The HPC4Mfg Program

Lawrence Livermore National Laboratory, Lead
Sept 2015 - Present

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U.S. DOE Advanced Manufacturing Office Program Review Meeting
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June 11-12, 2019

Overview of the High Performance Computing for Manufacturing (HPC4Mfg) program

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Program Goals

- Bring the power of DOE HPC resources to industry
- Solicitation process used to select projects

Timeline

- Program initiated September 2015
- Projected End: Ongoing

Budget

- Approximately $6-7M in projects/year
- 20% cost share required from industry projects
- Additional funds for summer student program
- Approximately 10-15% in management and outreach costs

Barriers and Challenges

- Industry is concerned about intellectual property and building trust between laboratories and industry takes time
- Alignment between industry priorities and DOE priorities is sometimes challenging

Partners

- Principal Laboratories: LLNL, ORNL, LBNL
- All DOE labs eligible to participate
- Industries that have manufacturing facilities in the United States are eligible to participate

AMO MYPP:

- Advanced Sensors, Controls, Platforms and Modeling for Manufacturing

Program Objective

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- Objective: Use national laboratory High Performance Computing capabilities to help industry meet the objectives of AMO mission areas in energy reduction.
- Benefit: Facilitate innovation by short-cutting the Edisonian approach.
- Problem: Industry is lagging in HPC adoption
  - Industry has difficulty estimating the return on investment of computational capabilities and therefore is reluctant to invest in HPC computers
  - Industry often does not have the talent needed for use with new computer architecture
  - Industry often does not have the technical talent when going into new areas

Program Approach: The HPC4Mfg Program issues solicitations to elicit industry challenges

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- Showing what is possible with HPC through demonstration projects
  - AMO funds < $300K to laboratories
  - Industry funds at least 20%; either in-kind support or optional cash contribution
  - We match laboratory researchers with industry so they do not have to know the labs to participate
- Encouraging the adoption of HPC through follow-on projects
  - AMO funds < $300K to laboratories
  - Industry funds at least 50%; at least half of which is a cash contribution
  - Project duration: one to two years
- Building the HPC Manufacturing community
  - Technical Colloquium webinars
  - Student intern programs

Program Approach: The solicitation topics directly align with AMO goals

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Broad impact on energy efficiency and/or productivity:

- Use HPC to overcome a key technical challenge
  - Process optimization
  - Advanced product design
  - Predicting performance and failure rates

Results of this program can help companies justify computational expenditures

- Companies have a hard time with ROI calculations on computational effort
- Traditional experimental methods are more easily understood
  - Experiments are expensive and limit innovation
- This program help “buy down” risk of computational effort

In both cases, projects need to articulate the national scope of impact of a successful outcome and how HPC uniquely contributes to that outcome

Program Approach – Solicitation process

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FEDBIZOPPS.GOV Federal Business Opportunities

Engage industry

Industry submits challenges

Match challenge to PI

AMO approval; Feedback to industry

Sign agreements

Concept paper → Full proposal → Award

Technical Review Committee

Inform industry

Technical Merit Review Committee
- Partner labs and AMO representatives
- Heavy focus on **nation-wide** impact to energy efficiency and clean energy technology industry-wide

Execution streamlined through the required use of the DOE short form

Program Status: The HPC4Mfg Program is in steady state

March – September 2015

Launch program with seedling projects

- LLNL established the program
- $1.5M: 5 seedling projects
- Industry outreach

September 2015–March 2016

Inaugural solicitation

- LBNL, ORNL join as partner labs
- $3M solicitation: 10 demonstration projects to 8 companies

March 2016 -

Steady state

- Solicitation twice a year
- Demonstration/Capability projects
- Summer internships
- Workshops, Industry Engagement Day
- Added participating laboratories: ANL, NREL, NETL, SNL, NETL

- *Compute resources from across the DOE complex*
- *Student internship programs*

