

BLAST FURNACE CFD SIMULATION AND VR VISUALIZATION

Dr. Chenn Q. Zhou

Founding Directors

Center for Innovation through Visualization and Simulation (CIVS)

Steel Manufacturing Simulation and Visualization Consortium
(SMSVC)

Purdue University Northwest, Hammond, IN 46323

czhou@purdue.edu

“Where Ideas Become Reality”



CENTER FOR INNOVATION THROUGH
VISUALIZATION & SIMULATION

PURDUE
UNIVERSITY
NORTHWEST



2200 169th Street
Hammond, IN 46323

219.989.2765
civs@purduecal.edu
www.purduecal.edu/civs

CIVS ROAD TO HPC APPLICATIONS

CFD Applied to
Refinery, Glass...

1995

CIVS
Sim. & Vis.

2009

HPC4Mfg BF
Seed Grant

2015

HPC4Mfg
BF Phase II

2016

2002

Blast Furnace
(BF) CFD
Modeling

2014

NIST
AMTech
Grant

2016

Steel Manufacturing
Simulation and Visualization
Consortium (SMSVC)



CIVS (Since 2009)

➤ Mission

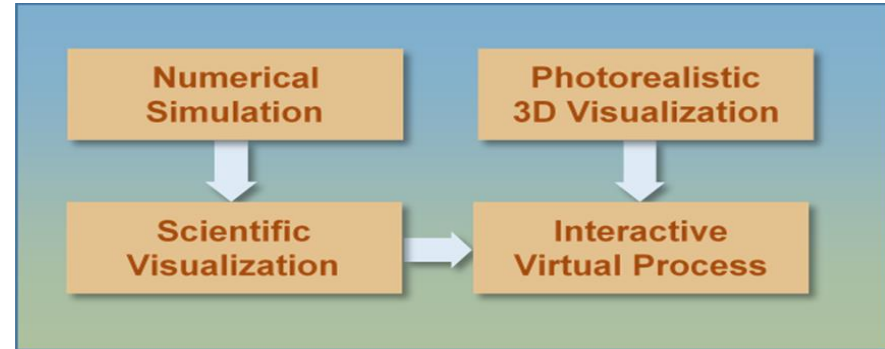
- Innovation
- Application (\$40+ million savings)
- Education (1000+ students)

➤ Strategies

- Integration of technologies
- Application driven approach
- Partnerships (110 partners)

➤ Applications

- Optimization & troubleshooting
- Design & scale-up
- Training



“A picture is worth a thousand words.” - F. Barnard, 1921

“An interactive simulation is worth a thousand pictures and million \$\$\$.”

STEEL MANUFACTURING SIMULATION AND VISUALIZATION CONSORTIUM (SMSVC)

- **Mission:** To develop and implement innovative technical solutions through advanced simulation and visualization technologies to ensure a competitive advantage for US steel manufacturing.

- 1) Workplace Safety
- 2) Energy Efficiency
- 3) Operation Efficiency
- 4) Reliability and Maintenance
- 5) Workforce Development
- 6) Environment Impacts
- 7) Raw Materials Utilization
- 8) Smart Manufacturing



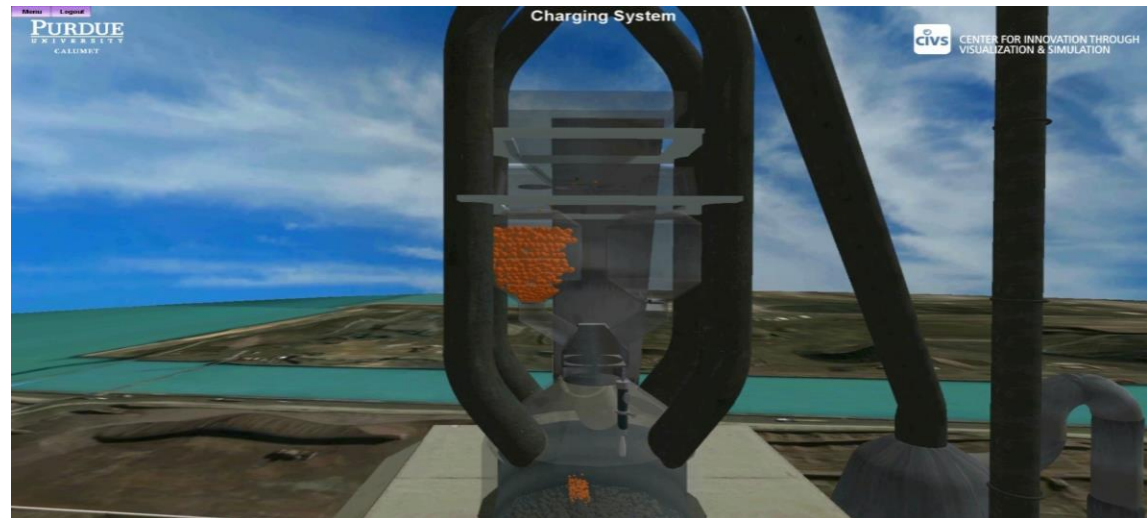
CFD SIMULATION AND VISUALIZATION OF BLAST FURNACES (2002 - 2015)

➤ Issues:

- Campaign life
- Energy efficiency
- Downtime
- Training

➤ Outcome:

