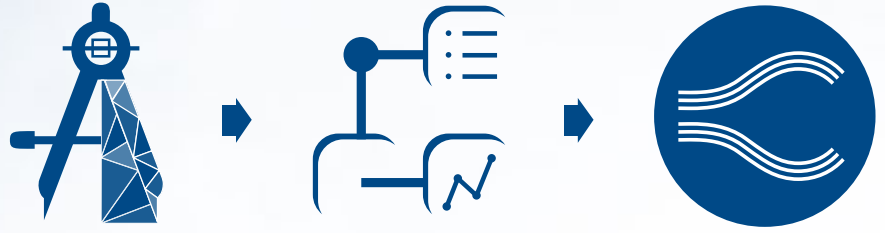CONFERENCE **AGENDA**

CONVERGE
2015 USER CONFERENCE

OCTOBER 5-9   RICHARD CHILDRESS RACING   **WELCOME, NC**

#CONVERGEUC2015

WELCOME

Kelly Senecal
Co-Owner, *Convergent Science*

WELCOME to the 2015 **CONVERGE** User Conference hosted by Richard Childress Racing in the lovely state of North Carolina. This year's conference features speakers from around the globe presenting on diverse topics ranging from race engine development and high performance computing to turbulent combustion modeling and aftertreatment systems. We are privileged to have keynote speeches by three leaders in internal combustion engine research. Thank you to all of our speakers for sharing your expertise with the **CONVERGE** community. We also thank this year's sponsors and invite you to visit their displays to learn more about their powerful products.

While we call this event our "User Conference," you're really much more than just a **CONVERGE** user. We believe that each of you is a collaborator, inspiring us to continue to innovate in a way that best meets your CFD needs. As a way of saying thank you, our goal is to offer a unique, informative, and enjoyable conference. During this week, we hope that you not only learn from fellow **CONVERGE** users but also get a behind-the-scenes view of NASCAR and kick back and relax at our networking activities.

On behalf of everyone at Convergent Science, thank you for attending our conference and we hope you enjoy the week.

SCHEDULE AT A GLANCE

	MORNING	AFTERNOON	EVENING
MONDAY 10/5	**INTRODUCTORY TRAINING** RCR Auditorium	**INTRODUCTORY TRAINING** RCR Auditorium	
TUESDAY 10/6	**WELCOME + PRESENTATIONS** RCR Auditorium	**PRESENTATIONS** RCR Auditorium	**NETWORKING: Wine Tasting + Murder Mystery Theater** Childress Vineyards *preregistration required*
WEDNESDAY 10/7	**PRESENTATIONS** RCR Auditorium	**PRESENTATIONS + CLOSING REMARKS** RCR Auditorium	**NETWORKING: Foothills Brewing Co.** Winston-Salem, NC *preregistration required*
THURSDAY 10/8	**ADVANCED TRAINING** RCR Auditorium	**ADVANCED TRAINING** RCR Auditorium	
FRIDAY 10/9	**ADVANCED TRAINING** RCR Auditorium	**ADVANCED TRAINING** RCR Auditorium	

KEYNOTE

Wayne Eckerle
Vice President of Corporate Research
and Technology, *Cummins*

Future Engine Technologies and the Importance of Modeling and Simulation in Their Development | Tuesday 8:30a–9:15a

WAYNE ECKERLE received BS (1975) and MS (1976) degrees in Aeronautical Engineering from Purdue University and a PhD in Fluid Mechanics from the University of Connecticut in 1985. Prior to joining Cummins, Wayne worked at UTRC for 10 years on a variety of internal flow projects including chemical laser systems, scramjets, and gas turbine combustion. Wayne was also an Associate Professor at Clarkson University teaching classes in Thermal Sciences and performing research in turbulent separated flows, two-phase flow heat transfer, and supersonic combustion.

Since joining Cummins in 1989 Wayne has held leadership positions in Metrology, Quality, Fuel Systems Technology, Thermal and Fluid Sciences, and Advanced Engineering. In his present position, Wayne is responsible for developing and integrating technology for Cummins' next generation of products. Wayne received the Cummins J. Irwin Miller Award of Excellence in 2005, an Honorary Doctorate from Purdue University in 2009, the Cummins Julius Perr Innovation Award in 2009, and became an SAE Fellow in 2011. Wayne is the holder of 10 US Patents.

Tang-Wei Kuo
Laboratory Group Manager: Diagnostics
and Simulation, *General Motors*

Automotive Engine CFD—Past, Present, and Future | Tuesday 4:20p–5:05p

TANG-WEI KUO has spent more than 30 years in the automotive industry working on advanced technology in the area of diesel and gasoline engines. He received his Bachelor degree in Mechanical Engineering from National Taiwan University in 1974 and Master's and Ph.D. degrees in Mechanical and Aerospace Engineering from Princeton University in 1979 and 1982, respectively.

Tang-Wei first joined Cummins Engine Company in 1981 and later joined GM in 1985. He is currently the Technical Fellow and Lab Group Manager heading research and development activities in the field of advanced optical diagnostics and Computational Fluid Dynamic (CFD) simulations. He also leads GM's global network in fundamental research on advanced spray, combustion, and emissions modeling through key collaborations with universities, national labs, and suppliers. He has earned more than 80 US and foreign patents and published more than 60 Technical papers. For his technical contributions, Kuo has received the Arch T. Colwell Merit Award from the Society of Automotive Engineers (SAE) International in 1984 and was elected Fellow of SAE International in 2012; Distinguished Paper Award, 32nd International Symposium on Combustion, from the Combustion Institute in 2008; Campbell and McCuen Special Achievement Innovation Awards from GM R&D in 2008; and GM's highest Chairman's Honor Award in 2008.