Program Results: Three solicitations have been released since the last review

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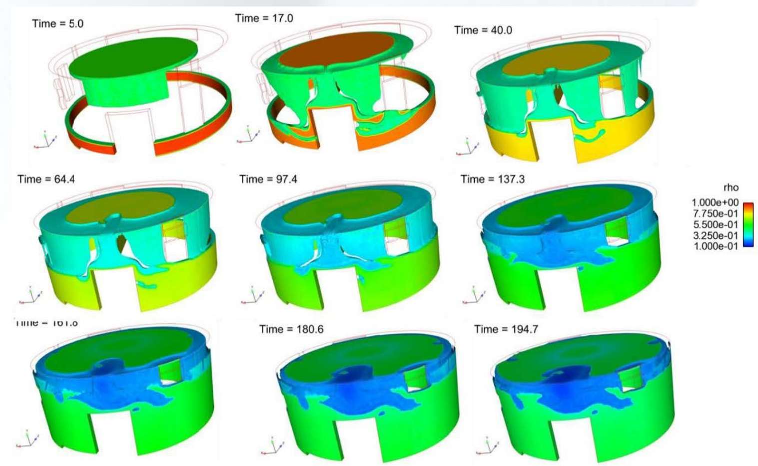
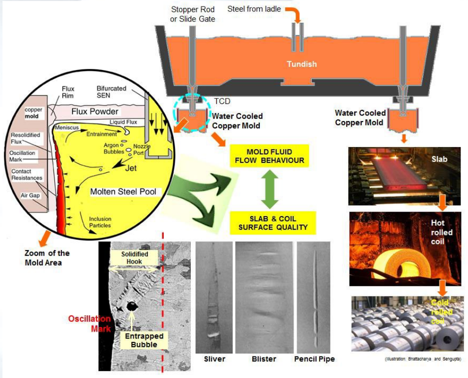
- Round 6
  - Special solicitation for Steel and Aluminum
  - 58 concept papers; 24 full proposals
- Round 7
  - Co-listed with HPC4Materials
  - 55 concept papers, 26 full proposals
- Round 8
  - Co-listed with HPC4Materials and HPC4Mobility
  - 25 concept papers under review



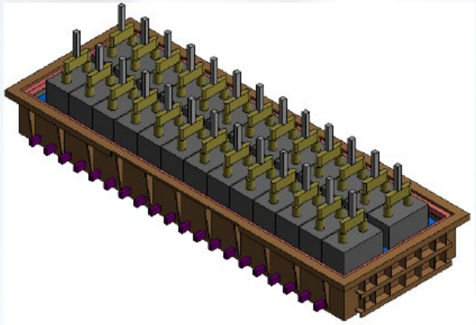
Program Results: The Round 6 projects selected are aligned with AMO goals

US Steel – Hot Rolling Process Optimization



ArcelorMittal – Reduced Defects in Steel

AK Steel – Improved Hot Rolling



Alcoa – Improved Aluminum Smelting Cell Design

We are seeing more interest in machine learning projects for process control, design of experiments, product optimization

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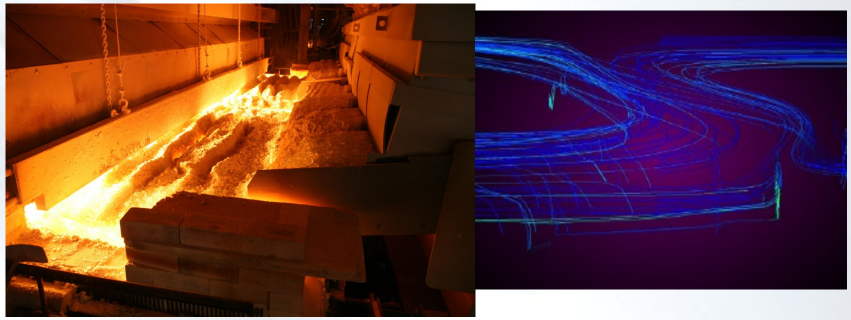


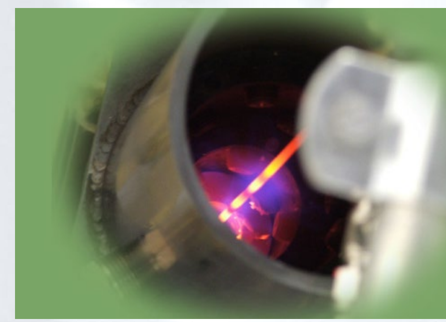
Vitro Glass –Furnace optimization : Use physics-based simulation as input data for ML reduced-order to reduce calculation time from 1 week to 1 minute

