Award: DE-EE0007613

Partners: CMTC/NIMBIS/NCSU/PNNL/RPI/SRNL/TA&MU/UCLA/UWA

Project Period: 12/20/2016 – 12/31/2021

Presenter: Raymond Collett, CEO CESMII

U.S. DOE Advanced Manufacturing Office Program Review Meeting

Washington, D.C. - June 13-14, 2017

Overview

- Project Objective
- Technical Innovation
- Technical Approach
- Transition & Deployment
- Measure of Success
- Project Management & Budget
- Results & Accomplishments
- Questions

Project Objectives

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- Smart Manufacturing will become the norm in U.S. manufacturing to allow for interoperability and ease of replication & re-use resulting in **reduced energy consumption and increased energy productivity**
- Smart Manufacturing will enable a common platform to drive manufacturing towards integrated toolsets and capabilities where data is an asset to empower real-time decision making.
- The project will utilize an integrated approach of advanced sensors, controls, platforms, and modeling across a diverse portfolio of Applied Research Test Beds to achieve critical mass for wide spread SM adoption
- **What are you trying to do?**
  - Enable smart manufacturing platform, based on an open-standards and open-source framework, to enable plug and play connectivity to enable Information Technology (IT) and Operations technology (OT) – IT/OT integration
  - Enable Smart Manufacturing to become the driving, sustainable engine that delivers real-time business improvements in U.S. Manufacturing
  - Enable rapid technology adoption to increase energy efficiency, energy productivity, and job growth
- **What is the problem?**
  - Industry (small, medium, and large) struggles with the inability to obtain, view, and act upon critical data from manufacturing processes.
  - There is no agile infrastructure that integrates sensors, modeling and control technologies through a vendor-agnostic platform, and marketplace of solutions and opportunities, that works with your existing infrastructure and supply chains.
- **Why is it difficult?**
  - Lack of interoperability among all solutions preventing replication and re-use
  - Current solutions are vendor specific
  - Small and Medium companies currently don't have in house expertise engage smart manufacturing

Technical Innovation

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- **How is it done Today?**
- Over the last 20 years, evolving improvements in sensors, controls, modeling, and IT systems have been incorporated into manufacturing to provide continuous, incremental improvements in efficiency and output
- Advanced sensor, control, platform, modeling, and optimization technologies are gradually being adopted in manufacturing operations, but the focus on optimization of individual operations does not capture the full performance impact available across the process with these technologies. This impedes ROI and constrains the responsiveness of manufacturing operations to dynamic market demands.
- **What's new in your approach, and why do you think it will be successful?**
- Leverage an integrated framework focused on the ability to act in real-time would facilitate the development and adoption of advanced sensors, controls, platforms, modeling, and optimization technologies.
- To achieve its goals, the Institute will focus on three core enabling approaches that will amplify the applied research and accelerate adoption potential, impact, and effectiveness of each advanced manufacturing technology area, both at the singular and system level. These core approaches are:
    - Broad Regional Network: Regional Centers throughout the U.S., interlinked to address and share local and national opportunities and resources to create a powerful force of on the ground for innovation, knowledge and technology transfer, and workforce development
    - A diverse portfolio of Test Beds: Test Bed simulations and actual operation in full scale environments will quantify the benefits of new technologies and the power of their integration, ultimately driving down the cost, time, and risk of early adoption
    - An open software architecture platform and marketplace (SM Platform and Market Place): The SM Platform is a set of cloud services that integrate a marketplace of resources and services. Offering an open platform for tool integration, the SM Platform will allow users to integrate the components required to assemble customized SM systems, and train the workforce in a full scale Test Bed environment. The advances in cloud computing, edge computing, and smart sensors and actuators will enable OEMs and SMEs to reduce the cost of implementing smart manufacturing systems significantly
- The regional centers provide access to small, medium, and large businesses by directly engaging with the manufacturing community in each region in the areas of R&D, workforce development, and an infrastructure for Test Beds

