September 26–30, 2016 | Madison, WI

# CONVERGE
## USER CONFERENCE
### 2016

**KNOWLEDGE**

**NETWORK**

**PERSPECTIVE**

#CONVERGEUC

# WELCOME #CONVERGEUC



**KELLY SENECAL**
CO-OWNER, CONVERGENT SCIENCE

**WELCOME** to the 2016 CONVERGE User Conference! This year's conference is back in our world headquarters of Madison, Wisconsin and features speakers and attendees from around the globe. We are pleased to offer presentations on topics ranging from reciprocating compressors and blood damage modeling to aftertreatment systems and wind tunnel design. Success in these diverse applications is a testament to the applicability of **CONVERGE**'s truly unique CFD approach to a wide array of flow problems. But as **CONVERGE** is increasingly used for new applications, reacting flows remain at the heart of what we do. This is showcased by numerous presentations on combustion modeling, fuel injection, and internal combustion engines, including our three keynotes by research leaders from Southwest Research Institute, Fiat Chrysler Automobiles, and Sandia National Labs.

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 have a chance to kick back and relax at our networking activities.

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

| | MORNING | AFTERNOON | EVENING |
|---|---|---|---|
| **MONDAY 9/26** | **INTRODUCTORY CONVERGE TRAINING + ENSIGHT TRAINING** Convergent Science | **INTRODUCTORY CONVERGE TRAINING + ENSIGHT TRAINING** Convergent Science | **NETWORKING: Welcome Reception** The Edgewater hotel *Sky Bar* |
| **TUESDAY 9/27** | **WELCOME + PRESENTATIONS** The Edgewater hotel *Grand Ballroom* | **PRESENTATIONS** The Edgewater hotel *Grand Ballroom* | **NETWORKING: CONVERGE Casino Night** The Edgewater hotel *Grand Ballroom* |
| **WEDNESDAY 9/28** | **PRESENTATIONS** The Edgewater hotel *Grand Ballroom* | **PRESENTATIONS** The Edgewater hotel *Grand Ballroom* | **NETWORKING: Trivia Night** The Edgewater hotel *Sky Bar* |
| **THURSDAY 9/29** | **ADVANCED TRAINING** Convergent Science | **ADVANCED TRAINING** Convergent Science | |
| **FRIDAY 9/30** | **ADVANCED TRAINING** Convergent Science | **ADVANCED TRAINING** Convergent Science | |

### Combustion Systems and "The Art of Development"
Tuesday 8:00a–8:40a

RON REESE received his B.S. in Mechanical Engineering in 1984 from The Ohio State University. Immediately upon graduation, he joined Chrysler, which in 2014 became Fiat Chrysler Automobiles (FCA). The majority of Reese's career has been spent within the Powertrain organization, where he led the combustion system development on several engine programs. Reese has been responsible for all engine performance simulations within FCA, including both 1D and 3D. More recently he was responsible for all pre-production and advanced gasoline combustion system development at FCA, including the highly successful DOE-funded "MultiAir MultiFuel" project. In January of 2016, Reese was promoted to the position of Senior Technical Fellow—ICE Combustion and Thermodynamics, which is the highest technical rank within FCA; he now advises the global company in this area. Reese has been an active member of CRC, USCAR, and the USDRIVE Advanced Combustion and Emissions Control Tech Team.

**RONALD A. REESE, II**
Senior Technical Fellow
ICE Combustion and Thermodynamics
*Fiat Chrysler Automobiles*

### Spray Combustion Research for the Engine Combustion Network
Tuesday 2:35p–3:15p

DR. LYLE PICKETT has been employed at Sandia National Laboratories' Combustion Research Facility, in Livermore, California, since 2000, where he is a Distinguished Member of the Technical Staff. He earned a PhD from the University of Wisconsin-Madison and B.S. and M.S. degrees from Brigham Young University, all in mechanical engineering. His group at Sandia is recognized for state-of-the art research using optical engines and laser-based diagnostics of combustion. Pickett's research expertise is in spray combustion in a unique chamber that produces engine-relevant conditions. Pickett leads an effort to share datasets at these conditions online through the Engine Combustion Network (www.sandia.gov/ECN), which is an international experimental and modeling collaboration dedicated to the improvement of engine CFD codes. He also leads the Spray Combustion Consortium, linking internal nozzle flows to spray mixing and combustion.

**LYLE M. PICKETT**
Distinguished Member of Technical Staff
*Sandia National Laboratories*

### CFD as an Integral Tool for Development of Current and Future Engine Systems
Wednesday 8:00a–8:40a

DR. CHARLES ROBERTS JR., is Director of Diesel Engines and Emissions R&D at Southwest Research Institute (SwRI) and is a Fellow of the Society of Automotive Engineers (SAE). Roberts manages R&D activity for diesel engines and emissions at SwRI, including emissions certification. Roberts also manages the SwRI Clean Diesel program, one of the world's longest-running and largest diesel engine cooperative research consortia, consisting of more than 20 client-companies from around the world. Roberts has authored over 35 technical papers and holds over 20 U.S. patents.