Eric Fluga
Engineering Technical Fellow,
Caterpillar

Why You Should Believe the Simulation | Wednesday 8:25a–9:10a

ERIC FLUGA is an Engineering Technical Fellow at Caterpillar. He has developed diesel engines and powertrains for over 30 years, using and developing simulations throughout his career. He led the group developing the ACERT technology used in most Caterpillar diesel engines today. He was a developer of Caterpillar's diesel engine performance simulation program and coupled it with the powertrain simulation program which is now used for complete vehicle performance modeling at Caterpillar. He led joint programs between Caterpillar and the US Department of Energy to improve engine fuel efficiency. He has 24 patents and has presented at SAE and US DOE conferences.

Eric started his engineering career at Ford in 1979 and joined Caterpillar 1981. He holds Bachelor's and Master's degrees in Mechanical Engineering, both from the University of Illinois.

MORNING

7:30 – 8:00	**REFRESHMENTS**
8:00 – 8:30	**WELCOME** Austin Dillon, Ty Dillon *NASCAR Sprint Cup, NASCAR XFINITY*
8:30 – 9:15	**KEYNOTE** Future Engine Technologies and the Importance of Modeling and Simulation in Their Development Wayne Eckerle, *Cummins*
9:15 – 9:40	Reducing the Time of the Racing Engine Development Cycle at ECR Engines Brian Kurn, *Earnhardt Childress Racing (ECR) Engines*
9:40 – 10:05	Understanding the Change Nathan Sykes. *Red Bull Racing*
10:05 – 10:20	**BREAK**
10:20 – 10:45	Large Eddy Simulation of Non-Reacting and Reacting JP8 Sprays with a Kerosene Surrogate and Detailed Chemistry Luis Bravo, *Army Research Laboratory*
10:45 – 11:10	Determining the Luminosity-Based Ignition Delay in Turbulent Spray Combustion Omid Samimi Abianeh, *Georgia Southern University*
11:10 – 11:35	Status and Roadmap for Engine Aftertreatment Scott Drennan, *Convergent Science*
11:35 – 1:00	**LUNCH + TOURS** *Richard Childress Racing* Immerse yourself in racing with a behind-the-scenes look at the Richard Childress Racing facility. The 20-minute tour will take you from frame to finish and include a look at how the pit crews train to stay race ready week after week.

AFTERNOON / EVENING

1:00 – 1:25	Numerical Study of Flash Boiling for a GDI Fuel Injector in the Eulerian Framework Kaushik Saha, *Argonne National Laboratory*
1:25 – 1:50	Applications of RANS and LES Simulations in Analyzing Jet Ignition Process for IC Engines Prasanna Chinnathambi, *Mahle*
1:50 – 2:05	**SPONSOR:** SmartUQ
2:05 – 2:20	**SPONSOR:** Penguin Computing
2:20 – 2:45	Scaling up a High-Fidelity IC Engine Simulation on 4096 Processors of an IBM Blue Gene/Q Supercomputer Janardhan Kodavasal, *Argonne National Laboratory*
2:45 – 3:10	Achieving Overnight Combustion Simulations with 1000+ Species using **CONVERGE** and Tabkin® Ferry Tap, *Dacolt*
3:10 – 3:30	**BREAK**
3:30 – 3:55	Two-Stroke Reed FSI Modeling and Validation Paul Westhoff, *BRP*
3:55 – 4:20	Shifting the CFD Paradigm with **CONVERGE** Daniel Lee, *Convergent Science*
4:20 – 5:05	**KEYNOTE** Automotive Engine CFD—Past, Present, and Future Tang-Wei Kuo, *General Motors*
5:05 – 5:15	Day One Closing Remarks
6:30 – 10:00	**MURDER MYSTERY DINNER THEATER + WINE TASTING** *Childress Vineyards*

* On Tuesday the RCR Museum will remain open until 6p for conference attendees.

WEDNESDAY, OCTOBER 7

MORNING

Time	Event
7:30 – 8:00	**REFRESHMENTS**
8:00 – 8:25	**CONVERGE in Europe** Chris Riley, *Convergent Science*
8:25 – 9:10	**KEYNOTE** Why You Should Believe the Simulation Eric Fluga, *Caterpillar*
9:10 – 9:35	3D Combustion CFD Using Converge: FCA Applications Haiwen Ge, *Fiat Chrysler Automobiles*
9:35 – 10:00	Application of High Performance Computing for Simulating Cycle-to-cycle Variation in Dual Fuel Combustion Engines Roy Primus, *General Electric*
10:00 – 10:15	**BREAK**
10:15 – 10:40	Predictive Turbulent Combustion Modeling and Tabulated Auto-Ignition for Diesel Engine CFD Simulation Antonio Pires da Cruz, *IFP Energies nouvelles*
10:40 – 11:05	Soot Modeling with the PSM Model in a Diesel Engine: Results and Discussion Frederic Ravet, *Renault*
11:05 – 11:30	Combustion System Optimization with **CONVERGE** Clément Dumand, *PSA Peugeot Citroën*
11:30 – 12:30	**LUNCH + TOURS** *Richard Childress Racing* Immerse yourself in racing with a behind-the-scenes look at the Richard Childress Racing facility. The 20-minute tour will take you from frame to finish and include a look at how the pit crews train to stay race ready week after week.

