Steel Manufacturing Simulation & Visualization Consortium (SMSVC)

www.steelconsortium.org
ABOUT CIVS

- Missions
  - Innovation
  - Application
  - Education

- Key Strengths
  - Integration of advanced technologies
  - Application driven approach for problem solving
  - Partnerships

- Background
  - Built on a long history of CFD applications on various industries including aluminum, glass (R&D 100 awards), power, refinery, steel, etc.
Simulation
Visualization
High Performance Computing

$38++ million savings from 5 of over 130 projects

92 external organizations collaborated

19,000+ visitors & 193 national and local news

82 PUC Faculty/Staff

3,400+ students used CIVS for learning

748+ students employed and mentored & 44 awards of best student papers

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The Only Limitation is Your Imagination
Impacts of Simulation and Visualization

Quotes:

- “The Reheating Furnace project…saved about $30,000 per year. The simulation of a Sinter Cooler helped to solidify our decision…resulted in approximately $20 million in cost avoidance.”
  
  David White, Director, Process Research Global R&D, ArcelorMittal

- “A project on the pulverized coal injection in the blast furnace….resulted in a yearly potential cost avoidance of $8.5 million and significant downtime avoidance by half…”
  
  John D’Alessio, Director, Process Technology and Excellence, U. S. Steel Canada
CIVS Examples: Steel Related Projects

- 3D Interactive Virtual Blast Furnace for Training
- 3D Video of Steel and Iron Making for K-12 Students
- 3D Visualization of Steelmaking for Safety Training
- 3D Visualization of Steel Manufacturing Processes
- Advanced Simulation and Visualization for Steel Optimization Consortium
- Auto Manufacturing Maintenance and Troubleshooting Simulator
- Blast Furnace Hearth Flow and Erosion CFD Model
- Blast Furnace Shaft CFD Model
- CFD Analysis of a Torpedo Car for Desulphurization
- CFD Analysis of Blast Furnace Bosh
- CFD Analysis of Stave Coolers of a Blast Furnace for Troubleshooting and Optimization
- CFD Model for Blast Furnace Pulverized Coal Injection and Coke Combustion CFD Model
- CFD Modeling of a Ladle with Rotational Stirring Lances
- CFD Simulation of Top Spray Cooling System in a Blast Furnace
- CFD Simulations and Optimization of a Batch Anneal Furnace
- CFD Simulations of Solid Liquid Mixing in a Stirred Tank for Troubleshooting and Optimization
- CFD Thermal Modeling of a Prototype LCCBF
- Comparison and Optimization of Blast Furnace Tuyere Designs
- Design of Sinter Cooler Simulation Pre-Processor Software
- Development of Blast Furnace Operation Stability Monitoring Program
CIVS Examples: Steel Related Project

- FEA Structural Analysis of a Vertical Edger in a Hot Rolling Mill
- Flow Analysis and Optimization of a Flooded Disc Scrubber
- Flow Analysis and Optimization of a Steel Ladle
- Interactive Incident Visualization for Steel Industry Safety Training
- Investigation of Tuyere Nose Failures in a Blast Furnace
- Methodology for Equipment Longevity Extrapolation Based on Finite Element Analysis
- Minimization of Blast Furnace Fuel Rate by Optimizing Burden and Gas Distributions
- Modeling of Weld Plant Production and Logistics
- Multi-Phase CFD Model of a Condenser Loop
- Numerical Investigation of Boiler for MACT Compliance
- Numerical Optimization of a QBOP Vessel for Minimizing Kidney Formation
- Numerical Simulation and Optimization of a Bottom-Blow Basic Oxygen Furnace
- Numerical Simulation and Optimization of a Preheating Furnace
- Optimization and Design of a Venturi Scrubber Throat
- Optimization of an Industrial Boiler Firing Metallurgical Gases
- Phase Diagram Interactive 3-D Visualization
- Pre-Processor Development for Blast Furnace Hearth CFD Model
- Simulation of a Sinter Cooler for Optimization and Design
- Slab Reheating Furnace Analysis for Process Optimization
- Study of High Rate Natural Gas Injection in a Blast Furnace Tuyere
- Virtual Steelmaking for Education & Outreach
Consortium Background

- A industry-led consortium launched by CIVS supported by more than 15 companies and other organizations.
- Result of the project is to establish the nation-wide consortium and to develop a technology roadmap to benefit the American steel industry.
- Project funded by National Institute of Standards and Technology (NIST) Advanced Manufacturing Technology (AMTech) Planning Grant, project period is June 2014 to May 2016.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Supporting Organization</th>
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<tr>
<td>ArcelorMittal</td>
<td>Enhanced Technologies</td>
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<tr>
<td>American Iron and Steel Institute</td>
<td>AISI</td>
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<tr>
<td>U.S. Steel</td>
<td>U.S. Steel Canada</td>
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<td>Union Gas</td>
<td>Berry Metal</td>
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<td>NUCOR</td>
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<td>NIPSCO</td>
<td>Indiana Economic Development Corporation</td>
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<td>Center of Workforce Innovations</td>
<td>Center for Innovation through Visualization and Simulation</td>
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Business Industry Leadership (BILT) & Technology Advisory Committee (TAC)

Ron Ashburn, AIST
Tathagata Bhattacharya, ArcelorMittal
Rick Bodnar, SSAB
John D’Alessio, U. S. Steel
Canada
Kelly Dallas, AIST Midwest Chapter
Larry Fabina, ArcelorMittal
Steve Hansen, SSAB
Robert Hyland, U. S. Steel

