

# National Network for Manufacturing Innovation: The Lightweight Modern Metals Manufacturing Institute

**Model-Based Enterprise Summit**

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# Manufacturing Innovation Institutes: Putting America at the Forefront of 21st Century Manufacturing

- The newest addition to the National Network of Manufacturing Innovation (NNMI).
- The LM3I Institute team, headquartered in the Detroit area and led by the American Lightweight Materials Manufacturing Innovation Institute (ALMMII).
- ALMMII brings together > 80-member organizations that pair the world's leading aluminum, titanium, magnesium and high strength steel manufacturers with universities and laboratories pioneering new applied technology development and research.



White House award announcement 2/25/2014



# What is Lightweighting?

- Lightweight materials enable reduced weight of a product, component, or system while maintaining or enhancing performance, operational supportability, survivability and affordability.
- Weight reduction when executed efficiently, encompasses the early integration of design, development, and implementation of lightweight materials, component fabrication, assembly, joining, and other technologies as well as the capability to manufacture and produce such materials and components at reasonable cost.
- It has broad applicability to military and commercial sectors for transportation segments including small boats and large ships, light and heavy ground vehicles, rail, and aerospace.



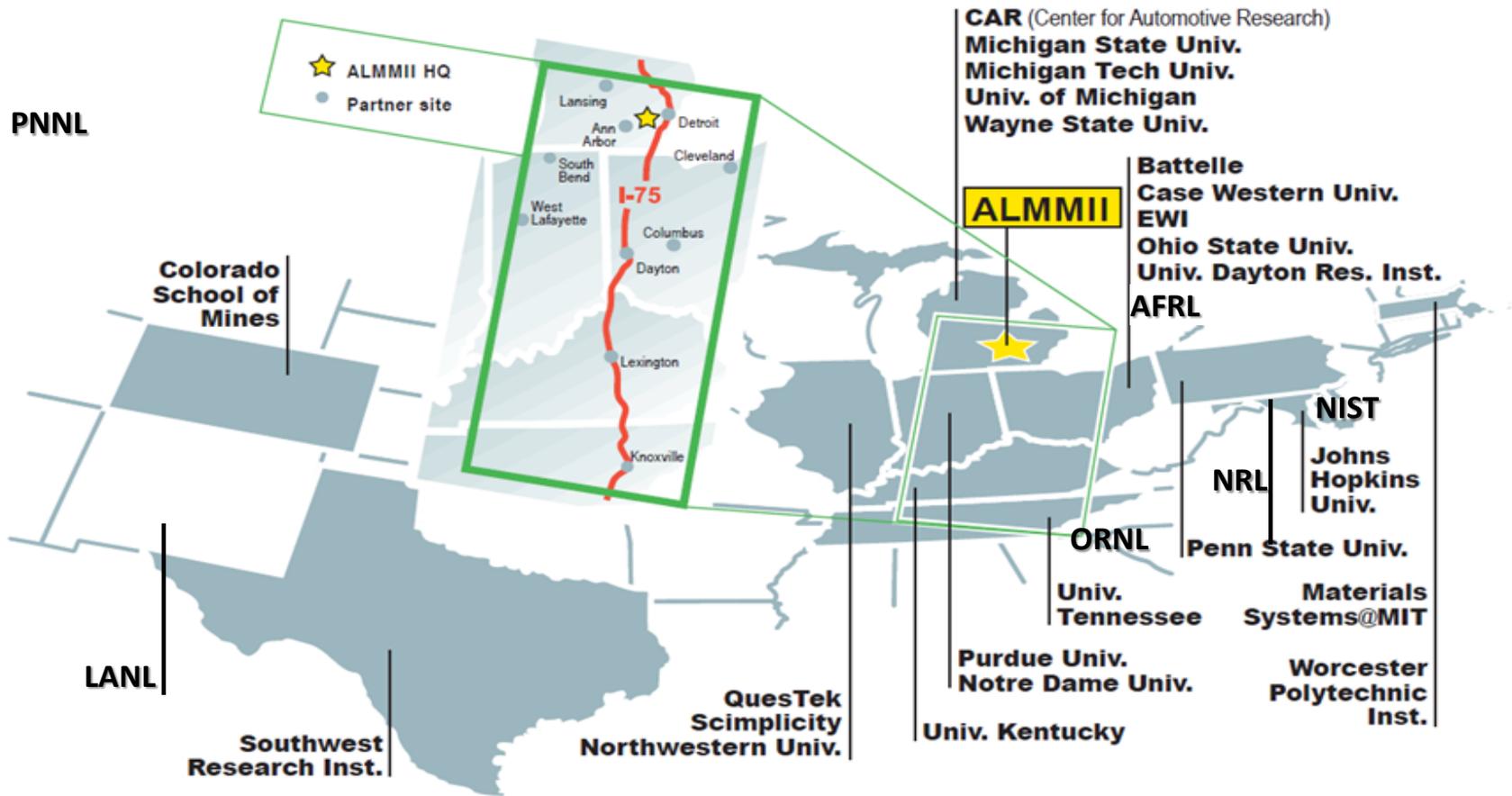
# Vision and Mission

**VISION:** Ensure that the United States is the world leader in the application of innovative lightweight metal production and component/subsystem manufacturing technologies.

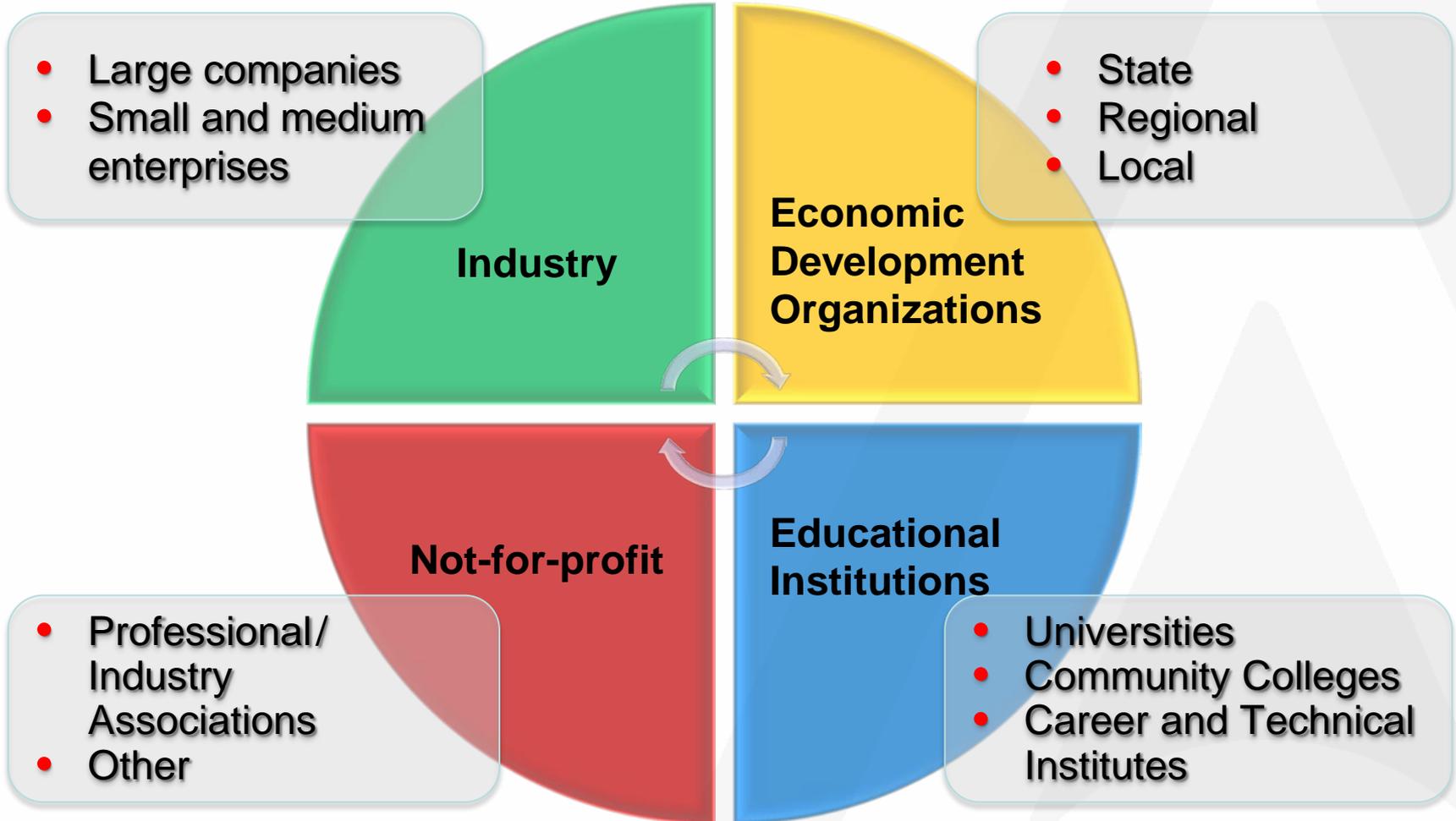
**MISSION:** Serve as the nation's essential bridge between basic research and final product commercialization for lightweight metals. The Institute's world-class facilities and technology development capabilities provide the "right" solutions to promote American competitiveness, energy efficiency, defense readiness, and economic growth. Cutting edge resources prepare an eager workforce equipped with advanced manufacturing skills to enable U.S. industry to commercialize innovative manufacturing processes.



