COMPANY PROFILE

Simulent Inc. is a leading Computational Fluid Dynamics (CFD) software development and engineering consulting company delivering the most advanced solutions in the market place for the design and testing of fluid and thermal systems.

Simulent's CFD products are capable of simulating three dimensional free surface flows with large surface deformation, surface merging and surface breaking, with applications in various multiphase flow and spray systems.

Simulent Inc. is affiliated with the Centre for Advanced Coating Technologies (CACT) at the University of Toronto (http://www.mie.utoronto.ca/labs/cact/). This relationship allows Simulent access to some of the greatest minds in CFD and coating technologies. Simulent Inc. is also a member of Consulting Engineers of Ontario and a member of the Professional Engineers of Ontario.

Incorporated in 1993 Simulent Inc is a spin-off from the University of Toronto with head office located in Toronto, Canada.

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PRODUCTS & SERVICES

Consulting Services

Simulent Inc. offers unparalleled resources expertise and technical support for a broad range of engineering applications. The staff include senior-level **CFD** specialists, leading software developers and experts in fluid flow, sprays and atomization, thermal plasma, thermal spray coating, heat and mass transfer, and phase change simulations and analysis. The management team is internationally known for their expertise and has provided consulting services to many companies in North America, Europe, China, and Japan.

Simulent is assisting companies in:

- Understanding the dynamics of complex flow-related problems.
- Improving and optimizing performance of design .
- Comparing performance of different designs.
- Minimizing the time and expense of prototyping.
- Reducing the cost, time and risk in design of new components & processes.

Software Solutions

Simulent Inc designs and delivers customized **CFD** software to meet the most complex fluid flow challenges. Simulent's core software suite includes several industry-specific modules which have been extensively validated and has helped to achieve some significant industry breakthroughs for our clients.

Simulent's innovative and flexible software modules allow for simulation of a wide variety of fluid flows, heat transfer and phase changes and analysis of fluid flow problems while eliminating the requirement for full scale testing – significantly reducing time, cost and risk. Simulent software provides the following partial list of industry-specific modules:

- SimSpray: For designing and engineeing the spray nozzles and atomization process.
- SimDrop: For analysis of roplet impact and solidification in Thermal Spray Coating, Cooling and Painting.
- SimCoat: For modeling the spray coating formation/ thichness/porosity in thermal sprays.
- SimSlosh: For designing safer tanker trucks and motor vehicle fuel tanks.
- SimPlasma: For understanding powder heating and melting in plasma jets or radio frequency inductively coupled plasmas

Hardware Solutions

HVOF-Gun Attachment*

High velocity oxy-fuel process (HVOF) has been demonstrated to be one of the most efficient techniques to deposit high performance coatings at moderate cost. The HVOF process has been shown to be technologically advanced to other thermal spray processes, the unique gun design makes a significant improvement on the final casting quality.

***US. Patent 6,845,929**

Pneumatic Droplet Generator*

The pneumatic droplet generator produces small, uniform droplets from a wide range of liquids and molten materials. It is simple to use, robust and particularly well suited for high-temperature applications requiring accurate dispensing or production of individual droplets on demand.

***US Patent 6446878**

Petroleum Coke Gasification on Molten Salt Pool

A specific process is being proposed by Simulent Energy for converting low-value petroleum coke into clean fuel gas or synthesis gas. This process also recovers elemental sulfur and vanadium concentrate while offering versatility. Almost any carbonaceous material, such as petroleum coke, residual oil, coal, wood, can be converted to either low- or medium-Btu gas by using air or oxygen combined with steam, respectively, as the primary oxidant.

CURRENT & PAST CLIENTS

Following is a partial list of major clients and projects of Simulent in the past and present:

US Department of Energy, UT-Battelle (Oakridge National Lab), Weyerhaeuser(US)
"Optimization of liquor nozzle design. Subprogram of DOE Project: Advancement of High Temperature Black Liquor Gasification Technology".

Alstom Power (ON)
"Prediction of Spray Characteristics of Black Liquor Gun Nozzle". A three dimensional free surface flow, computational fluid dynamics software was developed for Alstom Canada to simulate liquid film formation and break up in the splash plate nozzles.