Yury Krotov, Steel Dynamics
Ken Landau, AIST
Eugene Pretorius, NUCRO
Ronald Radzilowski, AK Steel
Kurt Sangster, NIPSCO
Hans Schade, AK Steel
Peter Schiestel, U. S. Steel
Canada
Richard Teets, Steel Dynamics
Joe Veheec, AISI
David White, ArcelorMittal
Consortium Vision, Mission, & Values

➢ Vision:
  ❖ To be the Institute of Choice for developing and applying advanced simulation and visualization technologies to ensure a competitive advantage for US steel manufacturing

➢ Mission:
  ❖ To develop and implement innovative technical solutions through the integration of advanced simulation and visualization technologies for the value chain of US steel manufacturing

➢ Values:
  ❖ Integrity, Effectiveness, Practical Application, and People
SMSVC Advantages

- Will utilize CIVS proven applied research track records:
  - Integration of cutting edge simulation and visualization technologies for superior visual outputs
  - Application driven approach for problem solving in diverse areas
  - Close interactions with collaborators and responsive to changes as needed

- Will ensure:
  - Intuitive and innovative problem solving
  - Cost-effective options
  - Speedy solutions
  - Integration of production and training tools
  - Informative decisions to reduce cost and downtime
Focus Research Areas

**Workplace & Process Safety:**
Example: Safety incident on a Melt Shop floor

**Energy Efficiency:**
Example: Reheating Furnace – saved $30,000 annually at ArcelorMittal

**Operation Efficiency:**
Example: Expansion of production and shipping capability is required at a steel plant

**Reliability and Maintenance:**
Example: Crane – saved $8 million equipment avoidance at USS

**Workforce Development:**
Example: Virtual Blast Furnace for Training with excellent feedback

**Environment Impacts:**
Example: Sinter plant venture scrubber

**Raw Materials Utilization:**
Example: Sinter Cooler – over $20 million capital cost avoidance at ArcelorMittal

**Smart Manufacturing:**
Example: Steel Plant Logistic Optimization
Preliminary Priority Project Topics

- **Group 1: Environmental Impacts, Energy Efficiency, Operation Efficiency, Use of Raw Materials, and Smart Manufacturing** (Workshop I: 1-7; Workshop II: 8 – 13)
  1. Optimization of Steel Mill Energy Efficiency
  2. 3D Integrated Blast Furnace MSV Capability
  3. Optimized Blast Furnace Fuel Injection
  4. Improvement of Control Strategies
  5. Expert System for Integration of Scheduling, Production, and Materials Flow
  6. Optimized Raw Material Handling Design and Practices
  7. Model steel cleanliness practices at LTS Caster

- 8. Zero By-product Fuel Flare
- 9. Reduce Energy Loss Between Core Processes
- 10. Optimize the Material Flow through a Constrained Facility
- 11. Optimization of Raw Materials Input into EAF for Reduced Cost and Higher Productivity
- 12. Richer Integration of Sensors and Data with Process Control Systems for Production Planning
- 13. Simulation and Optimization of Alternative Ironmaking Processes
Preliminary Priority Project Topics

Group 2: Workplace Safety, Workforce Development, Reliability & Maintenance (Workshop I: 1-3; Workshop II: 4 – 6)

1. Improving Steel Industry’s Image and Attracting/Retaining Workforce
2. Hot Rolling Simulation of Advanced High Strength Steels
3. Virtual Training to Improve Workplace Safety and Bridge the Skills Gap
4. Interactive Student-Steel Industry Programs and Tools
5. Early Intervention Maintenance
6. Virtual Simulation and Visualization Training: Safety, Operations, and Maintenance
Member Benefits

• Rapid access to research results
• Use of the technology for in-house applications
• Leverage of CIVS technologies and methodologies
• Leverage from federal and other funding agencies
• Industry-led decision-making
• Direct access to students for hiring
• Accelerated company innovation
• Direct collaboration with other members
Additional Benefits for Charter Members
(open enrollment until January 15, 2016)

• Discounted membership fee
• Input on initial project ideas in November 2015
• Voting for project selection in December 2015
• Guaranteed membership (new members require approval by existing members after January 15, 2016)
Specific Supplier Benefits

- Customized solutions for your steel related business
- Expanded use of your company’s product and technologies
- Research projects will directly benefit both steel producers and suppliers
- Opportunities to build closer relationships with steel producers
- Leverage of CIVS relationship with other industries
- Work with steel produces and suppliers to ensure competitiveness
- Validation of your product and technology for improved efficiency and optimization
- Utilization of initiative with government and for future research results and funding
- Collaboration with complementary companies for leveraging of funds
Status of Charter Membership

- Companies signed as of August 31, 2015
  - AK Steel
  - ArcelorMittal
  - NUCOR
  - Riverside Refractories, Inc.
  - SSAB
  - Steel Dynamics Inc.

- One contract in final stage for signatures
- Two contracts under review by company leadership
- List of potential members and out-reach assignments
Consortium Activities

- Charter member enrollment closes January 15, 2016 (contract processing takes 30-45 days)
- Call for projects November 2\textsuperscript{nd}, 2015
- 1\textsuperscript{st} Board Meeting December 4\textsuperscript{th}-5th, 2015
- Regular activities (e.g. projects, meetings)
  - Develop proposals and leverage funds (e.g. NIST AMTech Implementation grant)
- For more information contact:
  - Doreen M. Gonzalez-Gaboyan
  - steelconsortium@purduecal.edu
  - +1-219-989-2765
SUMMARY

- Global challenges require more innovations
- Advanced technologies are an essential part of innovation for our future
- Advanced simulation, visualization, and HPC provide innovative ways to create virtual worlds of real problems for efficient, effective, economic, and faster solutions to steel manufacturing related issues
ACKNOWLEDGMENTS

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