# Non-Industrial ALMMII Research Partners



# Partnerships are Essential



# Approach

ALMMII will focus on the total value chain for lightweight metals—***rapid development, qualification, optimized use, and commercialization of affordable lightweight structures*** for defense and commercial requirements.

ALMMII's bold approach includes:

- Early ***engagement of material designers, material suppliers, product designers, and the full manufacturing supply chain;***
- Employing ***systems engineering principles;***
- Developing innovative manufacturing processes in dedicated facilities with unparalleled capabilities;
- Using high-fidelity ***Integrated Computational Materials Engineering (ICME);***
- Developing a ***model-based, probabilistic toolkit for certification;***
- Supporting scale-up to commercial use; and
- Preparing an eager workforce equipped with 21st century advanced manufacturing skills.

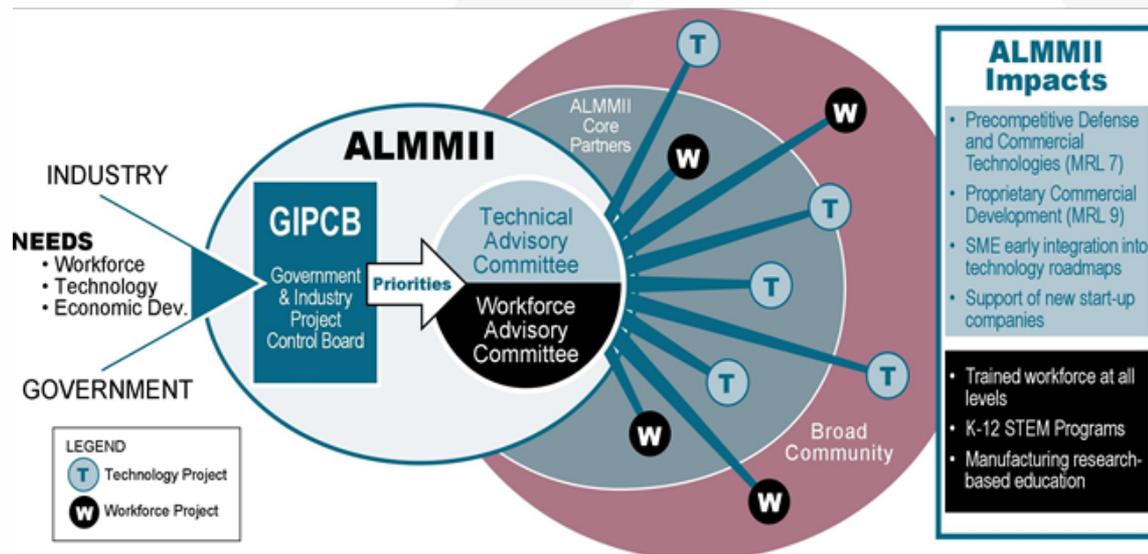
# Economic Impact

- ALMMII will have world-class capabilities and serve the metal production, metalworking, and casting manufacturing sectors across the nation, yet will have particularly strong regional impacts.
- ALMMII's regional focus will encompass an area that roughly follows the I-75 corridor from Michigan through Tennessee.