AFTERNOON / EVENING
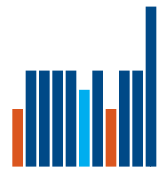
Time	Event
12:30 – 12:45	**SPONSOR:** Rescale
12:45 – 1:10	Case Studies from Japanese **CONVERGE** Users Masatoshi Ishikawa, *IDAJ*
1:10 – 1:35	Global Sensitivity Analysis of Diesel Engine Simulations Yuanjiang Pei, *Argonne National Laboratory*
1:35 – 2:00	Combustion and Emission Modeling in **CONVERGE** with LOGE Models Corinna Netzer, *Loge Deutschland GmbH*
2:00 – 2:25	Analysis of the Gasoline PPC Concept in a Poppet Valve 2-stroke HSDI CI Engine by Combining Experimental and CFD Modeling Activities Ricardo Novella, *CMT-Motores Térmicos*
2:25 – 2:45	**BREAK**
2:45 – 3:10	Uniformity Study of a Large SCR Urea After-Treatment System Xiao Fu, *Electro-Motive Diesel*
3:10 – 3:25	**SPONSOR:** TotalCAE
3:25 – 3:50	Engine Valve Temperature Prediction Using **CONVERGE** Ben Cantrell, *Caterpillar*
3:50 – 4:15	Obtaining Flame Statistics from Large Eddy Simulation of Reacting Spray Flames Muhsin Ameen, *Argonne National Laboratory*
4:15 – 5:00	Roundtable Discussion *Convergent Science*
6:30 – 10:00	**FOOTHILLS BREWING CO. + LIVE BLUEGRASS MUSIC** *Winston-Salem, NC* *Bus leaves at **6:00pm**. Please see pg. 10 for more information about transportation to and from the event.*

TRAINING SCHEDULE OVERVIEW + DESCRIPTIONS

MONDAY, OCTOBER 5

RCR AUDITORIUM : ROOM A

Introduction to CONVERGE
8a-noon, 1p-5p
RCR Auditorium

Lunch is provided between noon and 1pm for all training attendees.

THURSDAY, OCTOBER 8

RCR AUDITORIUM : ROOM A

Conjugate Heat Transfer Modeling in CONVERGE
8a-noon
RCR Auditorium | Room A

Advanced Surface Preparation Tools in CONVERGE Studio
1p-3p
RCR Auditorium | Room A

Advanced Post-Processing Tools in CONVERGE Studio
3p-5p
RCR Auditorium | Room A

FRIDAY, OCTOBER 9

RCR AUDITORIUM : ROOM A

New Features in CONVERGE
8a-9a
RCR Auditorium | Room A

Radiation Modeling in CONVERGE
9a-10a
RCR Auditorium | Room A

Advanced Combustion Modeling in CONVERGE
10a-noon
RCR Auditorium | Room A

Fluid-Structure Interaction Modeling in CONVERGE
1p-3p
RCR Auditorium | Room A

Volume of Fluid Modeling in CONVERGE
3p-5p
RCR Auditorium | Room A

THURSDAY, OCTOBER 8

RCR AUDITORIUM : ROOM B

Ensight Advanced Training
8a-noon
RCR Auditorium | Room B

Scaling CONVERGE Simulations with Cloud HPC: Basic Simulation Setup + Advanced Training
noon-1p (*lunch provided*)
RCR Auditorium | Room B

Genetic Algorithm Optimization in CONVERGE
1p-3p
RCR Auditorium | Room B

Engine Aftertreatment Modeling in CONVERGE
3p-5p
RCR Auditorium | Room B

FRIDAY, OCTOBER 9

RCR AUDITORIUM : ROOM B

CONVERGE—GT SUITE Coupling
8a-10a
RCR Auditorium | Room B

Sealing in CONVERGE
10a-noon
RCR Auditorium | Room B

CONVERGE for General Purpose CFD
1p-3p
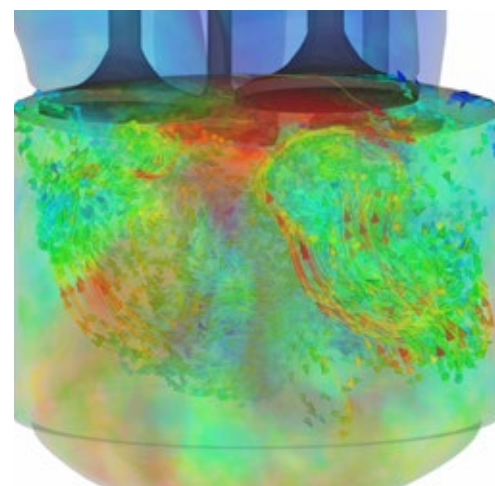*RCR Auditorium | Room B*

Gas Turbine Combustion Modeling in CONVERGE
3p-5p
RCR Auditorium | Room B

CONVERGE TRAINING

Convergent Science is proud to offer effective, engaging training. Our experienced Support Team offers free introductory training several times per year at our world headquarters in Madison, WI. The one-day Introduction to **CONVERGE** Studio course includes plenty of hands-on practice as you prepare several geometries for simulation. The multi-day Introduction to **CONVERGE** course provides a comprehensive introduction to each step of the **CONVERGE** workflow and to the many options available in **CONVERGE**. We also offer onsite training for our customers' convenience.

