HPC 4 MANUFACTURING

The HPC4Mfg Program

Lawrence Livermore National Laboratory, Lead
Sept 2015 - Present

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The HPC4Mfg program is designed to bring the many benefits of high-performance computing benefits brings many benefits to US Industry

- Accelerate innovation
- Lower energy costs
- Reduce testing cycles
- Reduce waste/reduce rejected parts
- Quality processes and Pre-qualify
- Optimize design
- Shorten the time to market

The HPC4Mfg program lowers the barriers to bringing the power of HPC to the manufacturing community

- **Industry Status**:
  - Some larger companies use HPC, but struggle to stay current
  - Few small to medium companies use HPC
- **DOE Status**:
  - DOE labs possess 5 of the top 10 HPC systems worldwide; 2 of top 4 in Graph500
  - Broad expertise in the application HPC
  - Can be a challenge for industry to understand the best way to partner with DOE

HPC4Mfg creates partnerships that leverage DOE lab expertise and compute resources to address critical problems in the manufacturing sector

The HPC4Mfg program is building an ecosystem to support HPC adoption by industry

- Showing what is possible with HPC through demonstration projects
  - AMO funds < $300k to laboratories
  - Industry funds at least 20% in-kind support w/ optional cash contribution
  - Project duration < 1 year

- Encouraging the adoption of HPC through capability projects
  - Execution mechanisms and funding source varies
  - Project duration: multiple year
- Building the HPC Manufacturing community
  - Industry Engagement Day
  - Student intern programs

Our unique approach to building teams helps ensure each project's success

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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

Inform industry

Concept paper → Full proposal → Award

Technical Review Committee

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

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

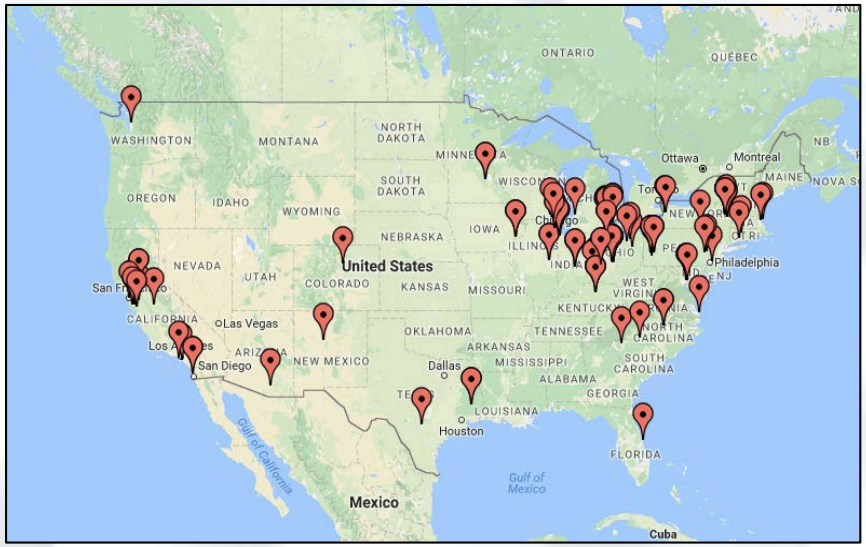
- Solicitation twice a year (typically $3M each)
- Summer internships
- Implementation/Development projects
- Added participating laboratories: ANL, NREL

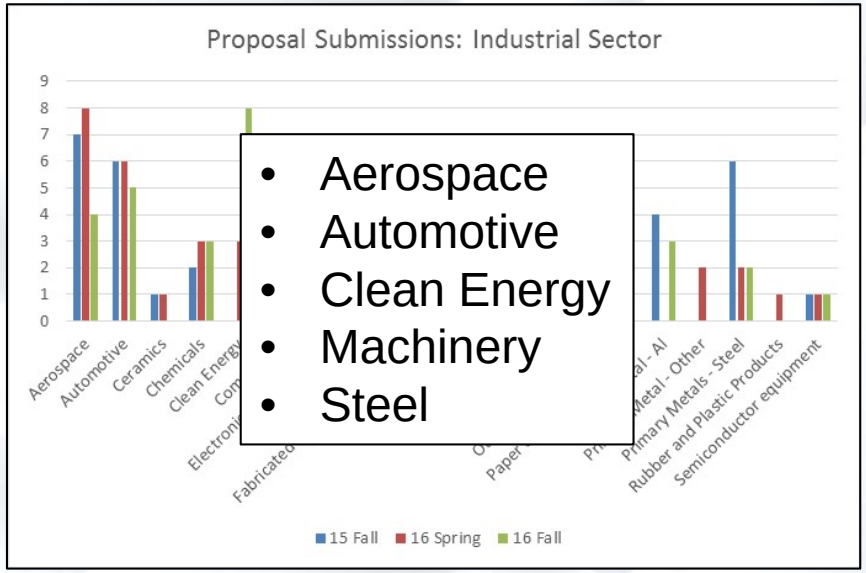
- *Compute resources from across the DOE complex*
- *Launched annual Industry Day*
- *Student internship programs*