AK Steel – Hot roll process optimization

Use physics-based simulation as input data for ML reduced-order model for fast process optimization

Arconic – Design of Experiments – Casting

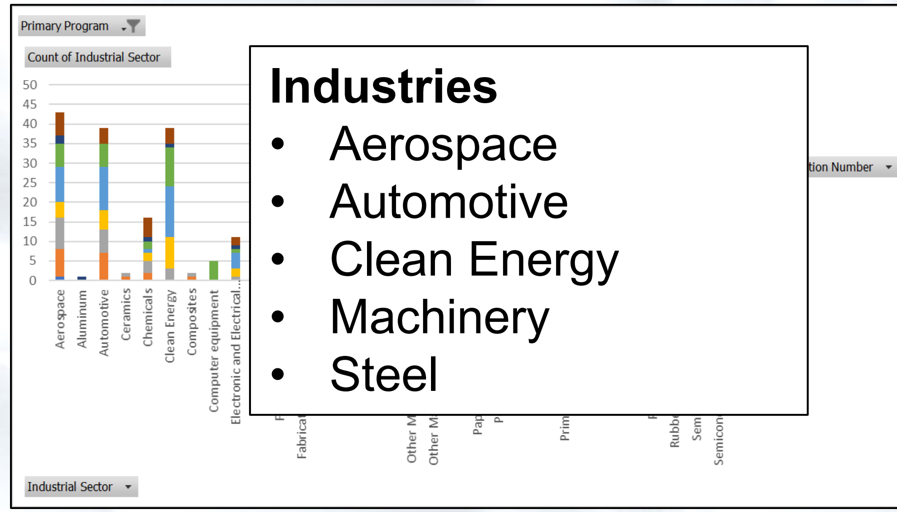
Use data from models and experiments as input to ML neural net to determine where additional experimental data is needed



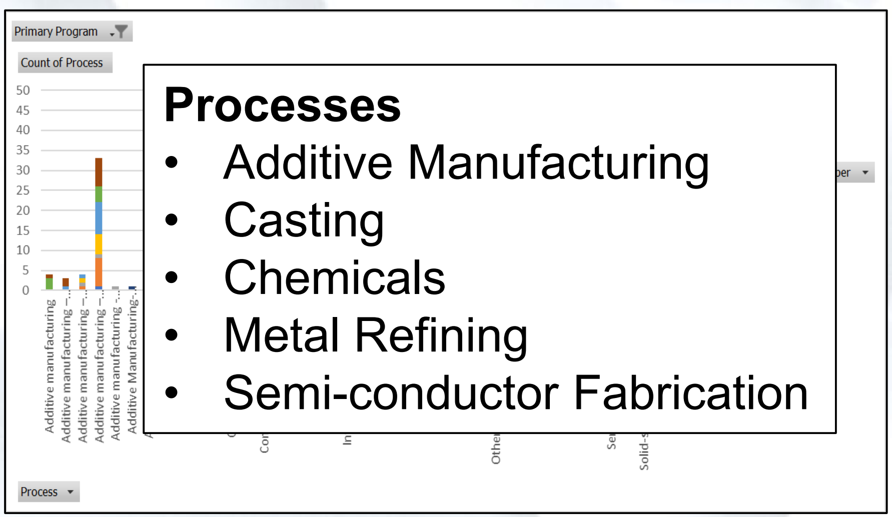
VAST Power Systems – engine design

Use CFD for data input into ML neural net to optimize flow parameters of an engine