**CHARLES E. ROBERTS, JR.**
Director, Diesel Engines and Emissions
R&D, Engine, Emissions and Vehicle
Research Division
*Southwest Research Institute*

# PRESENTATION SCHEDULE DETAIL

**7:45–8:00**
**WELCOME**
Kelly Senecal, *Convergent Science*

**8:00–8:40**
**KEYNOTE**
Combustion Systems and "The Art of Development"
Ronald Reese, *Fiat Chrysler Automobiles*

**8:40–9:05**
High Throughput Supercomputing for Sensitivity Analysis on Engine Simulations
Janardhan Kodavasal, *Argonne National Lab*

**9:05–9:30**
Combustion System Optimization for a Low-Octane Gasoline Fuel in a Heavy-Duty Diesel Engine Using Design of Experiments
Yuanjiang Pei, *Aramco Services Company*

**9:30–9:55**
DOE-Based Simulation Approach to Study the Impact of Production Tolerance on Performance and Emissions
Alen Jose, *Automotive Research Association of India*

**9:55–10:10**
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**10:10–10:25**
**BREAK**

**10:25–10:50**
CFD Engine Simulations' Role within Diesel Combustion Research—A Diesel Hydrocarbon Perspective
Chad Koci, *Caterpillar Inc.*

**10:50–11:15**
Evaluation of the Detailed Soot Model in CONVERGE for Engine Applications
Jian Gao, *General Motors*

**11:15–11:40**
Urea Deposit Prediction in the Aftertreatment System of a Medium-Duty Diesel Engine
Yong Sun, *Isuzu Technical Center of America*

**11:40–12:05**
Advancements in Aftertreatment Modeling with CONVERGE
Scott Drennan, *Convergent Science*

**12:05–1:05**
**LUNCH**

**1:05–1:20**
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**1:20–1:45**
3D CFD Simulation of Knocking Combustion and Analysis on Combustion System Design
Yaodong Liu, *FAW Company Limited*

**1:45–2:10**
3D Engine Knock Prediction and Evaluation Based on Detonation Theory
Corinna Netzer, *LOGE Deutschland GmbH*

**2:10–2:35**
Simulation of Spark-Ignited Combustion in Automotive Engines, Extension to Knocking Evaluation
Frédéric Ravet, *Renault*

**2:35–3:15**
**KEYNOTE**
Spray Combustion Research for the Engine Combustion Network
Lyle Pickett, *Sandia National Labs*

**3:15–3:30**
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**3:30–3:45**
**BREAK**

**3:45–4:10**
Diesel Sprays and Diesel Sector Simulations Using ECFM3Z
Adèle Poubeau, *IFP Energies nouvelles*

**4:10–4:35**
Dynamic Adaptive Combustion Modeling of Diesel Spray Flames Based on Chemical Explosive Mode Analysis
Chao Xu, *University of Connecticut*

**4:35–5:00**
A Novel Flamelet Tabulation Approach
Prithwish Kundu, *Argonne National Lab*

## WEDNESDAY, SEPTEMBER 28

**7:45–8:00**

**WELCOME BACK**
Katie Beutel, *Convergent Science*

**8:00–8:40**

**KEYNOTE**
CFD as an Integral Tool for Development
of Current and Future Engine Systems
Charles Roberts, *Southwest Research Institute*

**8:40–9:05**

SI Engine Simulation Using ECFM-ISSIM
Model with CONVERGE v2.3
Stéphane Chevillard, *IFP Energies nouvelles*

**9:05–9:30**

Towards Predictive Ignition Simulation
Under Dilute/Lean Conditions Through
Detailed Understanding of the Energy
Deposition Process
Anqi Zhang, *Argonne National Lab*

**9:30–9:55**

Modeling of Gasoline Direct Injection
Nozzle Flow and Spray Formation
Kaushik Saha, *Argonne National Lab*

**9:55–10:10**

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**10:10–10:25**

**BREAK**

**10:25–10:50**

Use of Numerical Modeling to Design a
Wind Tunnel and Validate Measurements
Millicent A. Coil, *Orbital Technologies Corporation*

**10:50–11:15**

Energy-Based Blood Damage Model for Left
Ventricular Assist Device using CONVERGE
Choon-Sik Jhun, *Penn State University*

**11:15–11:40**

Numerical Analysis of a Reciprocating Com-
pressor Considering Fluid-Structure Interaction
Claudio José Santos, *Embraco*