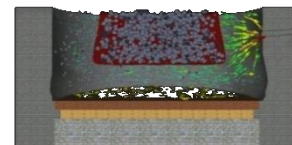
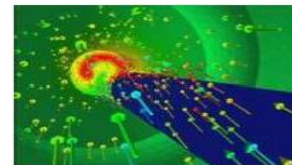
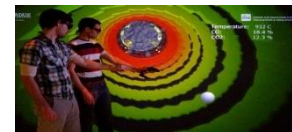
- Virtual blast furnaces
- Copyrighted software
- Multimillion \$\$\$ savings
- Significant downtime reductions
- Six Best Paper awards



Collaborators: ArcelorMittal USA, ArcelorMittal Dofasco, AK Steel, Stelco, Union Gas, and U.S. Steel
Supporters: DOE AMO, AISI, AIST, and Companies

HPC4Mfg SEED GRANT & PHASE II

- LLNL Technical Manager: Dr. Aaron Fisher
- Goals:
 - Significantly reduce computational time
 - Improve model resolutions
 - Integrate blast furnace models for process control, optimization, design and troubleshooting
 - Use for smart manufacturing



STEEL MANUFACTURING
SIMULATION
SMSVC
& VISUALIZATION
CONSORTIUM

- Industrial know how
- Implementation

civs

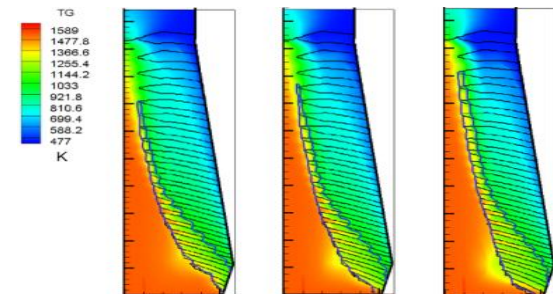
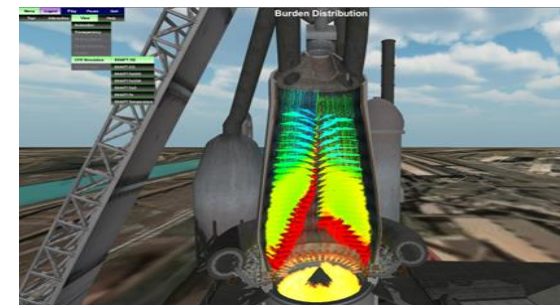
- Model Development
- Simulation
- Visualization

**Lawrence Livermore
National Laboratory**

- Parallelization
- CS expertise
- HPC

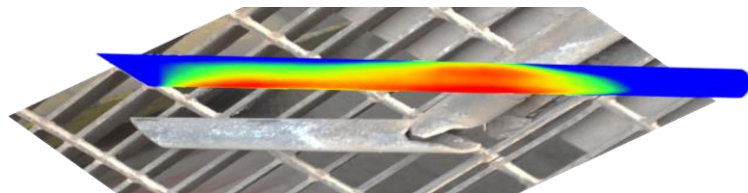
SAMPLE RESULTS & EXPECTED OUTCOMES

- Phase I:
 - Run 126 cases with various operating conditions
 - ✓ 64 HPC cores: 48 hrs (2 days)
 - ✓ 8 PC cores: 756 hrs (31 days)
- Expected results in Phase II:
 - 100 times faster
 - Help reduce coke consumption by 5%, potentially saving \$80M/yr



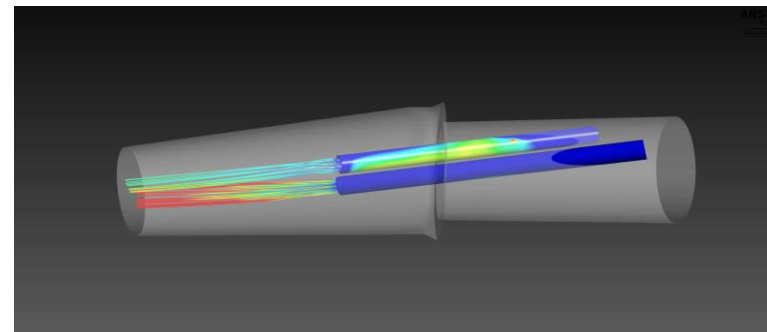
EXAMPLE OF TROUBLESHOOTING U.S. Steel GW #14

- **Issue:**
 - Downtime due to lance failures
- **Outcomes:**
 - Cause of failures
 - Design modification
 - **No more lance failures**

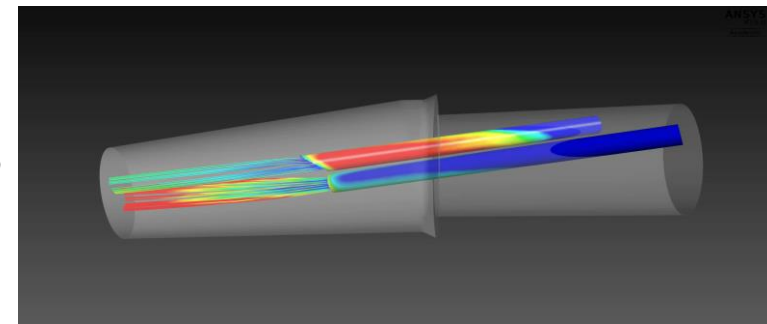


Original angled lance

*New
Design*



*Old
Design*



Thank You!

<http://centers.pnw.edu/civs/>
www.steelconsortium.org