In addition to introductory training, we offer advanced **CONVERGE** training on topics such as CHT, advanced combustion modeling, genetic algorithm optimization, and fluid-structure inter-action modeling. Advanced training is available at our annual user conference and at other times on request.

We also host webinars throughout the year. Presented by Convergent Science software developers and support engineers as well as our partners, these webinars help you learn how to get more out of your **CONVERGE** experience. Webinar topics include how to set up user-defined functions and how to use high-performance computing and cloud solutions for **CONVERGE**.

Introduction to CONVERGE
MONDAY, 8a – noon, 1p – 5p
RCR Auditorium: A + B

This one day workshop, which will be held prior to the user conference and the advanced workshops, will provide an introduction to **CONVERGE**. We will start our discussion with pre-processing tasks such as surface import, surface cleanup, and boundary flagging using an example engine geometry. We will then practice working through the case setup process, including assigning boundary conditions and initial conditions, in **CONVERGE** Studio. We will close by discussing the mesh manipulation strategies in **CONVERGE**. In this workshop we will not discuss physical models for processes such as turbulence, spray, and combustion because many of these models will be discussed in the advanced workshops. If you plan to attend any of the advanced workshops after the UGM but have not yet taken the **CONVERGE** introductory training, we highly recommend attending this introductory workshop.

Conjugate Heat Transfer Modeling in CONVERGE
THURSDAY, 8a – noon
RCR Auditorium: A

For several years **CONVERGE** has been able to interface with other software packages to model heat transfer in solids. Now **CONVERGE** can do both CFD and solid heat transfer modeling in the same simulation, which can greatly simplify the process of predicting temperature in solids that are dependent on fluid interfaces, e.g., heads and valves in engines. **CONVERGE** also has a built-in supercycle feature to account for the disparate timescales in the solid and fluid domains by allowing the solid side of the simulation to progress with faster timescales than the fluid side of the simulation. **CONVERGE** 2.3 has an additional feature for modeling valve/seat contact resistance in engines, which is critical to accurate prediction of valve and head temperatures.

Advanced Surface Preparation Tools in CONVERGE Studio
THURSDAY, 1p – 3p
RCR Auditorium: A

CONVERGE Studio 2.3 contains powerful new tools for cleaning even exceptionally dirty geometries. This workshop will discuss several of these new features. The Coarsen tool can be used to reduce the number of triangles in a geometry, which may be useful when working with a large geometry. The Boolean tool can perform Boolean operations such as union, intersection or difference. The surface healing tool, which was one of the most-requested features, can fix geometry problems with the click of a button. We will discuss the advantages and limitations of this feature. Finally, the surface wrapper tool can create watertight models by wrapping the existing geometry to create a new surface.

Advanced Post-Processing Tools in CONVERGE Studio
THURSDAY, 3p – 5p
RCR Auditorium: A

CONVERGE Studio is not just for pre-processing! There are several powerful post-processing tools in the Line Plotting module in **CONVERGE** Studio. This workshop will discuss (1) how to generate and customize plots and create reports, (2) how to combine output files from multiple restarts, (3) how to use the Fast Fourier Transform calculator to transform the signal between the time and frequency domains and to complete engine knock analysis, (4) how to use the Apparent Heat Release calculator to calculate the apparent heat release from a pressure signal, and (5) how to use the Engine Work calculator to calculate the work and IMEP from cylinder pressure.

CONVERGE + CHT

Unlike most CFD codes, which must be coupled with an FEA code, **CONVERGE** combines conjugate heat transfer (CHT) analysis of the solids with the fluid calculations to provide an all-in-one solution. With its fully-coupled and automated meshing approach, **CONVERGE** automatically creates a mesh for both the fluid and solid at runtime, which makes setup for CHT analysis easy and efficient.

This unique approach uses time-based spatially averaged temperature and heat transfer coefficients to perform the steady-state heat transfer calculations. Super-cycling provides the ability to run coupled fluid and heat transfer simulations efficiently and allows for transient heat transfer calculations without the need for extended simulation times. And with **CONVERGE**'s Cartesian meshing with the cut-cell technique, moving components are handled with ease and accuracy without the need to stretch or deform the mesh.

FULLY COUPLED CHEMISTRY

Rather than requiring you to run your chemistry models separately, the chemistry and CFD solvers are fully coupled in **CONVERGE**. **CONVERGE** solves chemistry at each time step and then sends updated mass fraction and temperature data back to the solver.

CONVERGE includes an efficient, parallelized solver with no mechanism size limit. Our solver is equipped with a multi-zone model, dynamic mechanism reduction (DMR), and adaptive preconditioning to increase the efficiency of linking detailed chemistry with CFD. With these techniques, mechanisms with up to 1,000 species are now being simulated with **CONVERGE**. Detailed chemistry coupled with AMR offers the ability to study complex phenomena such as extinction, ignition, and emissions with ease.

In addition, **CONVERGE** contains state-of-the-art combustion models such as ECFM3Z, RIF, FGM, and G-Equation. Coupled with automated meshing, these models help you optimize the speed versus accuracy trade-off. Our GT-POWER coupling allows for complex chemistry analysis inside the SCR catalyst brick. Take advantage of fully coupled urea-water spray 3D simulations with proven 1D SCR chemistry analysis using detailed surface chemistry for NOx reduction and ammonia slip predictions.