The HPC4Mfg program has a diverse portfolio

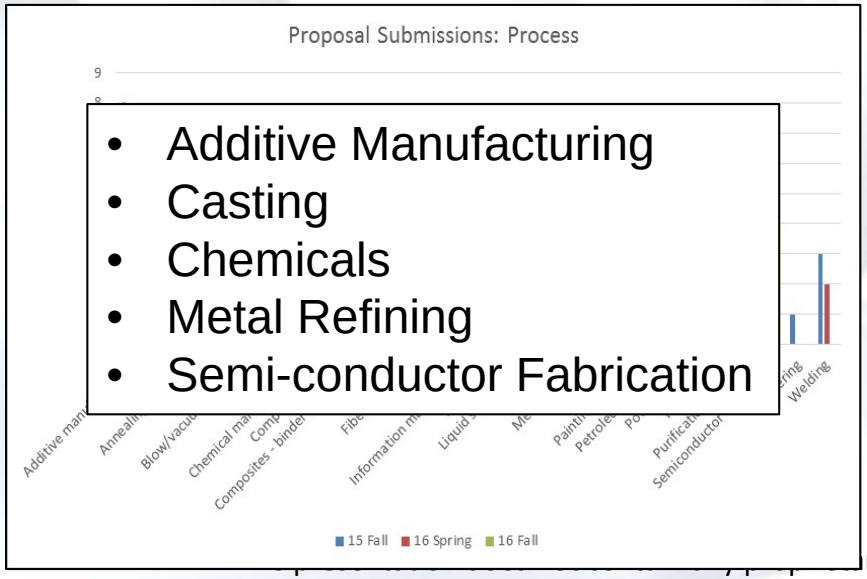
- $>13M technical portfolio
  - Executing on 41 projects with 33 industry partners and 5 labs
  - 40 demonstration; 1 capability
  - Seedling project funded by Office of Transportation
- Spring 2017 Solicitation announced soon
  - $3M available
  - New area of materials in severe environments
  - Other DOE offices informally involved

The concept paper participation has been diverse in both geographic location and topic

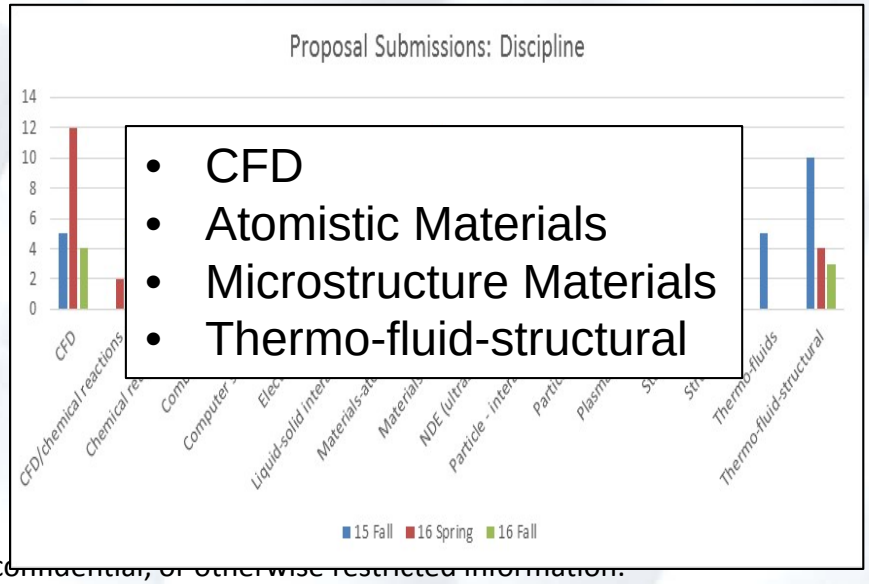




- Aerospace
- Automotive
- Clean Energy
- Machinery
- Steel



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



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

ry, confidential, or otherwise restricted information.