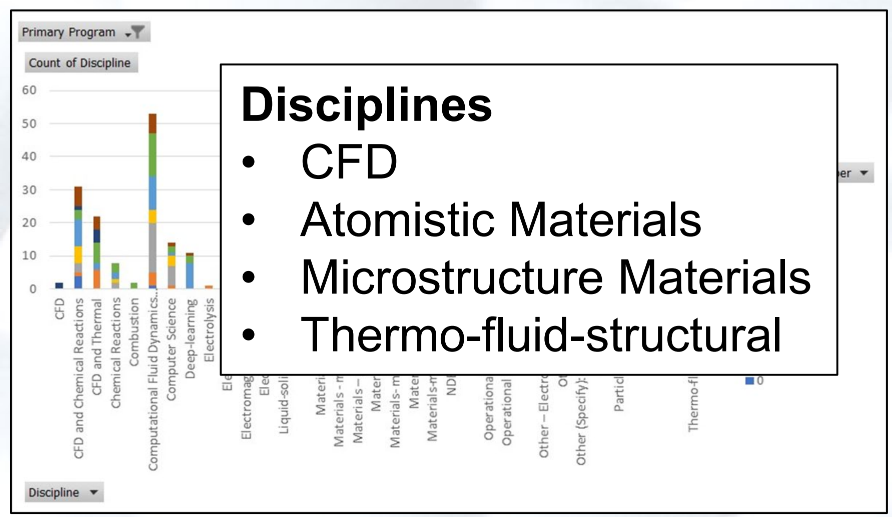
Results: Concept paper participation has been diverse in both geographic location and topic



Industries
- Aerospace
- Automotive
- Clean Energy
- Machinery
- Steel



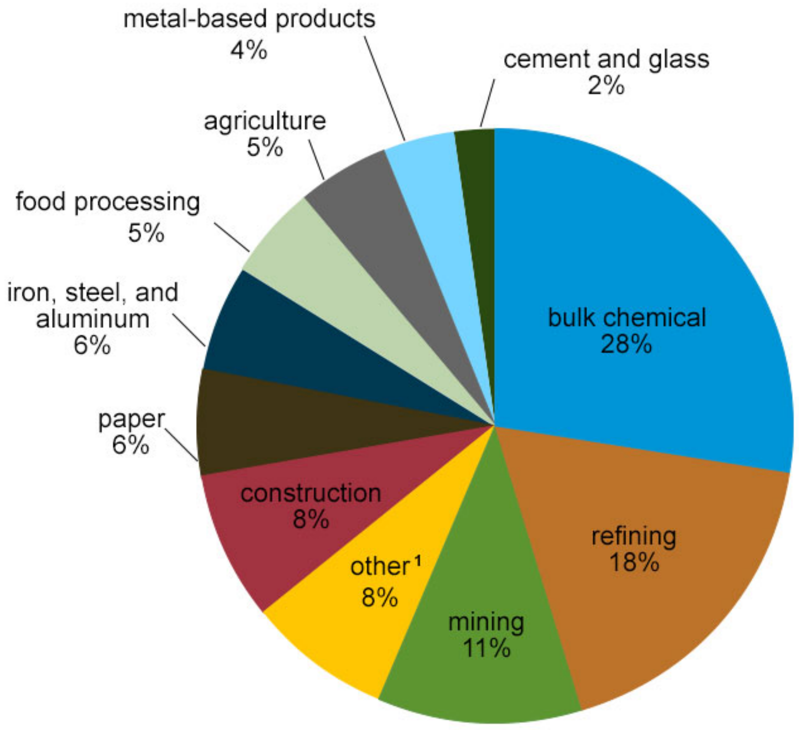
Processes
- Additive Manufacturing
- Casting
- Chemicals
- Metal Refining
- Semi-conductor Fabrication



Disciplines
- CFD
- Atomistic Materials
- Microstructure Materials
- Thermo-fluid-structural

Large energy consuming industries in our portfolio

U.S. industrial sector energy consumptiony by type of industry, 2017



Note: Includes electricity purchases and energy sources used as feedsctocks for making products. [1]*Other* includes wood products (1%), plastics products (1%), and all others (6%).
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*, Tables 25-35, February 2018

Chemicals	3
Petroleum Refining	2
Glass	3
Paper and Allied Products	4
Primary Metal - Al	5
Primary Metals - Steel	8
Food Products	1
Total	26

