HPC 4 MANUFACTURING

An ecosystem to support US manufacturing adoption of High Performance Computing

2016 PROJECT PEER REVIEW
U.S. DEPARTMENT OF ENERGY
ADVANCED MANUFACTURING OFFICE
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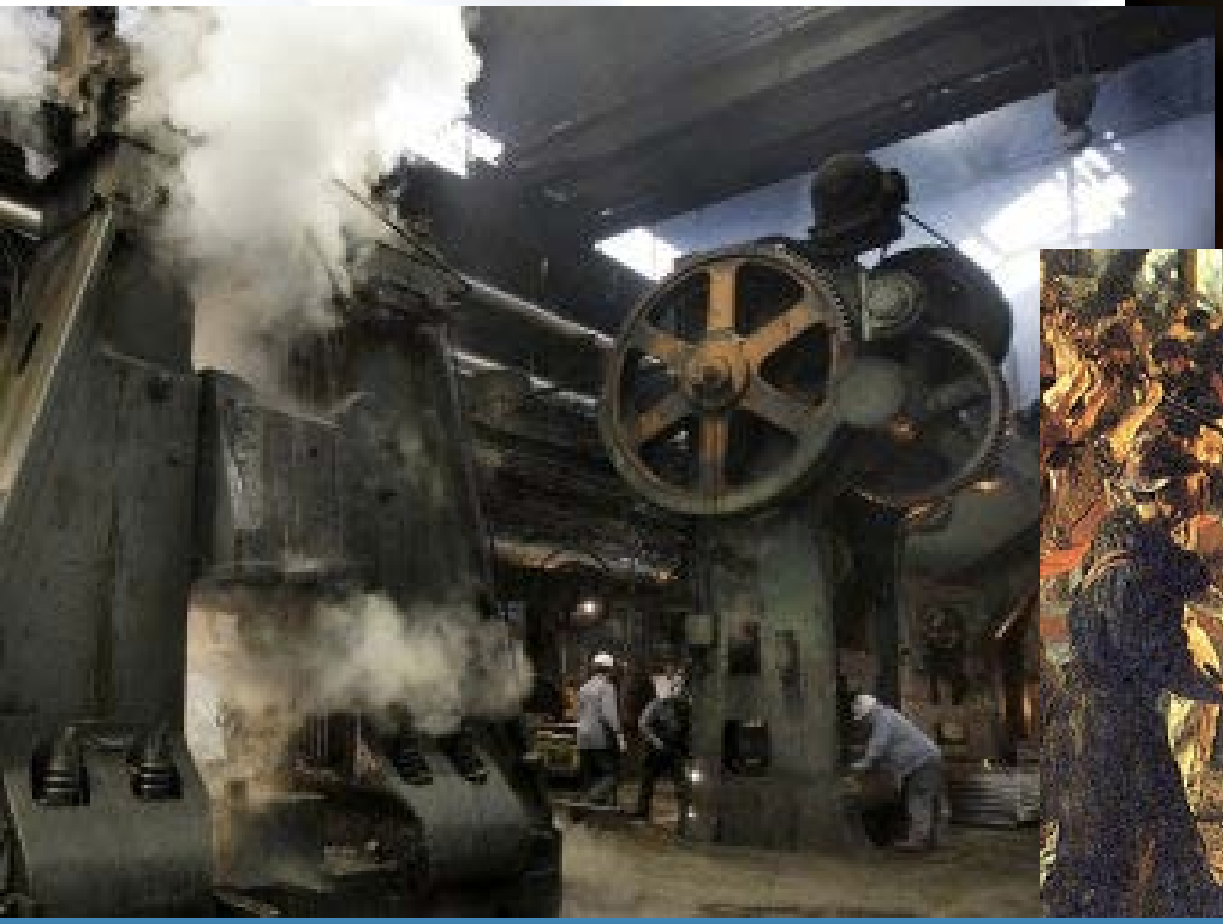
US manufacturing is undergoing a technological revolution



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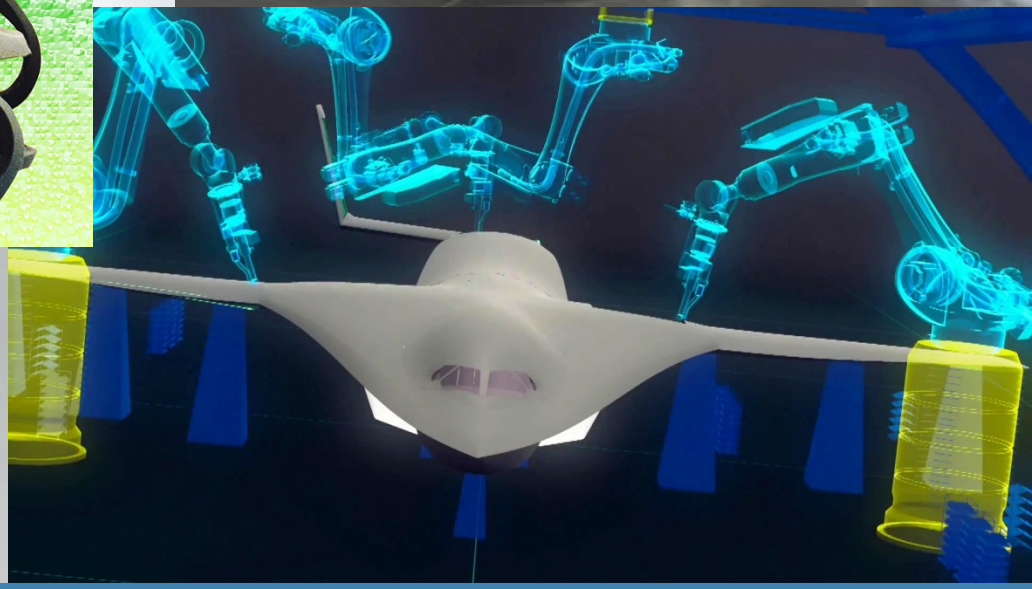