- With the concentration of metals producers and users in the ALMMII region, the economic impact will be significant (i.e., the 2011 census estimated that over 400,000 people were employed nationally in the metal stamping, metalworking, machining and casting industries with almost half of the metalworking jobs located in Michigan, Ohio and Indiana).



# Technology Transition

- Technology Transition is central to ALMMII's strategy, and is absolutely essential to realize the widespread defense, economic and industrial base impacts expected from the LM3I investment.
- Priorities for ALMMII will be defined by technology, workforce, and economic development needs for defense and commercial industrial sectors, with particular focus on transportation requirements.
- ALMMII will bring together government, industry, non-profits and academia to deliver workforce and technology development programs.
- Workforce projects will create a pipeline of talent capable of adopting the developed technologies.



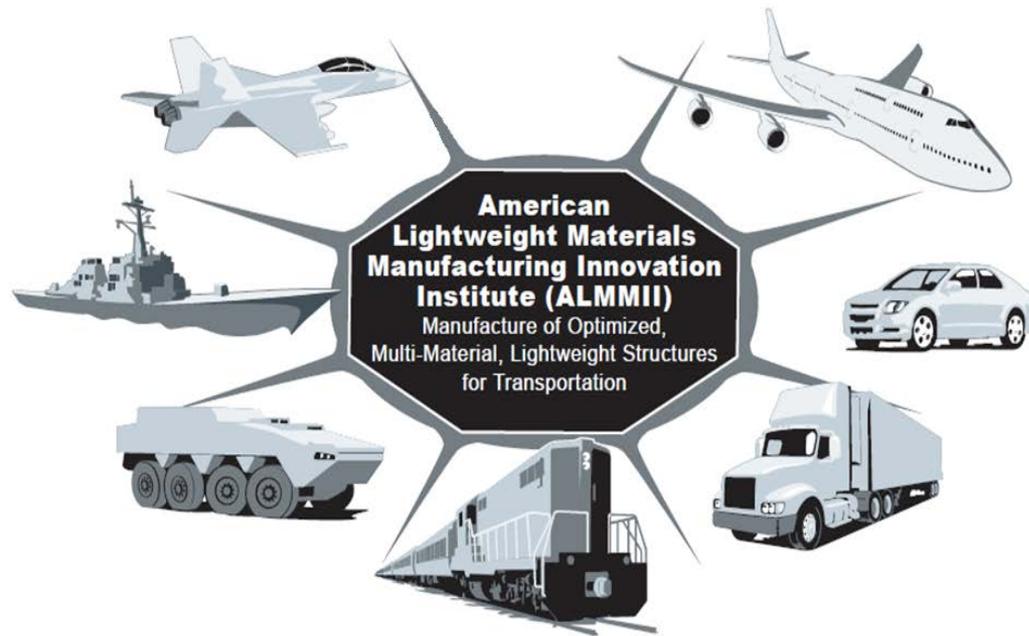
# Education / Workforce Development

- Integrative education, training, and workforce development is core, sustained aspect of ALMMII mission.
- Total effort is focused in five areas:
  - (a) K-12 STEM; (b) Community Colleges; (c) 4-year College and Graduate Programs; (d) Continuing Education; and (e) Workforce Development
- ALMMII will apply locally relevant economic development approach that connects to the larger, industrially driven National Network of Manufacturing Institutes and National Certifying Bodies.