Program Innovation: Webinar outreach events

- On-line technical colloquiums are inexpensive ways to engage industry partners
- Manufacturing Day Web Event (October 5,2018)
  - 4 talks
    - Program Overview
    - Machine Learning an Vitro Glass
    - Membrane Design – 2 talks
  - 2 Panels of 4 speakers each
    - Additive Manufacture
    - CFD projects
- Machine Leaning Seminar
  - 3 Overview talks
    - Program overview
    - Machine learning applications
    - Machine Learning basics
  - 3 talks on material design
  - 1 talk process design
  - 2 talks on mobility systems
  - 1 talk on error in predictions

Transition

- Demonstration projects are expected to show the potential of HPC to improve manufacturing processes
- Follow on projects can be requested
  - Must move the technology closer to operation/ deployment
  - Higher cost share requirement showcases company commitment
- Possible transition paths for HPC4Mfg projects
  - HPC technology incorporated and run in-house
  - Follow on CRADA with national lab to continue work
  - Use of external commercial software/cloud computing

If HPC4Mfg is successful…

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- The development and deployment of energy-efficient manufacturing is accelerated through funded projects
- HPC becomes a useful tool to a broad array of small, medium, and large companies in designing new products, reducing cost and energy consumption, accelerating time to market
- More collaborations between DOE labs and U.S. manufacturers are enabled increasing competitiveness
- Simulation capabilities at the DOE laboratories are improved

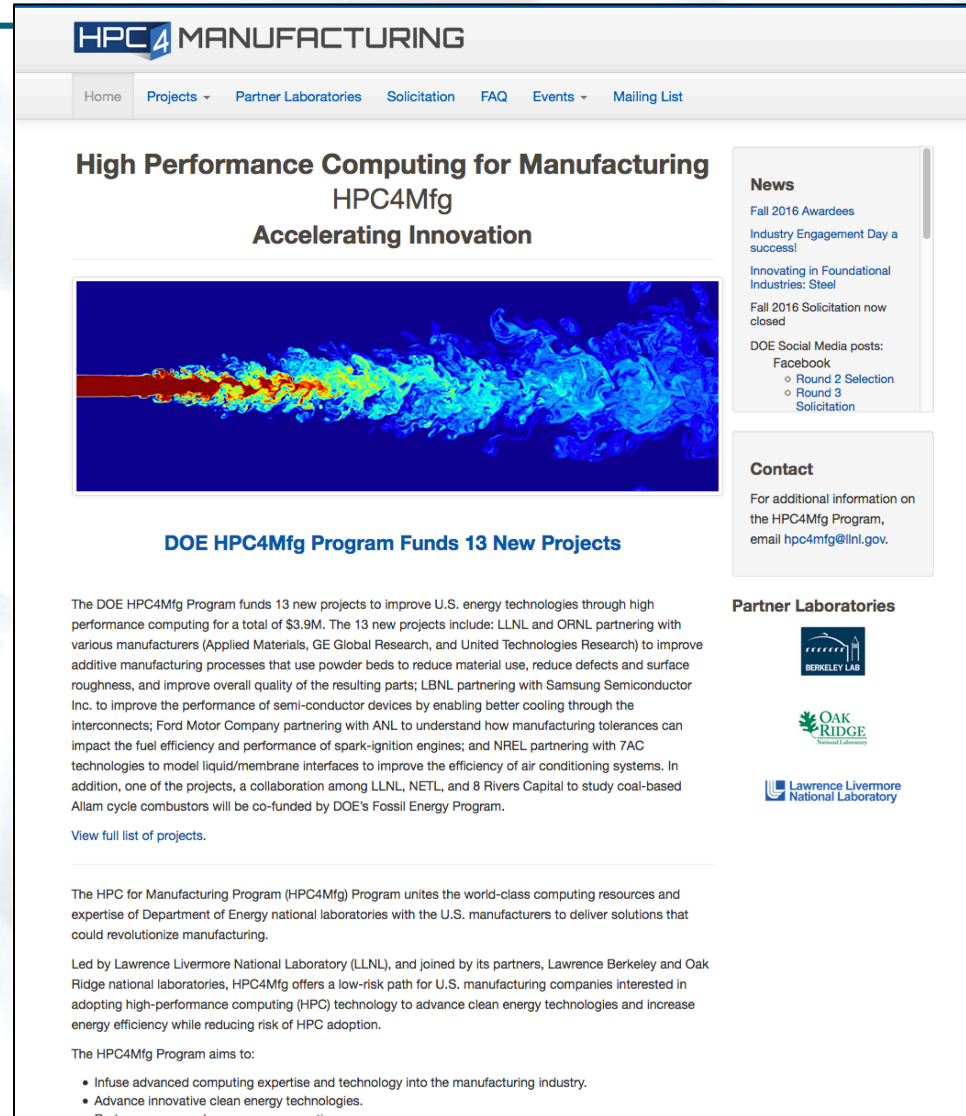
Questions?