Technical Approach

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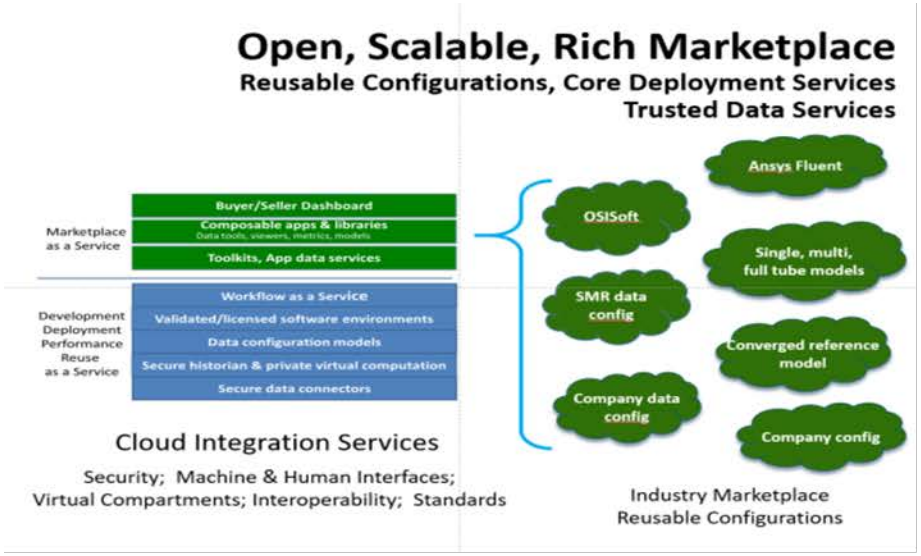
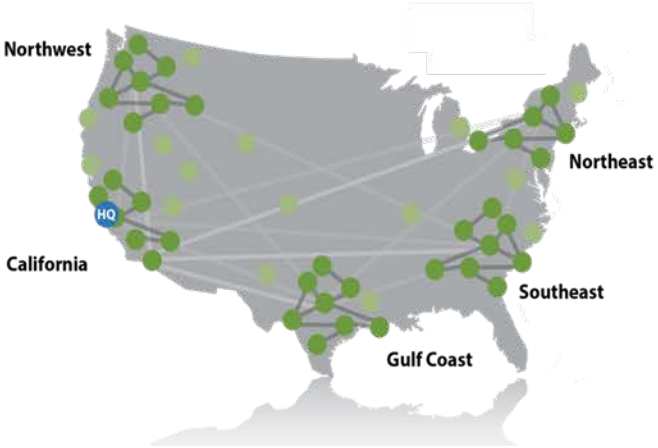


What is the technical approach for the project?

- Develop and demonstrate an open architecture Smart Manufacturing (SM) Platform and Market Place that starts at the shop floor optimizes equipment and processes through advanced sensors, controls, platform, modeling, and high performance computing and optimization technologies
- Leverage extensive application of real-time, sensor-driven enterprise data analytics, modeling, optimization and metrics
- Accelerated development, deployment and reuse of smart data-driven, new applications and multivendor system applications to contextualize the data so that real time decisions can be made with all the complex operations occurring in processes

- **Address participant roles and responsibilities:** Beginning with the initial and now adding to the CESMII proposal team that we are now in close discussions with to drive value for them and transition to membership include: 95 industry, 53 academic and research institutions, 8 national labs, 19 local and state organizations, 21 associations, All across 31 states, they will guide the development and test bed areas to insure broad base impact as well as support the development of the technology roadmap
- **Risks, unknowns, unique execution attributes:** There is no agile open infrastructure that integrates sensors, modeling and control technologies through a vendor-agnostic platform, and marketplace of solutions and opportunities, that works with existing manufacturing infrastructure and supply chains. This solution set will provide a unique solution set to expand the types of solutions and benefits that can be developed using full scale test beds for broad base adoption