## *Education Target:*

**K-12 STEM | Vocational Schools | Community Colleges |  
Workforce Development and Training | Universities | Adult  
Continuing Education and Professional Development**

# ALMMII Technology Portfolio Planning



- **ALMMII is building a technology portfolio serving the military and commercial industrial sectors**
- **Technology project portfolio developed from ideas submitted by all partners:**
  - **Academia, Federal & National Laboratories**
  - **Non-Profit Laboratories**
  - **Industry**
- **Projects prioritized by large Industry partners with input from government agencies to ensure commercialization plans are in place**

# ALMMII Technology Portfolio Planning

## TECHNOLOGY PILLAR AREA COORDINATION STRUCTURE

LIGHTWEIGHT METALS: AHSS, Al, Ti, Mg		PRIMARY METAL AND COMPONENT/SUBSYSTEM FABRICATION						
		Melt Processing	Powder Processing	Thermo-mechanical Processing	Agile, Low Cost Tooling Processing	Coatings	Joining & Assembly	
SUBSYSTEM DESIGN & FABRICATION	TOOLS & METHODS	ICME						
		Design						
		Validation/ Certification						
		Cost Model						
		Supply Chain						
		Life Cycle Analysis						
	FOCUSED PERFORMANCE AREAS	Corrosion						
		Ballistics / Blast						



# EXAMPLE PROJECT IDEAS

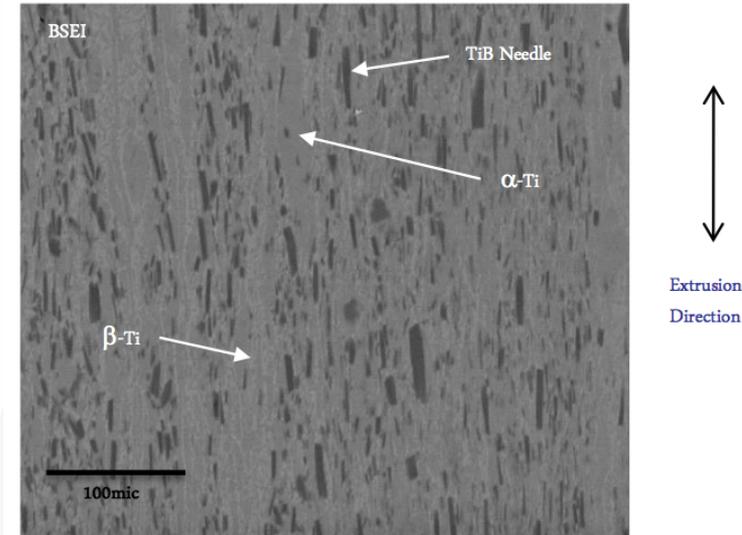
# Thin Wall Castings

- Large thin-wall castings offer part consolidation (compared with steel stampings) at reduced cost and energy consumption
- Thin-wall castings have improved mechanical properties and design flexibility (varying thicknesses)
- Significant Weight Reduction



# Fabrication of Submicron Reinforced Powder Metal Composites

- Mechanical alloying of Al metal matrix composites utilizing submicron reinforcement increases strength and eases challenges with fabrication compared to cast or standard powder blended MMCs.
- Use of submicron reinforcements in Ti, Mg, or Fe should increase material properties (strength and modulus) while decreasing density and improving downstream processability versus coarse reinforced metal matrix composites.
- The submicron reinforced materials with increased properties and reduced density enable dramatic weight savings for aerospace, automotive, and military applications.