HPC4Mfg is extending our scientific knowledge in different industrial sectors

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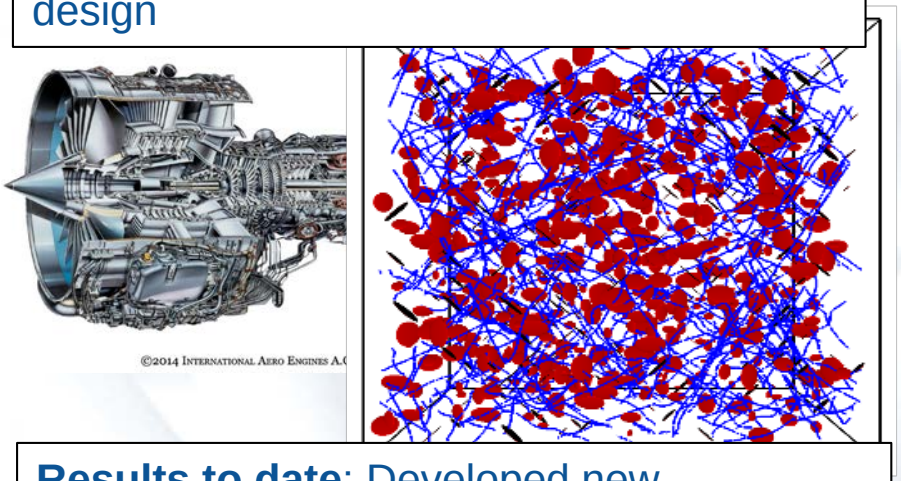
Creating new lightweight alloys

Goal: Predict the strength of lightweight aluminum-lithium alloys produced under different process conditions; could save millions of fuel costs if used in aircraft design

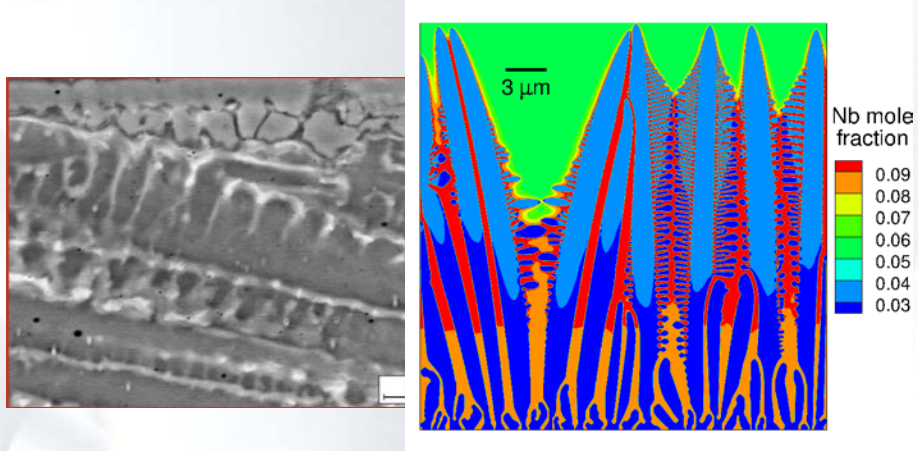


Results to date: Developed new dislocation mobility laws for Al-Li alloys; examining influence of different precipitate density; predicting yield strength for differing particle sizes

Team: LIFT with LLNL and Univ Mich.

Dendritic Growth in AM Parts

Goal: Use HPC to model multi-scale morphology of solidification microstructure of Nickel base 718



Results to date: Predicting crystal growth over large domains from multi-component alloys using phase field approaches; moving to new alloy systems and 3D

Team: UTRC with ORNL/LLNL

HPC4Mfg is improving industrial workflows and speeding up modeling time using HPC

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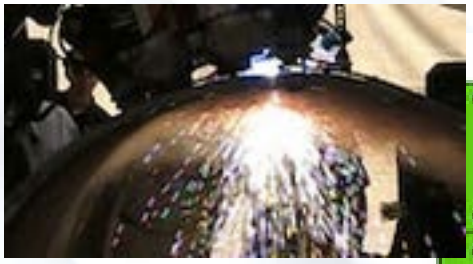
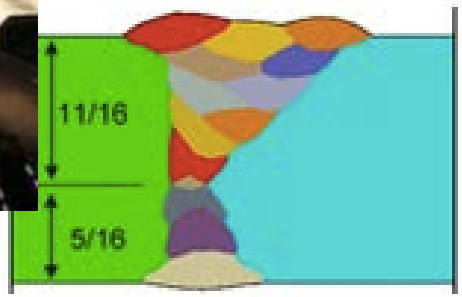
Weld Predictor Tool

Goal: Develop an improved online welding software modeling application using advanced 3D models, more material hardening laws, and open source parallel codes





Images courtesy of EWI

Results to date: Developed new front end interface and automated meshing tools; working on new parallel simulation tools for thermal analysis, microstructure prediction, and mechanical analysis

