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 140+ projects

92+ external organizations collaborated

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

3,700+ students used CIVS for learning

82 PUC Faculty/Staff

20,700+ visitors & 213 national and local news

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CIVS METHODOLOGY

- Application-driven
- Step-by-Step & Section-by-Section
- Validation & Verification
- Combination of open sources, commercial software and in-house codes
- 3-D interactive multiple platforms including immersive virtual environment, AR, PC, mobile, or web versions
**COMPUTER SIMULATION**

**Definition:** Use a computational model to simulate behaviors of a real system or process.
- Computational Fluid Dynamics (CFD)
- Finite Element Analysis (FEA)

**Benefits:** widely used for design, troubleshooting, optimization, scale-up, and training
- Insights
- Foresights
- Efficiency
VISUALIZATION

- **Computer Visualization:** 2D or 3D images, or animations of a process or phenomena
  - Graphics, Picture, Video, Interactive, or web-base
  - Virtual Reality: PC, Projection, 3D TV, Oculus Rift
  - Augmented Reality: Phone, Tablet, Google Glass
INTEGRATION OF SIMULATION AND VISUALIZATION

- Efficient, effective, and economic tools
  - Easier to communicate complex results
  - Faster “trial and error”
  - Lower risk for testing new ideals
  - More informed decisions

“A picture is worth a thousand words.”
F. Barnard, 1921
The Only Limitation is Your Imagination
BENEFITS OF SIMULATION AND VISUALIZATION

- More effective communication
- More answers to “what if” questions
- Less time, lower cost, better performance
  - Less work – efficiency
  - Less time and cost
  - Better performance – optimization

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F. Barnard, 1921
COMMUNITY AND INDUSTRY PARTNERSHIPS

PUC CIVS
- Application driven
- Advanced facility and software
- Talented faculty and students
- Training of future work force

Community/Industry
- Real-world technical know-how
- Real constraints
- Validation data
- Faster and cost-effective solutions
CIVS APPLICATIONS

- Reduce cost
- Short time
- Increase yield
- Improve accuracy

- Safety
- Design
- Troubleshooting
- Optimization
- Scale-up

- Simulation
- VR Visualization
- High Performance Computing

- Training
- Facilities
- Planning

- Energy
- Environment
- Productivity
- Quality

- Data Visualization
- Marketing

Reduce cost
Short time
Increase yield
Improve accuracy
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.
## Companies and Organizations Supporting the Consortium

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<td>ArcelorMittal</td>
<td>Enhanced Technologies</td>
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<td>AIST</td>
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<td>U.S. Steel</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
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, NUCOR
Ronald Radzilowski, AK Steel
Kurt Sangster, NIPSCO
Hans Schade, AK Steel
Peter Schiestel, U. S. Steel Canada
Richard Teets, Steel Dynamics
Joe Vehec, 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
  - Pre-competitive general models that are customizable to individual company needs

- **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 producers 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
Charter Members

Companies signed as of October 6, 2015

- AK Steel
- ArcelorMittal
- NUCOR
- Riverside Refractories, Inc.
- SSAB
- Steel Dynamics Inc.
- U. S. Steel Corporation
Consortium Activities

- Charter member enrollment closes January 15, 2016 (contract processing takes 30-45 days)
- Call for projects November 2, 2015
- 1st Board Meeting December 4, 2015
- Regular activities (e.g. projects, meetings)
  - Develop proposals and leverage funds (e.g. NIST AMTech Implementation grant)

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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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