Smart, sustainable, safe, surging

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Labs partner with industry to lower risk of High Performance Computing (HPC) adoption

LLNL

ORNL

Data Analytics

LBNL

HPC4Mfg

Modeling and simulation


Food Processing


Petroleum refining

HPC4Mfg

- Guide design
- Optimize processes
- Pre-qualify parts
- Reduce testing
- Increase innovation


Chemical Separation


Steel Making


Pulp and Paper

Process, modeling, data

An ecosystem for the labs to efficiently impact industry

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HPC4Mfg was patterned after successful pilots

- AMO sponsors, LLNL leads and LBNL and ORNL partner with the program
- Lab/industry partnerships demonstrate the impact of HPC
  - AMO funds up to $300K for lab staff and systems; industry 20% in-kind
  - Project duration < one year
  - Significant increase in energy efficiency and advancing clean energy technologies nation-wide
- Private-public contracting is streamlined
- Building HPC manufacturing community
  - Attract HPC professionals to manufacturing
  - Share what is learned while protecting IP
  - Develop student programs

All main elements are in place and running steady state

Peer-reviewed solicitation is effectively

FEDBIZOPPS.GOV Federal Business Opportunities

Industry submits challenges

Match challenge to PI

Recommendation for AMO approval; Feedback to industry

Sign agreements

Concept paper → **Full proposal** → **Award**

Due July 18th

Mid-August

Industry feedback: "... assignment of PI for co-development of full proposals demystifies national lab engagement…"

Communication is key

- Seek out potential partners
- Link lab PI to submitter to co-develop proposal
- Feedback to all submitters

Technical Merit Review Committee

- Partner labs and AMO representatives form a trusted team
- Heavy focus on **nation-wide** impact to energy efficiency and clean energy technology industry-wide
- Diverse portfolio of projects

The HPC4Mfg Program has had significant engagement from industry

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Status after March 2015 startup
- Executed six seedlings totaling $2.1M
- Awarded $3M from Fall15 solicitation
- $3M Spring16 solicitation, in progress
- Adopted DOE Short Form CRADA
- Established summer internships at labs

Future
- Solicitation twice a year
- Annual Industry Day
- Increase HPC manufacturing community
  - Continued lab outreach to industry
  - Students, professors, industry interns
  - Other lab partners as program grows

Challenges/risks
- Reach out to companies that don't know they need HPC
- Identify exit strategies for companies

EATON Powering Business Worldwide

PPG

GLOBALFOUNDRIES

United Technologies Research Center

EWI We Manufacture Innovation

SORAA

P&G

AGENDA 2020 TECHNOLOGY ALLIANCE

PURDUE UNIVERSITY CALUMET

Carbontec Energy Corporation

ZoomEssence CREATING THE NEXT WAVE OF INNOVATION

GE

Alift

Current projects address diverse challenges

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Process Optimization

- Energy reduction of industry spray drying technology
- Highly scalable multi-scale FEA simulation for efficient paper fiber structure
- Tailoring microstructure in laser powder bed fusion manufacturing process
- Numerical simulation of fiberglass drawing process
- Development of reduced glass furnace model to optimize process operation
- Modeling the E-Iron nugget process
- High-fidelity model of coupled flow and mechanical deformation of porous paper web
- Study fluid behavior Inside an ammono-thermal gallium nitride reactor using CFD
- Integrate, parallelize, optimize existing CDF steel blast furnace simulation codes

Design Improvement

- Computation design and optimization of ultra-low power device architectures
- Massively parallel multi-physics multi-scale large eddy simulations of a fully integrated aircraft engine combustor and high-pressure vane
- Microstructural modeling and control in laser-powder bed additive manufacturing

