSS Microstructure	On Schedule
Jan-13	Initial 3GAHSS Coupons	On Schedule



Approach/Strategy

- This effort is aimed at developing an ICME approach specifically aimed at 3GAHSS using existing computational methodologies and tools that will allow relevant information to enable the development of complete and consistent models both at the component and assembly levels.
- It involves a collaborative partnership automotive OEMs, steel companies, universities, a national lab and industry.
- Accomplishment of project objectives will result from adherence to the guiding principles set forth in the NAE ICME report “Integrated Computational Materials Engineering. A Transformational Discipline for Improved Competitiveness and National Security” along with those in the NAE report “Materials Science and Engineering Forging Stronger Links to Users”.
- OEM members will be heavily involved in developing system requirements, acceptance criteria and performance targets in the integration and design of components for 3GAHSS automotive assemblies, which will require OEM participation in CAE design of a 2006 or later vehicle assembly.
- A/SP Steel companies will be involved in the design and manufacture of 3GAHSS alloys to meet the project objectives.

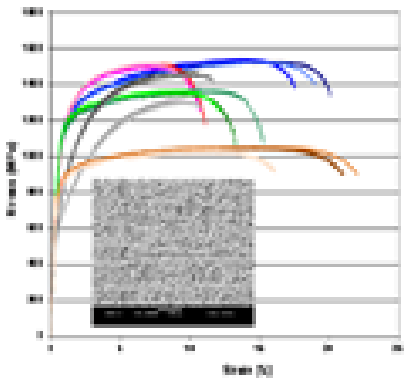
Approach/Strategy



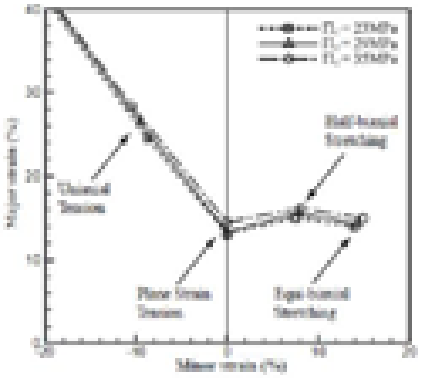
ST = Subtask

Approach/Strategy

Phase II. Forming, Assembly, Design Optimization, ICME Integration, Technical Cost Modeling



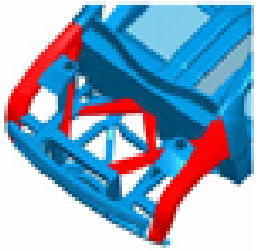
Bulk Properties from ICME

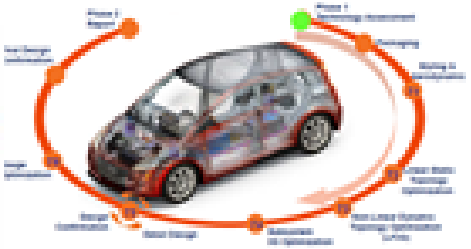


Task 3. Forming and Fracture and Validation

Task 4. State-of-Art Joining Technology from Prior Data

Task 5. Design Optimization





Task 6. Integration

Task 7. Technical Cost Modeling

Technical Accomplishments and Progress

As of March 2013

- Project Launched on February 1, 2013
  - Questionnaires were completed by sub-recipients to define first year objectives, communication channels, and interdependencies between project participants necessary to define the ICME framework.
- Kick-Off Meeting held on March 12, 2013
  - Defined project teams
  - Highlighted first year objectives and deliverables
- BAO QP980 steel available for work to begin

Collaboration and Coordination with Other Institutions

- The project is supported by five universities, one national laboratory, six steel companies, three automotive OEMs and two companies from supporting industries.
- The task teams are comprehensive and involve all institutions to facilitate the integration and validation of the materials engineering computer models

Universities/National Labs	Industry	Industry (Cont.)
Brown University	Chrysler Group LLC	U. S. Steel
Clemson University	Ford Motor Company	EDAG, Inc.
Colorado School of Mines	General Motors Company	Livermore Software Technology Corporation
Michigan State University	AK Steel Corporation	
Pacific Northwest National Lab	ArcelorMittal	**Consortias**
University of Illinois	Nucor Steel Corporation	Auto/Steel Partnership
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	ThyssenKrupp USA	

Proposed Future Work

- For the period February 2013 – September 2013
  - Define 3GAHSS constitutive material parameters using BAO QP980 steel as a baseline
  - Outline ICME framework using defined input/output parameters for each material length scale model
  - Propose initial 3GAHSS microstructure
  - Provide 3GAHSS vehicle assembly design and performance information

- For the period FY 2014
  - Determine process for making experimental 3GAHSS heats
  - Pour and roll experimental 3GAHSS heats
  - Use experimental 3GAHSS coupons to validate and/or refine computer models
  - Begin Task 5 Design Optimization process using initial 3GAHSS material properties with increasing emphasis on Task 4 Assembly
  - Increased emphasis on Task 3 Forming using 3GAHSS experimental heats
  - Continue Task 6 Integrate to integrate material computer models

Summary

- The ICME 3GAHSS project was launched on February 1, 2013.

- Accomplishments in the first two months of the project consist of launching the project, holding a kick-off meeting, establishing technical teams and coordinating the communication between project participants

- The project is highly leveraged with notable participants from the Department of Energy, NETL, academia, a national lab, and the automotive and steel industries.