Bradley Mechanical Services (ON)
"Modeling the Epoxy Coating procedure in piping systems". The objective of this project was to develop software for the internal epoxy coating process. The developed software is used by field personnel to estimate the necessary working parameters in pipe lining processes in order to have a full coverage of the epoxy with the least possible defects. **This project was a 2010 recipient of the Award of Merit from the Consulting Engineering of Ontario (COE).**

G E Global Research (NY)
"Modelling of the Coating Process: Modifications to Simulent Drop, Simulent Coat, and Simulent Plasma codes". Through a joint research project these software tools were modified and enhanced to be able to model the thermal spray coating which is practiced in GE Global.
"Numerical Simulation of the Gas Phase in METTECH Axial III Plasma Torch". In this project using the In-House codes and CFX, Simulent prepared the necessary input files that GE can use to run the numerical modeling of their torches.

Wuzhong Instrument Co (China)
"Numerical Simulation of the Rotary Eccentric Plug Control Valve ". The main objective of this project is to employ advanced computational fluid dynamics (CFD) modeling to understand the fluid flow field behavior through the current control valve at various operating conditions. In addition to slurry velocity, pressure, and concentration fields, the simulation results provided useful information about cavitation and flashing.

CANDU Owners Group(COG), Canada
"Investigation of Moderator Temperature Fluctuations and Impact on Fuel Channel Integrity". A numerical model of a CANDU Moderator Test Facility (MTF) was carried out. The results showed fluctuations in velocity and temperature. The high velocity gradients between the inlet jets and the surrounding slower moving moderator fluid generate small vortices with low fluctuation amplitude but high frequencies. The simulations determined the causes for and the nature of the moderator temperature fluctuations and assessed the scaling methodology on the moderator flow and temperature behavior.

"A CFD Modeling of 37-Element Fuel String in a 5.1% Crept Channel". Two different operating conditions were considered, one to result in a single-phase flow and the other in a two-phase flow inside the bundle. A wall-boiling model was employed to simulate sub-cooled boiling on the walls of the heated fuel pins. A methodology was developed to use the partitioned fuel channel model as an alternative to the full numerical model. The model was examined and verified and capabilities of the two-fluid CFD method for simulating single- and two-phase bubbly flows in 37-element fuel string in 5.1% crept fuel channel were demonstrated.

Pratt & Whitney Canada (ON)
"A Computer Code to Design Fuel Injector Filmers". In this project a three dimensional computer code was developed to predict the formation and characteristics of the liquid films in a P&W fuel injector.

Clyde Bergmann (Germany)
"Spray Characterization of SMARTFLEX Nozzle". In this project numerical simulation was used to characterize the newly developed spray nozzle SMARTFLEX, to determine the spray angle and coverage, location of the jet break up, and estimating the drop size, spray distribution, spray coverage and spray impact. Once the model was verified with the experimental results, the effect of boiler parameters on the spray characteristics was studied and the nozzle geometry was optimized to obtain the optimum spray parameters.

"Modeling Water Cannon Jet System". Numerical modeling was used to predict the jet break up of this jet system which is used inside the boilers to clean out the ashes. The model was developed for outside boiler conditions.

Crystal Fountains Inc. (Canada)
"Simulation of decorative water fountains".

Xerox Corp. (NY)

Plasco Energy Group (ON)

StormBlok (NY)

Japan Fine Ceramic Centre (JFCC)

Genpak (ON)

Karbomont (QC)

Grace Semi Conductor (China)

University of Tokyo

University of Kanazawa

University of Rhode Island

University of Toronto

University of Buffalo

University of Limoges (France)

Nanyang Technological University

(Singapore)

Government Granting Agencies (Canadian)

Materials Manufacturing Ontario, MMO (Now part of the Ontario Center of Excelence)
National Research Council Canada/Industrial Research Assistance Program
National resources Canada The CANMET Energy Technology Centre
National Science and Engineering Council of Canada, NSERC

PUBLICATIONS

The following is a partial list of our recent publications.