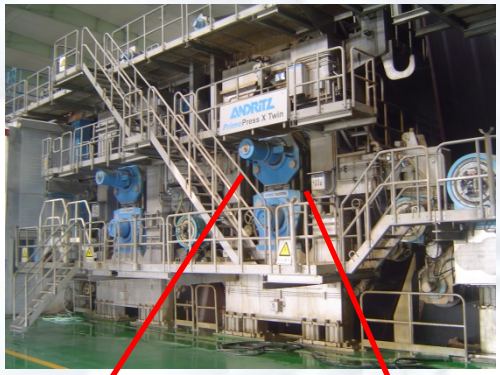
New Computational Tools

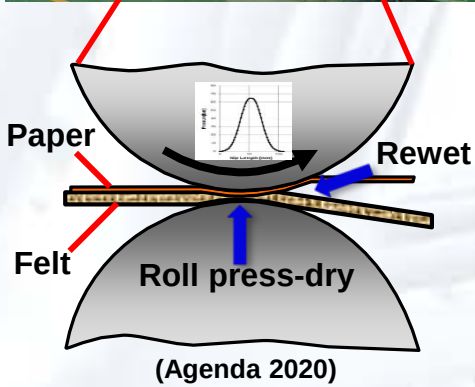
- Materials engineering tools for optimizing strength of forged Al-Li turbine blades
- Integrated predictive tools for customizing microstructure and material properties of AM aerospace components
- Open-source tools for weld prediction

Reducing energy in paper-making could save 80 trillion BTUs per year

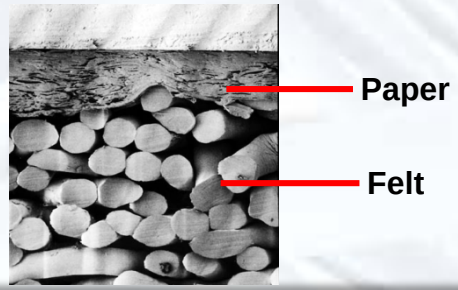
Industry partner: Agenda 2020—paper-manufacturing consortium

- Rewetting of paper pulp after pressing: widely considered leading contributor—3rd largest—to energy intensity of paper making
- LLNL and LBNL developing coupled-physics simulations
  - Determine how water flows through porous paper pulp during, after pressing process
  - The two approaches are continuum and pore-based models
- New press designs could reduce energy consumption by up to **20% (80 trillion BTU, in $250M annually)**





(Agenda 2020)



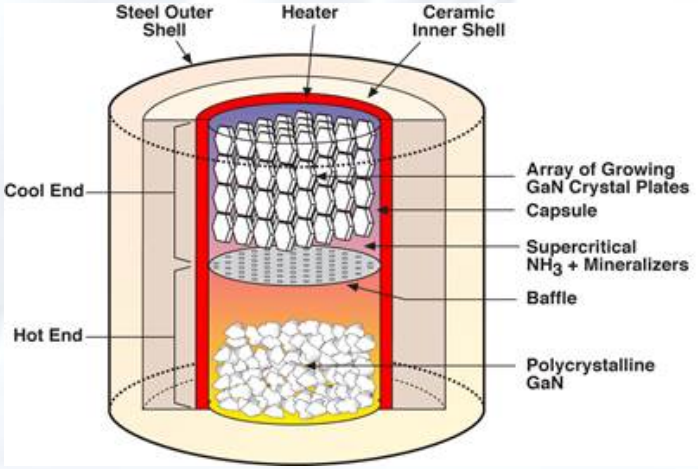
Scaling up a new GaN process could yield 20% cheaper LED lighting and new power electronics

Industry partner: SORAA

- Scale-up of GaN crystal growth technology could
  - Reduce production costs of highly efficient, high-brightness LED lighting **by 20%**
  - **Enable development of next-generation** power electronics for renewables

- LLNL is modeling chemistry of ammono-thermal crystal growth to assist process scale-up

- New high-fidelity model will save years of trial-and-error experimentation typically needed to facilitate large-scale commercial production



Panel: Rajeev Pakalapati; Poster: Nick Killingsworth, LLNL

Reducing coke usage in steel-making could save $80 million per year

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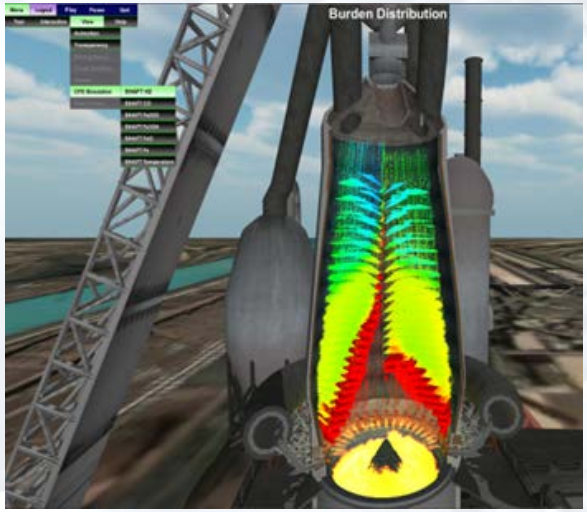
Industry partner: Purdue Calumet (steel-manufacturing consortium)

- Carbon – rich natural gas and coke used in large quantities in steel production
- Molten iron production optimization will reduce carbon loads to environment and process costs
- LLNL improves blast furnace models:
  - Runs complex reactive flow simulations through coke, iron ore particles
  - Simulations identify furnace conditions with reduced coke utilization
- Optimized blast furnace processes could save **$80 million/year** industry-wide by reducing coke consumption



Poster: Aaron Fisher, LLNL

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