Ensight Advanced Training
THURSDAY, 8a – noon
RCR Auditorium: B

In this workshop we will assume that attendees have a basic understanding of EnSight. EnSight is a powerful post-processing tool. This four-hour workshop will focus on advanced usage of EnSight, mainly pertaining to IC engines. We will discuss topics including plane tool clips (with arbitrary orientation); uniformly spaced vector arrows; auxiliary clipping; path line simulations; offset paths; queries and plotters; importing and plotting *.out files from **CONVERGE**; volume rendering to plot soot, NOx, etc.; and spray visualization, **CONVERGE**-customized versions of EnSight, multi-case comparisons, remote server connect, automation using Python (swirl/tumble, moving clip plane, etc.), advanced animations (keyframe), and frame modenew features and updates in version 10.1 as well as what's coming in version 10.2.

Scaling CONVERGE Simulations with Cloud HPC: Basic Simulation Setup + Advanced Training
THURSDAY, noon – 1p
RCR Auditorium: B

Looking to run your **CONVERGE** simulations more efficiently and with the latest hardware? Now you can, with Rescale's cloud simulation platform. Come eat and learn with members of Rescale's technical engineering team as they spend a few minutes explaining how to easily and quickly set up a **CONVERGE** job on Rescale's platform, and then dive into more advanced features. Rescale's engineering team will show you how to specifically monitor **CONVERGE** jobs, run custom builds and user defined functions, as well as perform remote visualization using Ensight directly from Rescale's platform.

Genetic Algorithm Optimization in CONVERGE
THURSDAY, 1p – 3p
RCR Auditorium: B

This workshop will focus on model optimization in **CONVERGE**, including Genetic Algorithm (GA) optimization and Design of Experiments (DoE) model interrogation. We will discuss different types of optimization and the details of the GA methodology, and we will use examples to illustrate how to set up the utility, select parameters, and run an optimization. Finally, we will discuss the best practices of optimization, such as model setup, parameter and range selection, and search space considerations, and advanced applications such as geometry modification.

Engine Aftertreatment Modeling in CONVERGE
THURSDAY, 3p – 5p
RCR Auditorium: B

This workshop will focus on the application of **CONVERGE** to urea/SCR engine aftertreatment. We will discuss urea decomposition and hydrolysis to ammonia, and we will describe the setup and physical properties of Urea Water Spray (UWS) modeling in **CONVERGE**. In addition, we will review wall film and wall interaction models, phenomena (filming, rebounding, stripping, and separating) that can lead to urea deposit formation, and the application of conjugate heat transfer (CHT) for accurate wall thermal boundary conditions. We will discuss SCR surface chemistry approaches that use **CONVERGE** coupled with GT-SUITE. This workshop will include sample cases for practical urea/SCR systems as well as validation cases. Finally, we will discuss future development for engine aftertreatment.

New Features in CONVERGE
FRIDAY, 8a – 9a
RCR Auditorium: A

The Convergent Science development team is constantly improving **CONVERGE**, both to make its current features more efficient and to add novel capabilities. In this workshop we will discuss spray-, combustion-, turbulence-, and numerics-related enhancements that will yield more accurate or efficient simulations and novel additions that can help you extend the reach of your numerical analyses.

Radiation Modeling in CONVERGE
FRIDAY, 9a – 10a
RCR Auditorium: A

Radiative energy transfer is important in high temperature simulations that include gases and surfaces that emit, absorb, and scatter radiative energy. This workshop will focus on the theory behind the Discrete Ordinates Finite Volume Method (DO-FVM), the different radiation submodels, and how to model radiative energy transfer in **CONVERGE** simulations. We will set up example cases that have thermal radiation in flows with and without combustion as well as a case that uses non-thermal ultraviolet radiation.

Advanced Combustion Modeling in CONVERGE
FRIDAY, 10a – noon
RCR Auditorium: A

CONVERGE contains a variety of combustion sub-models for three-dimensional combustion modeling in internal combustion (IC) engines. In this workshop, we will discuss five advanced combustion models: the delta PDF combustion model (SAGE), the G-equation combustion model, the Representative Interactive Flamelet (RIF) combustion model, the 3-Zone Extended Coherent Flame Model (ECFM3Z), and the Flamelet Generated Manifold (FGM) combustion model (new in **CONVERGE** 2.3). Among these models, the G-equation model is suitable for simulating premixed spark ignition processes in gasoline engines, while the RIF and ECFM3Z models are used for simulating diffusion-controlled diesel engines. The SAGE and FGM models are generalized combustion models that can be applied to diffusion controlled diesel engine simulations or premixed gasoline engine simulations. This workshop will focus on the underlying theory of these combustion models, the advantages and disadvantages of each model, and how these models are coupled with the CFD solver in **CONVERGE**.

Fluid-Structure Interaction Modeling in CONVERGE
FRIDAY, 1p – 3p
RCR Auditorium: A

Rigid body fluid-structure interaction (FSI) describes how the presence of one or more immersed objects affects the flow field and how the forces from the surrounding fluid influence the dynamics of the object. This workshop will discuss the theory behind FSI, the numerics of the dynamics solver, and the coupling of the dynamics solver to the flow solver in **CONVERGE**. It will also cover several examples (a pressure relief valve, a spool valve, and an injector armature) that highlight the current capabilities of **CONVERGE**. Finally, we will discuss complex examples that invoke a user-defined function coupled with FSI to model deforming bodies such as reed valve petals or a spring-close ball valve.