Additional information at HPC4Mfg.org

Questions can be sent to HPC4Mfg@llnl.gov

Robin Miles, Director HPC4Mfg

Four HPC4Mfg posters on display at the reception give a sampling of technical projects



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Home | Projects | Partner Laboratories | Solicitation | FAQ | Events | Mailing List

High Performance Computing for Manufacturing
HPC4Mfg
Accelerating Innovation

DOE HPC4Mfg Program Funds 13 New Projects

The DOE HPC4Mfg Program funds 13 new projects to improve U.S. energy technologies through high performance computing for a total of $3.9M. The 13 new projects include: LLNL and ORNL partnering with various manufacturers (Applied Materials, GE Global Research, and United Technologies Research) to improve additive manufacturing processes that use powder beds to reduce material use, reduce defects and surface roughness, and improve overall quality of the resulting parts; LBNL partnering with Samsung Semiconductor Inc. to improve the performance of semi-conductor devices by enabling better cooling through the interconnects; Ford Motor Company partnering with ANL to understand how manufacturing tolerances can impact the fuel efficiency and performance of spark-ignition engines; and NREL partnering with 7AC technologies to model liquid/membrane interfaces to improve the efficiency of air conditioning systems. In addition, one of the projects, a collaboration among LLNL, NETL, and 8 Rivers Capital to study coal-based Allam cycle combustors will be co-funded by DOE's Fossil Energy Program.

View full list of projects.

The HPC for Manufacturing Program (HPC4Mfg) Program unites the world-class computing resources and expertise of Department of Energy national laboratories with the U.S. manufacturers to deliver solutions that could revolutionize manufacturing.

Led by Lawrence Livermore National Laboratory (LLNL), and joined by its partners, Lawrence Berkeley and Oak Ridge national laboratories, HPC4Mfg offers a low-risk path for U.S. manufacturing companies interested in adopting high-performance computing (HPC) technology to advance clean energy technologies and increase energy efficiency while reducing risk of HPC adoption.

The HPC4Mfg Program aims to:

- Infuse advanced computing expertise and technology into the manufacturing industry.
- Advance innovative clean energy technologies.
- Reduce energy and resource consumption.

News

Fall 2016 Awardees

Industry Engagement Day a success!

Innovating in Foundational Industries: Steel

Fall 2016 Solicitation now closed

DOE Social Media posts:
Facebook
- Round 2 Selection
- Round 3 Solicitation

Contact

For additional information on the HPC4Mfg Program, email hpc4mfg@llnl.gov.

Partner Laboratories

BERKELEY LAB

OAK RIDGE National Laboratory

Lawrence Livermore National Laboratory

Computer Resources: from start of HPC4Mfg program

Computer	Lab	Mc-h
Badger	SNL	1
Bebop	ANL	24
Blues	ANL	2
Cab	LLNL	38
CADES	ORNL	3
Clusters		5
Cori/Edison	LBNL	245
EOS	ORNL	30
Ghost	SNL	5
Mira	ANL	125
Peregrine	NREL	31
Quartz	LLNL	30
Serrano	SNL	10
Surface	LLNL	0
Syrah	LLNL	18
Theta	ANL	16
Titan	ORNL	182
Vulcan	LLNL	18
Total		**783**

- Average ~10M core-hours per project
- Total of about $20M in computational resources