Technical Approach

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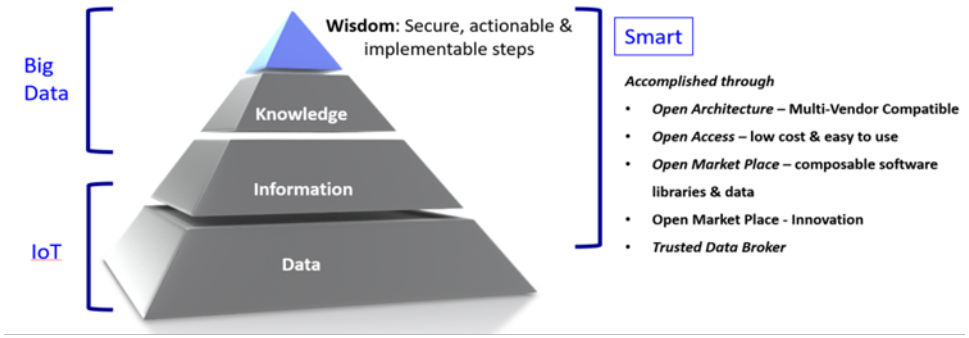
What's the difference?

What is the technical approach for the project? The industry Test Bed enables complement of full scale Test Beds that target the CESMII objectives and the following selection factors:

- A diverse set of industry sectors with cross-cutting challenges
- Energy intensive and energy dependent manufacturers
- Significant energy impact targets and scalable impacts
- Small, medium and large manufacturers ensuring participation of women, underrepresented minorities and veterans
- Continuous, batch and discrete manufacturing structures
- Smart System Applications involving significant real-time data, and multiple uses of sensors, controls, models, and platforms, including the SM Platform
- Support of embedded and new workforce development tools
- Support of synergistic partnership agreements between societies, associations, and regional manufacturing diversity

The table to the right illustrates a typical progression of SSA development and the projected benefits as the use of more data and comprehensive models results in continuous improvement in energy productivity



Factor	Year 1	Year 2	Year 3	Year 4	Year 5
Decrease First of a Kind SSA D&C Cost/Risk	25%	30%	35%	40%	50%
Accelerated D&C Outcomes	2 years to 1 year	+5% faster	+10% faster	+15% faster	+20% faster
Decrease Replication SSA D&C Cost/Risk		60% first replication	65% multiple replications		
Energy Productivity Increases – Baseline (No control)	0–5 % Simple decision model	5–10 % Extended model	10–15 % Controls integration	15–20% High fidelity modeling	±25% Prediction, new operations

SSA: Smart System Application
D&C: Development & Configuration

Technology and Knowledge Transfer

(Template request: Transition & Deployment)

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- **Who Cares? Who is the end user?** Virtually any manufacturer Small/Medium/Large can use SM Systems and Technologies to improve energy and operational productivity in discrete/batch/process facilities
- **Does it improve their mission/capabilities?** Yes, it enables Smart Manufacturing to become the driving, sustainable engine that delivers real-time business improvements in U.S. Manufacturing and reduced energy consumption. As a result rapid technology adoption will increase energy efficiency, productivity, and job growth
- **What is the commercialization approach?** To build an institute that is member driven and focused on producing valuable applied research and test beds that produce demonstrable results that will be pulled into the market by end users once commercialized
- **Who Cares? Who is the end user?** The RMC network structure of CESMII makes it possible to build a vibrant and extensible network of regional and national activity and capability. Beginning with the initial and now adding to the CESMII team at the proposal stage was comprised of the following team members showing active cross market engagement:
  - 95 industry
  - 53 academic and research institutions
  - 8 national labs
  - 19 local and state organizations
  - 21 associations
  - All across 31 states
- Active membership activities are in process