Volume of Fluid Modeling in CONVERGE
FRIDAY, 3p – 5p
RCR Auditorium: A

Volume of fluid (VOF) methods are some of the most popular numerical techniques for locating moving and deforming interfaces between fluids in multiphase flow simulations. In this workshop, we will discuss numerical details, example cases, and some validation calculations for the various VOF options in **CONVERGE**. One VOF method in **CONVERGE** is based on the species mass fraction equation and is appropriate for miscible or compressible multiphase flow calculations. **CONVERGE** 2.3 contains two new approaches based on the mass fraction-based VOF - one-way coupling and the Eulerian-Lagrangian Spray Atomization (ELSA) model - for detailed simulation of sprays. Another VOF method, which solves for the void fraction directly, is available in **CONVERGE** as two separate schemes: Piecewise-Linear Interface Calculation (PLIC) and High-Resolution Interface-Capturing (HRIC). These schemes have been tested on a range of problems including a breaking dam, a rising droplet, and spray injection, and each test case illustrates the ability of the method to track interfaces sharply.

HANDLING MOVING GEOMETRIES WITH EASE

CONVERGE's unique Cartesian meshing with cut-cell technique makes obtaining accurate results from moving geometries a reality. Our technique maintains the model fidelity regardless of the mesh resolution and allows for complex component motion without a moving or stretching mesh. This technique increases accuracy and, combined with **CONVERGE**'s fully coupled and automated meshing, makes setup as simple as specifying the axis and velocity of the moving component.

CONVERGE can simulate the moving components and tight clearances required for many applications. No user meshing time is required – simply set up your grid parameters and **CONVERGE** will automatically create the mesh and add resolution when and where it is needed.

CONVERGE's Adaptive Mesh Refinment (AMR) technology refines the mesh intelligently. AMR adjusts the grid based on user-specified quantities to efficiently address the runtime versus accuracy trade-off. In addition to AMR, **CONVERGE** includes fixed embedding and other grid scaling options.

CONVERGE's unique meshing approach and advanced AMR technology help you achieve the desired level of accuracy without requiring any user meshing time. Grid-convergent results are now a reality. Use **CONVERGE** to generate stable, accurate results suitable for analyzing complex design alternatives with moving gemoetries.
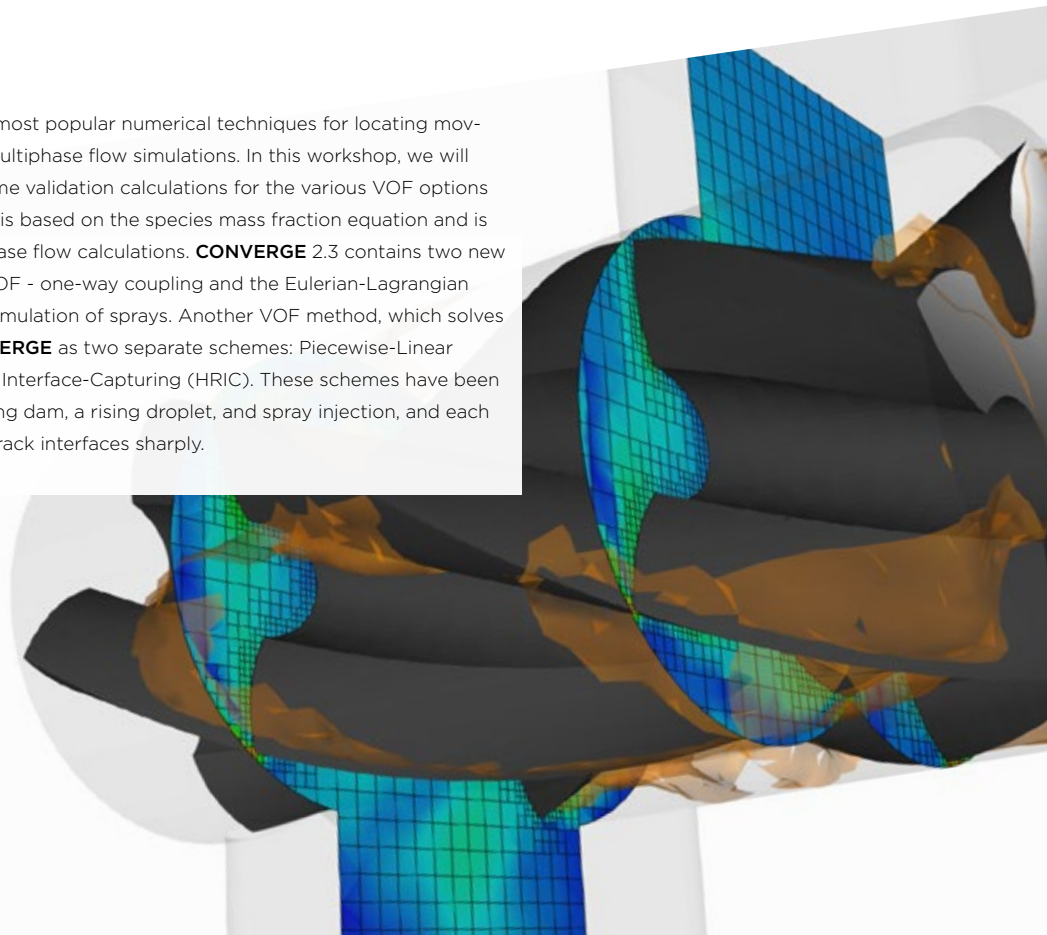
FLUID-STRUCTURE INTERACTION

Because the meshing process is completely automated at runtime in **CONVERGE**, you can quickly obtain accurate results for your fluid-structure interaction problems. **CONVERGE** uses a stationary, orthogonal mesh that, when combined with Adaptive Mesh Refinement (AMR), drastically reduces runtimes and increases accuracy by putting cells only where they are needed.