**Ti-3Al-2.5V/TiB/10p Microstructure**

Material	Density g/cm <sup>3</sup> (lbs./in <sup>3</sup> )	E GPa (msi)	0.2 % YS MPa (ksi)	UTS MPa (ksi)	Strain to Fail (%)	Fatigue Strength (R=-1) MPa (ksi)
Ti MMC	4.48	142 (20.6)	1130 (164)	1270 (184)	5	725 (105)
Ti-6Al-4V	4.43	114 (16.5)	900 (131)	1000 (145)	12	550 (80)

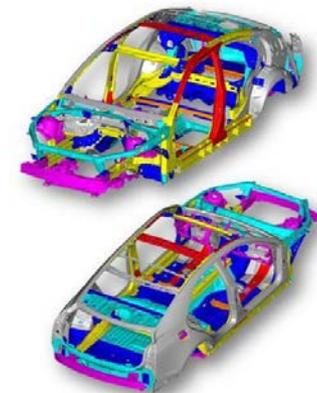
# Third Gen Advanced High Strength

## Applications of the Technology

- Third Generation Advanced High Strength Steels (3GAHSS), i.e. high strength sheets steels with excellent formability, have been developed for automotive applications
- High strength sheet steels can be used for IED blast protection and for lightweight structural designs in a variety of transportation vehicles.
- Alloying and processing concepts can be extended to production of heavier thickness plate products with essential combinations of strength and toughness for applications beyond light vehicles.

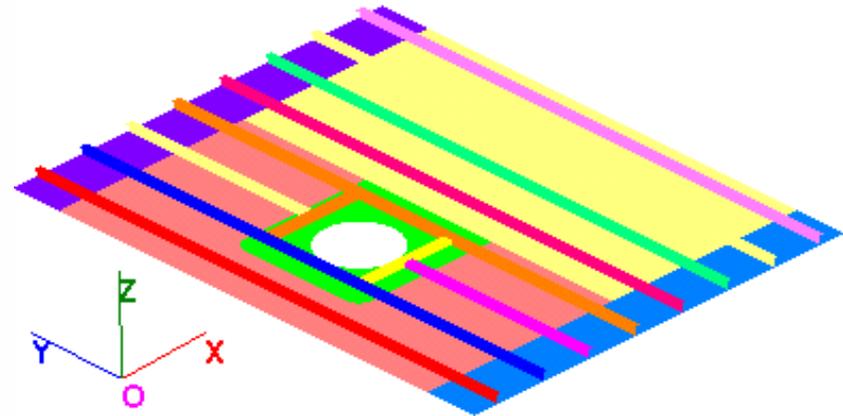


AHSS application in car bodies



# Distortion-Free Construction of Lightweight Stiffened Panels

- **Modern stiffened panel designs using high-strength thin steel plate with welded thick “insert” (similar to TWB in auto industry) have become widely used in new generation surface combatants for achieving increasingly stringent requirements in:**
  - Lightweighting
  - Improved blast performance and structural life, and reduced total ownership costs
- **Conventional welding/assembly methods failed miserably:**
  - Severe buckling distortions
  - Drastically increased rework/construction costs
  - High residual stress related concerns over structures' fitness for service



# Technology Project Portfolio Development Status

- Technology development project ideas collected from industry and research partners
  - Research Partner Workshop to clarify submissions
- Institute Technology Leader Workshop to Prepare Ideas for Industry / Government Prioritization Workshop
  - Ideas vetted for metals processing scope and MRL level
  - Ideas integrated where possible
  - 30 Ideas selected for Industry/Government Workshop
- Silver & Gold Industry / Government Prioritization Workshop
  - Project ideas reviewed by pillar processing area
  - Polling of participants to gage interest/intent to work on project ideas
  - Subsequent confirmation of industry priorities
- IPCB / IPT Review
  - Prioritized 13 project ideas → White Papers → Full Work Plans

# Headquarters Facility

- Selected building near downtown Detroit (Corktown area) for HQ facility – 107,000sq-ft; began negotiations with letter of intent to lease (April 2014)
- Long negotiation process; lease signed July 22, 2014 followed with Detroit Mayor press conference July 23<sup>rd</sup>.
- Architectural drawings approved and light renovation activity began on August 11, 2014.
- All building permits received (zoning, structural, electrical, plumbing, mechanical) from City of Detroit to initiate full time renovation activity on September 24<sup>th</sup>.
- Planned ribbon cutting January 15, 2015



From This – First Visit (April 2014)



To This – In Progress (November 2014)