Technology and Knowledge Transfer

(Template request: Transition & Deployment)
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- **What is the technology sustainment model?**
- The SM Platform enables extraction of real-time, operational data from manufacturing, systems, processes and supply chains for new applications, capabilities and toolkits using existing infrastructure. **This opens opportunities that are not easily achieved in the current model of taking an application to the data.**
- By lowering infrastructure and deployment costs, the SM Platform will provide a vehicle for new innovations and adoption opportunities. Capital investments formally used for infrastructure are now available for Smart System Application development
- Opportunities are now possible to use real-time sensor, control, modeling, and optimization technologies in a unified, systems integrated environment greatly accelerating use and change.
- Importantly, the SM Platform is being developed as an industry driven infrastructure that offers:
  - Open architecture: vendor agnostic, standards based integration and interoperability with commercial and open source platform technologies.
  - Open access: low cost access to SM Platform technologies
  - Open Market Place: open access to composable, market driven commercial and open source application libraries including data management, modeling, analytics, and metrics
  - Trusted data broker: secure, owner managed data exchanges that can also be managed to meet regulatory requirements and business agreements for both private and public uses

Measure of Success

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"when we are successful, then Smart Manufacturing IS the standard for Manufacturing in 2030"

If you're successful, what difference will it make? What impact will success have? How will it be measured?

- CESMII has objectives and metrics in the following areas:
  - Lead a National Effort to develop, test, and widely deploy SM
  - Support SM RD&D infrastructure to provide capabilities for and collaboration in open, pre-competitive work among multiple parties
  - Be financially self-sustaining
  - Establish a technical education and workforce development program that leverages Regional Network
  - Develop a roadmap for SM technologies that is regularly updated
  - Stimulate the growth of a SM domestic supply chain
  - Demonstrate the participation of underrepresented groups in CESMII

What is the potential energy impact? Economic impact?

- Energy savings were estimated conservatively at 12.5% for each of first 5 years with steadily increasing market penetration of CESMII's SM technologies to 5 % by year 5. In years 5 through 10, energy savings of 20% were assumed with market penetration steadily increasing from 5% to 15%.
- These assumptions are based on direct results from current Smart Manufacturing Leadership Coalition, and information provided by industry partners. During the first 10 years of operation, over 2,100 TBtu of energy can be saved by CESMII's actions, which will create energy savings of $195 billion [sources for calculations cited below]

[1] U.S. Manufacturing Energy Use And Greenhouse Gas Emissions Analysis (http://www.energy.gov/sites/prod/files/2013/11/f4/energy_use_and_loss_and_emissions.pdf)
[2] 2010 consumption trended to 2017 using Energy Information Administration (EIA) annual growth factors from Annual Energy Outlook (AEO) 2013 and AEO 2015. 2017-2026 growth uses industry-specific annual growth factors from the AEO 2015
[3] U.S. Manufacturing Energy Use And Greenhouse Gas Emissions Analysis (http://www.energy.gov/sites/prod/files/2013/11/f4/energy_use_and_loss_and_emissions.pdf)
[4] Annual energy savings multiplied by EIA AEO 2015 industrial sector annual average energy prices and cumulated