1. Lin E., Parizi H., Pourmousa A., Chandra S., Mostaghimi J.; "Annular Flow of High-Viscosity epoxy in Circular Pipes" 7th International Conference on Heat transfer, Fluid Mechanics and Thermodynamics-HEFAT2010, Antalya, Turkey, 19-21 July 2010.

2. Hamideh B. Parizi. Javad Mostaghimi, Larry Pershin, Hamid S. Jazi, "Analysis of the Microstructure of Thermal Spray Coatings: A Modeling Approach" Journal of Thermal Spray Technology, Volume 19(4) 736- June 2010.

3. H. Parizi, L. Rosenzweig, J. Mostaghimi, S. Chandra, T. Coyle, H. Salimi, L. Pershin, A. McDonald, C. Moreau, "Numerical simulation of droplet impact on patterned surfaces", J. Thermal Spray Technol., 16, 2007, 713_721.

4. D. Levesque, M.P. Fard, S. Morrison; "*BLSpray: Understanding the effect of black liquor properties and splash plate nozzle configuration on Spray Characteristics*"; Pulp & paper Canada; 106:10 (2005), pp 198-203.

5. V. Mehdi-Nejad, F. Farhadi, N. Ashgriz;"*_Naturally Induced Oscillation in Twin-Fluid Atomizers"; ILASS Americas* May 22 – 25, *2005,* Irvine, California.

6. Y. Hong, N. Ashgriz, J. Andrews, H. Parizi, "*Numerical Simulation of Growth and Collapse of a Bubble Induced by a Pulsed Micro Heater*", Journal of Microelectromechanical Systems, Vol. 13, No. 5, Oct. 2004.

7. M.P. Fard, N. Ashgriz, J. Mostaghimi, D.M. Levesque and S. Morrison, "*Film Thickness and Velocity Distribution in a Splash-Plate Atomizer: Comparison between Simulations and Experiments*", Proceedings of the 9th International Conference on Liquid Atomization and Spray Systems, Sorrento, Italy, July 2003.

8. Denise Levesque, Stuart Morrison, Mohammad P. Fard and Javad Mostaghimi, "*Simulation of the Spray Characteristics of Black Liquor*", PAPTAC 89th Annual Meeting (Pulp and Paper Technical Association of Canada), Montreal, January 2003.

9. H.B. Parizi, M.P. Fard, A. Dolatabadi, "*A computer code to design liquid containers for vehicles* ", Proceedings of Eleventh Annual Conference of the CFD Society of Canada.

10. Hamideh. B. Parizi, M.P.Fard, A. Dolatabadi, "*A Computer Code for Design Improvement in Liquid Containers for Road Vehicles*",Proceedings of AMT 2003, Advanced Manufacturing Technologies for the Automotive Industry, May 13-14, 2003 London, Canada.

11. M.P.Fard, Hamideh. B. Parizi, A. Dolatabadi, "*An Efficient Tool for Designing Fuel Injectors* ", Proceedings of AMT 2003, Advanced Manufacturing Technologies for the Automotive Industry, May 13-14, 2003 London, Canada.

12. M.P. Fard, N. Ashgriz, J. Mostaghimi, L.A. Prociw and T.C.J. Hu, "*Modeling Liquid Film Formation and Breakup in an Industrial Spray Nozzle*", in the proceedings of the 15th Annual Conference on Liquid Atomization and Spray Systems, Dearborn, MI, May 2002.

Other relevant publications.

1. M. Pasandideh-Fard, V. Pershin, S. Chandra, and J. Mostaghimi, "*Splat Shapes in a Thermal Spray Coating Process: Simulations and Experiments*", J. of Thermal Spray Technology, 11, 206-217, 2002.

2. J. Mostaghimi, M. Pasandideh-Fard and S. Chandra, "*Dynamics of Splat Formation in Plasma Spray Coating Process*", Plasma Chemistry and Plasma Processing, 22, 59-84, 2002.