With AMR, **CONVERGE** automatically refines the grid based on fluctuating and moving conditions such as temperature or velocity. You can specify the important variables (*e.g.*, velocity for a flow case), and **CONVERGE** will refine the grid based on these variables.

CONVERGE also accomodates fixed grid embedding. Fixed grid embedding allows you to easily specify regions in the domain where additional resolution is needed. To improve the accuracy of the simulation while minimizing the computational time, **CONVERGE** includes options for you to control the location and duration of each embedding.

With its fully coupled and automated meshing capabilities, **CONVERGE** is well-suited to analyze and optimize fluid-structure interaction problems.

CONVERGE—GT SUITE Coupling
FRIDAY, 8a - 10a
RCR Auditorium: B

CONVERGE and GT-SUITE can be coupled in a variety of ways. This workshop will demonstrate two coupling options. (1) In conventional 1D-3D coupling, **CONVERGE** performs a 3D simulation while GT-SUITE performs a 1D simulation. The information at the interfaces is exchanged or mapped between the two programs. (2) In hydromechanical coupling, you define a system with rigid bodies in GT-SUITE and subject the rigid bodies to fluid forces and constraints using **CONVERGE**. **CONVERGE** calculates the forces on the object and relays this information to GT-SUITE. GT-SUITE then solves the rigid body dynamics equations to update the object's state and sends this information back to **CONVERGE**. Finally, **CONVERGE** moves the object.

Sealing in CONVERGE
FRIDAY, 10a – noon
RCR Auditorium: B

CONVERGE's sealing tool will close gaps between parts that are moving relative to one another. The sealing process is dynamic in that the surface enclosing the computational domain is recreated at each time-step based on the boundary motion and the seal definitions, and thus this tool can be applied to cases where gaps between moving boundaries need to be sealed dynamically, including two-stroke engines, Wankel engines, components connected by pins and bearings, pumps, and rotating machinery. In this workshop, we will give an overview of the sealing algorithm and explain the geometric approach used to recreate the sealed, watertight surface from the boundaries and seal definitions. We will then discuss best practices for surface preparation and case setup. Lastly we will demonstrate specific examples of applying seals to a check valve, a two-stroke engine, a Wankel engine, crankcase components, a gerotor pump, and a supercharger.

CONVERGE for General Purpose CFD
**FRIDAY**, 1p – 3p
RCR Auditorium: B

CONVERGE has taken the in-cylinder engine CFD simulation world by storm. But the features that make **CONVERGE** so powerful as an engine simulator-automatic, Cartesian cut-cell meshing and Adaptive Mesh Refinement (AMR) - also provide tremendous benefits for general-use applications. In this workshop, we will focus on some of the general-use applications for which we have recently used **CONVERGE** to generate captivating and illuminating transient results. We will talk about why automatic, Cartesian cut-cell meshing and AMR are perfect tools for capturing complex flow through small clearances, complex geometry, and moving parts, regardless of the industry or application. We will also talk about how the use of our fluid-structure interaction (FSI) model has enabled us to capture flow concepts that previously have been studied only with steady-state analysis in other CFD codes. Attend this session to discover how **CONVERGE** can help you save setup time and achieve insightful transient results for your most complex and challenging CFD applications.