Project Management & Budget

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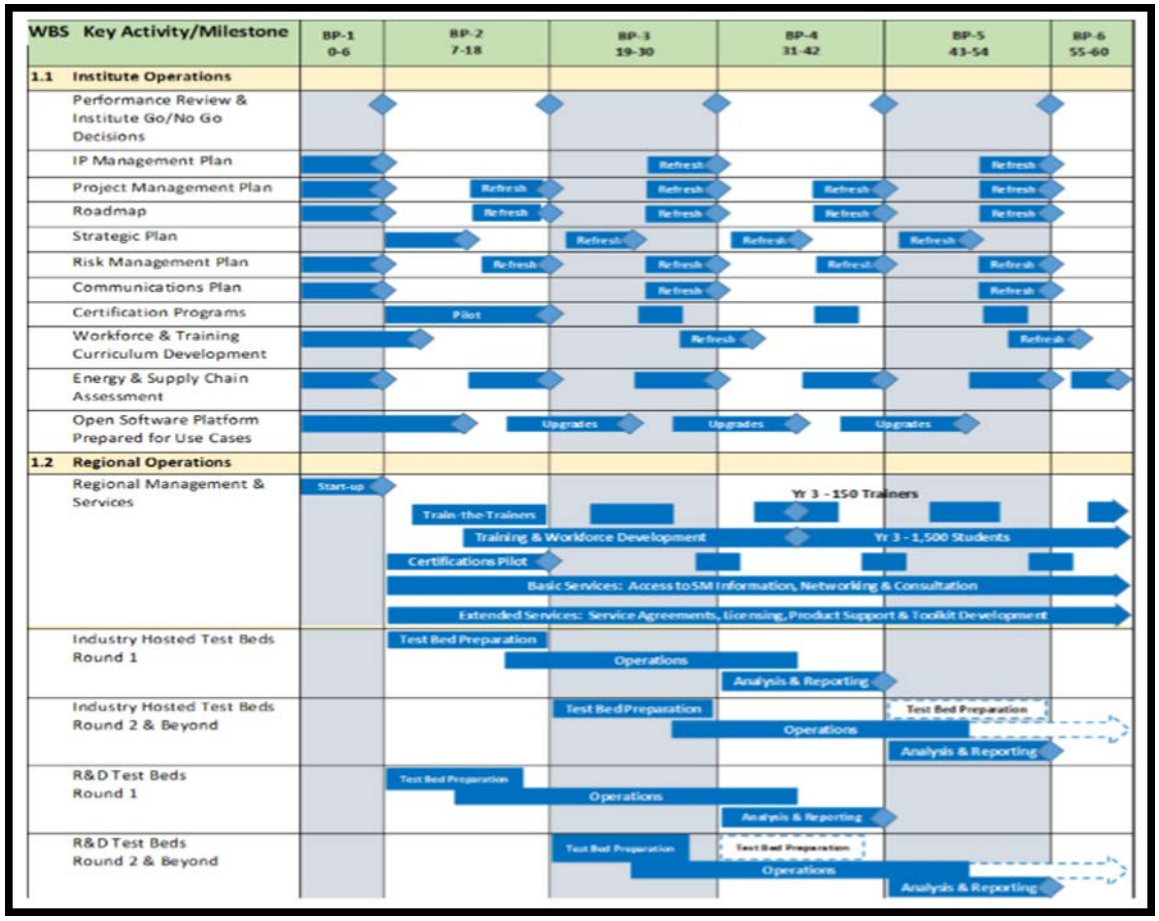

Total Project Budget 12/20/2016 – 12/31/2021 Progress measured in Budget Period using the Project Management Plan (per assistance agreement DE-EE0007613)	
DOE Investment	$69,486,838.00
Cost Share	$170,655,303.00
Project Total	$240,142,141.00

Results and Accomplishments

Update: Where are we today?

Where are you in the project? Budget Period-1 Institute Launch

What milestones have you completed? On track with all Budget Period-1 Milestones

What accomplishments have been made to-date? What results do you have to report?

- Institute Formed, CEO & Interim Staff hired, Permanent Staff & RMC Transitions/Hiring in process
- Engaging with Membership for Outside-In input
- Offices Identified & moved into
- Multiple Institute Kick-off event(s)
- Early application projects being identified
- Value to Membership is the Foundation to their SUCCESS
- Initial Technology Roadmap and Strategic Investment Plan completion, to be refreshed each Budget Period

Describe work to be completed between now and the end of the project, as applicable

- National network of large scale application, RD&D, and full scale test beds
- Nationwide and continuous baseline testing and performance improvement tracking on test beds and advanced systems
- Fully available open architecture SM Platform and vibrant and growing marketplace
- Certification of SM people, products, and systems
- Workforce development, training, and tools for large scale utilization for new and existing workforce members in K-12, Community Colleges, Regional Manufacturing Centers, and other training locations
- Nationally & Internationally recognized roadmap for SM technologies that is regularly updated
- Vibrant growth of a SM domestic supply chain with active participation of underrepresented groups