3. M. Pasandideh-Fard, S. Chandra and J. Mostaghimi, "*A Three-Dimensional Model of Droplet Impact and Solidification*", Int. J. of Heat Mass Transfer, 45, 2229-2242, 2002.

4. M. Pasandideh-Fard, M. Bussmann, S. Chandra, and J. Mostaghimi,"*Simulating Droplet Impact on a Substrate of Arbitrary Shape*", Atomization and Sprays, 11, 397-414, 2001.

5. V. L. Pershin, M. Pasandideh-Fard, S. Chandra and J. Mostaghimi,"*Effect of Substrate Properties on the Formation of Plasma Sprayed Alumina Splats*", in the proceedings of the International Thermal Spray Conference, Singapore, May 2001.

6. M. Pasandideh-Fard, J. Mostaghimi and S. Chandra, " *3D Model of the Impact and Solidification of a Droplet on a Solid Surface*", AIAA 2001-2567, Anaheim, CA, 2001.

7. M. P. Fard, H. B. Parisi and J. Mostaghimi," *Computational Modeling of the Atomization of a Liquid Jet Impinging on a Solid Plate*", in the proceedings of the 9th Annual Conference of the CFD Society of Canada, Waterloo, 220-225, 2001.

8. M. Bussmann, S. Chandra, and J. Mostaghimi, "*Modeling the Splash of a Droplet Impacting a Solid Surface*", Physics of Fluids, Vol. 12, Number12, 2000.

9. M. Pasandideh-Fard, M. Bussmann, S. Chandra, J. Mostaghimi, "*Droplet Impact on a Tube: Simulations and Experiments*", 8th International Conference on Liquid Atomization and Spray Systems, Pasadina, CA, USA, July 2000.

10. M. Pasandideh-Fard, M. Bussmann, S. Chandra, and J. Mostaghimi, "*On a 3D Computational Model of Free Surface Flows including Internal Obstacles*", Proceedings of the 8th Annual Conference of the CFD Society of Canada, Montreal, 603-610, 2000.

11. M. Passandideh-Fard, J. Mostaghimi, S. Chandra, "*Numerical Simulation of Thermal Spray Coating Formation*", Proceedings of International Thermal Spray Conference, Montreal, 2000

12. M. Bussmann. J. Mostaghimi and S. Chandra, "*On a Three-Dimensional Volume Tracking Model of Droplet Impact*," Physics of Fluids, Vol. 11, pp. 1406-1417, 1999.

13. M. Pasandideh-Fard, S.D. Aziz, S. Chandra and J. Mostaghimi, "*Surface Cooling by an Impinging Water Drop*," paper HTD99-89, The 33rd National Heat Transfer Conference, Albuquerque, NM, August 15-17, 1999.

14. M. Pasandideh-Fard, J. Mostaghimi and S. Chandra, "*On a Three-Dimensional Model of Free Surface Flows with Heat Transfer and Solidification*," paper FEDSM99-7112, The 3rd ASME/JSME Joint Fluids Engineering Conference, San Francisco, CA, July 18-23, 1999.

15. M. Pasandideh-Fard, J. Mostaghimi and S. Chandra, "*Modeling Sequential Impact of Two Molten Droplets on a Solid Surface*," The ILASS-Americas 12th Annual Conference on Liquid Atomization and Spray Systems, Indianapolis, IN, May 16-19, 1999.

16. M. Bussmann, S. Chandra and J. Mostaghimi, "*Numerical results of off-angle thermal spray particle impact*," Proceedings of UTSC'99, pp 783-786, Düsseldorf, Germany, March 17-19, 1999. M. Pasandideh-Fard, R. Bhola, S. Chandra and J. Mostaghimi, "*Deposition of tin droplets on a steel plate: simulations and experiments*," International Journal of Heat and Mass Transfer, Vol. 41, pp 2929-2945, 1998.

17. M. Bussmann, S.D. Aziz, J. Mostaghimi and S. Chandra, "*Modeling the Fingering of Impacting Droplets*," Proceedings of CFD98, the 6th Annual Conference of the CFD Society of Canada, pp IV43-48, Quebec City, PQ, June 7-9, 1998.