Team: Edison Welding Institute with ORNL/OSU

Paper Towel Design

Goal: Use HPC to evaluate different microfiber configurations to optimize drying time while maintaining user experience

Results to date: New mesh tool reduces product design cycle by 2X cycle; additional cores by another 8X; largest non benchmark run of Paradyn code at LLNL

Team: Procter and Gamble with LLNL

HPC4Mfg is leading to significant energy savings in new products or processes

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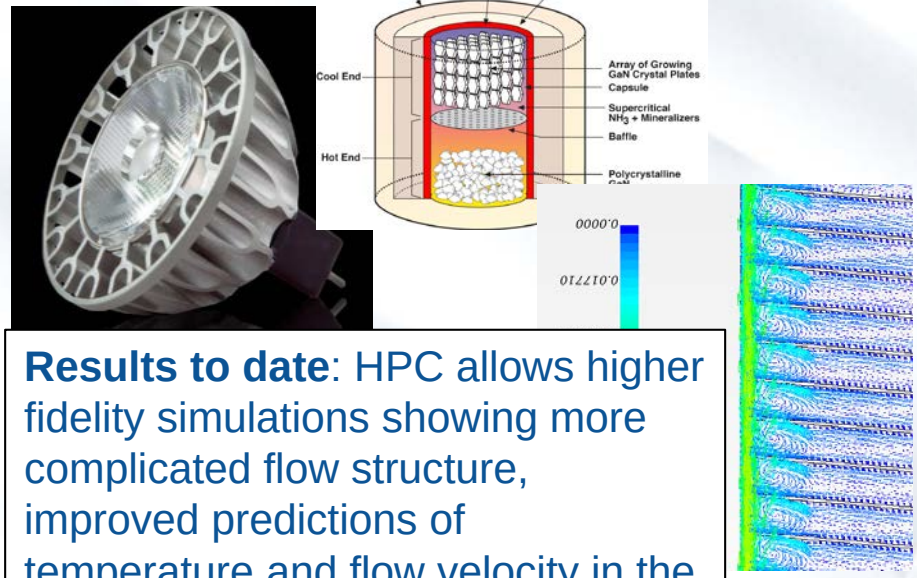
More efficient LED lightbulb

Goal: Model ammono-thermal crystal growth of GaN to scale up the process; reduce production costs of LED lighting by 20%

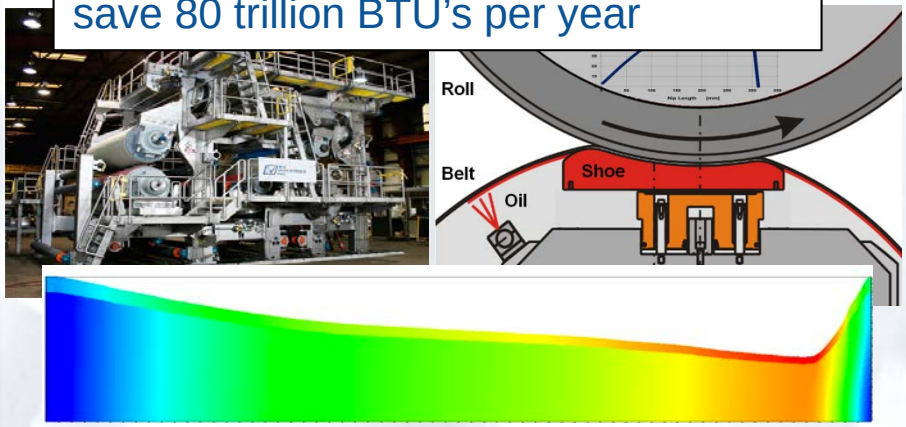


Results to date: HPC allows higher fidelity simulations showing more complicated flow structure, improved predictions of temperature and flow velocity in the reactor; now optimizing uniform growth of crystals

Team: SORAA with LLNL

Energy savings in paper making

Goal: Use multi-physics models to reduce paper rewetting in the pressing process; reduce 3rd most intense energy consumer in paper making; save 80 trillion BTU's per year



Results to date: Using both continuum and pore-scale approaches to determine how water flows through porous paper pulp; simulations can be used to optimize drying

Team: Agenda2020 with LBNL/LLNL

If HPC4Mfg is successful…

- The development and deployment of energy-efficient manufacturing is accelerated through funded projects
- The production or adoption of clean tech is enabled 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
Lori Diachin, Director, HPC4Mfg

Robin Miles, Project Manager, HPC4Mfg

Jeff Roberts, Director, Advanced Energy Technologies

Seven HPC4Mfg posters on display gave a sampling of technical projects