Gas Turbine Combustion Modeling in CONVERGE
FRIDAY, 3p – 5p
RCR Auditorium: B

This workshop will focus on the application of **CONVERGE** to gas turbine combustion and combustor analysis. We will review how to set up liquid and gaseous fuels for gas turbines and discuss the use of both the detailed chemistry model and the new Flamelet Generated Manifold (FGM) model for gas turbine models. We will discuss several other topics as well: wall temperature predictions with conjugate heat transfer (CHT); transient RANS and LES simulations and steady-state analysis in reacting and non-reacting cases; gas turbine ignition, Lean Blow Out (LBO), and extinction; and emissions analysis for NOx, CO, and soot.
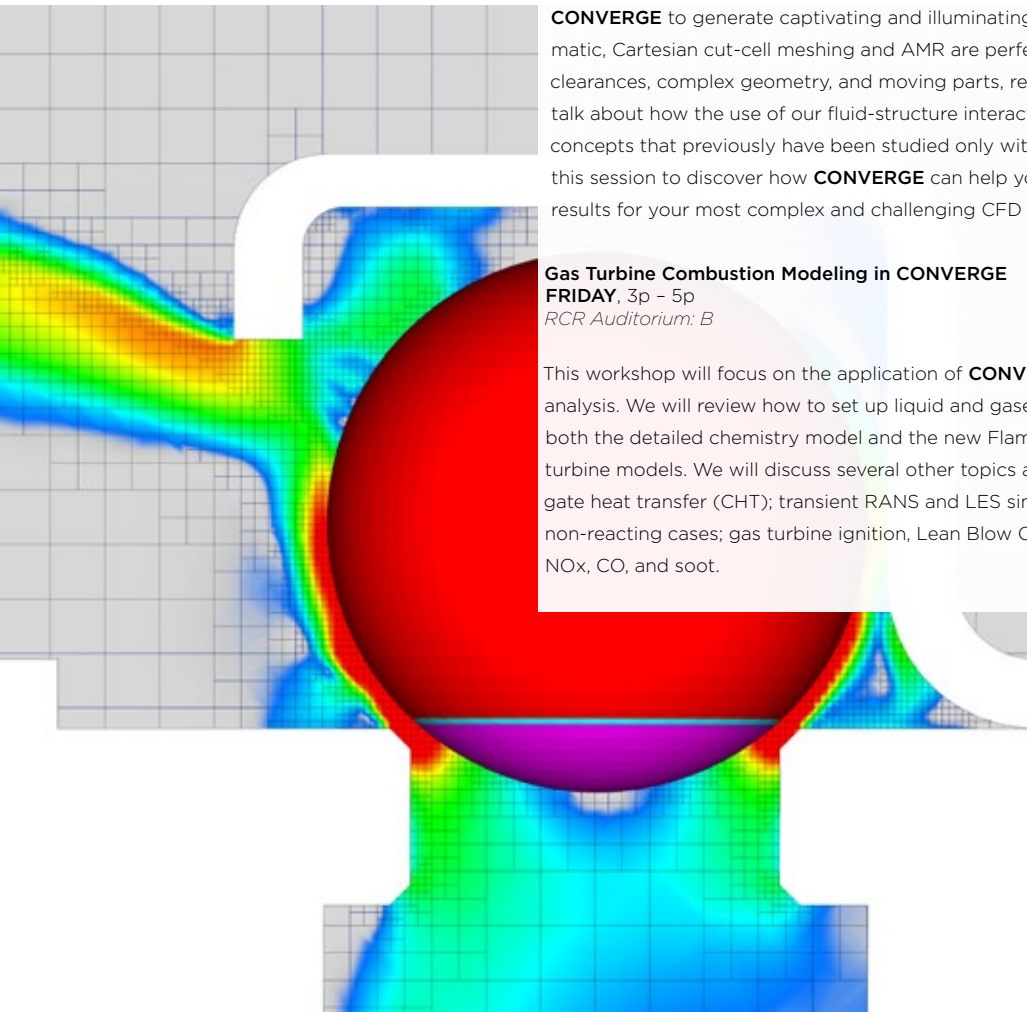
NETWORKING INFORMATION

MURDER MYSTERY DINNER THEATER AND WINE TASTING
Tuesday, 6:30p – 10p
Childress Vineyards

The vineyard is within walking distance of the hotel. Directions are available at the hotel front desk.
Preregistration required.

Join us for an evening of networking in a relaxed atmosphere on the close of day one's presentations. The Murder Mystery Company will host participants in an evening of murder mystery dinner theater. Things take a turn for the gutter at Mafia Don Lou Zar's juice joint when someone is put on ice! The crowd is chock full of potential suspects. Jealous, jilted lovers, a rival Mafioso, and a pair of undercover feds make an appearance at this speakeasy and not a single person is muttering a word! Help find out who's on the level and who's on the lam by trading clues with your guests, gathering information, and solving the crime before the murderer hotfoots it out of there!

Childress Vineyards features 72 acres of vineyards and 11 varieties of European Vitis vinifera cultivars. The terroir, with its combination of humid climate, long growing season and gravely, red clay soil are the key natural features of Childress Vineyards. Childress Vineyards produces a broad range of wines to appeal to both the introductory palate and the seasoned taster. More than 30 wines are produced including Classic house blends, premium varietals, a sparkling wine, dessert wines, Reserves, Signature Reserves and Muscadine wines.

FOOTHILLS BREWING COMPANY + LIVE BLUEGRASS MUSIC
Wednesday, 6:30p – 10p (***bus leaves at 6:00pm***)
Foothills Brewing Company

*Bus leaves for Winston-Salem at **6:00pm.** Bus seating is limited*.
Preregistration required.

Join us for an evening of live traditional bluegrass music and networking in near-by Winston-Salem, NC. Bluegrass music developed as a style during the mid 1940s. Musically, bluegrass is typically thought of as a combination of old-time music, blues, ragtime and jazz and is generally played with accoustic instruments such as the banjo, mandolin, fiddle, guitar and bass. Local styles and instrument choices may vary among musicians.

Foothills Brewing Co. began brewing beer at their West 4th Street location in March 2005, with three 15-barrel fermenters. The main pub also includes a full menu of food concoted by Chef Shane. He brings a wealth of experience and cooking savvy to the Foothills kitchen.

GOLD
SPONSORS

CONVERGE
CFD SOFTWARE

CONVERGE is a multipurpose computational fluid dynamics (CFD) code with innovative features including a fully coupled automated mesh created at runtime and Adaptive Mesh Refinement (AMR).

CONVERGE
IN THE CLOUD

CONVERGE in the cloud is now available for small to mid-size companies and larger companies with overflow. Experience the power of **CONVERGE** on a pay-per-use basis without any of the overhead costs associated with a large computational cluster.

CONVERGE
CFD SOFTWARE *Lite*

GT-SUITE users can take advantage of the power of the **CONVERGE** workflow at no extra cost.

INSPIRING INNOVATION

JOIN US next fall for the **2016 USER CONFERENCE** in Madison, WI.

CONVERGENT SCIENCE

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