**11:40–12:05**

Converge Beyond IC Engines:
Aftertreatment and Underhood Cooling
Nagendra Dittakavi, *Caterpillar Inc.*

**12:05–1:05**

**LUNCH**

**1:05–1:20**

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**1:20–1:45**

Modeling the Liquid Piston XMv3 Rotary
Engine in CONVERGE
Tiago Costa, *University of Minho*

**1:45–2:10**

3D Computational Fluid Dynamics Modeling
of a 1 kWe Free Piston Linear Alternator
Aimilios Sofianopoulos, *Stony Brook University*

**2:10–2:35**

Study of the Scavenging of a Two-Stroke
Uniflow Diesel Engine by Multi-Cycles Simulation
with CONVERGE v2.3 and Combustion Modeling
with ECFM3Z
Jérémy Galpin, *IFP Energies nouvelles*

**2:35–3:00**

Conjugate Heat Transfer Simulations of
a Heavy-Duty Engine
Charles Finney, *Oak Ridge National Lab*

**3:00–3:25**

Modeling Heat Loss Through Pistons and
the Effect of Thermal Boundary Coatings in
Diesel Engine Simulations using CHT Models
Yan Wang, *Navistar*

**3:25–3:40**

**BREAK**

**3:40–4:05**

On the Pursuit of a Physically Grounded
Quasi-Dimensional CCV Model Using LES
Navin Fogla, *Gamma Technologies*

**4:05–4:30**

Predicting Cyclic Variability in Motored Engines
Using LES With HPC Advancements
Muhsin M. Ameen, *Argonne National Lab*

**4:30–4:55**

Shot-to-Shot Variability in Lagrangian
Simulations of Diesel Fuel Sprays Using
Large-Eddy Simulations
Noah Van Dam, *Argonne*

**4:55–5:20**

Convergent Science: Current Status and
Future Developments
Daniel Lee, *Convergent Science*

# TRAINING SCHEDULE

All training will take place at **Convergent Science World Headquarters, 6400 Enterprise Lane, Madison**. Transportation to and from The Edgewater hotel will be provided each day.

- **DeLOREAN** N120
- **GTO** S251
- **CORVETTE** N233

## MONDAY, SEPTEMBER 26

| Time | DeLOREAN N120 | GTO S251 | CORVETTE N233 |
|---|---|---|---|
| 8:00-12:00 | Internal Combustion Engine Modeling in CONVERGE | Advanced EnSight 10.2 | Basic EnSight 10.2 |
| 12:00-1:00 | Lunch Break | Food will be served in the common area adjacent to **DELOREAN** (N120). *Additional seating is available outside and in conference rooms and common areas.* | |
| 1:00-5:00 | Internal Combustion Engine Modeling in CONVERGE (cont.) | Advanced EnSight 10.2 (cont.) | Basic EnSight 10.2 (cont.) |

## THURSDAY, SEPTEMBER 29

| Time | DeLOREAN N120 | GTO S251 | CORVETTE N233 |
|---|---|---|---|
| 8:00-12:00 | Advanced Combustion Modeling | Advanced Conjugate Heat Transfer Modeling | Gas Turbine Engine Combustion |
| 12:00-1:00 | Lunch with rescale | Food will be served in the common area adjacent to **DeLOREAN** (N120). *Program will take place in DeLOREAN (N120).* | |
| 1:00-3:00 | User-Defined Functions | Genetic Algorithm Optimization | Advanced Fluid-Structure Interaction |
| 3:00-5:00 | CONVERGE + GT–SUITE Coupling | Volume of Fluid Modeling | Advanced Sealing |

## FRIDAY, SEPTEMBER 30

| Time | DeLOREAN N120 | GTO S251 | CORVETTE N233 |
|---|---|---|---|
| 8:00-12:00 | Engine Aftertreatment Modeling | Advanced Surface Preparation Tools in CONVERGE Studio | |
| 12:00-1:00 | Lunch with Sculptor® | Food will be served in the common area adjacent to **DeLOREAN** (N120). *Additional seating is available outside and in conference rooms and common areas.* | |
| 1:00-3:00 | Advanced Emissions Modeling | Numerical Methods | Heat Transfer Mapping |
| 3:00-4:00 | | | Radiation Modeling |
| 3:00-5:00 | Advanced Topics in Internal Combustion Engine Modeling | Tools for SAGE Detailed Chemistry | |
| 4:00-5:00 | | | Scripts for Simulation Analysis and File Management |

## MONDAY, SEPTEMBER 26

### BASIC ENSIGHT 10.2
8am-5pm

EnSight Desktop for **CONVERGE** is licensed by Convergent Science for all **CONVERGE** customers. In this introductory training course you will learn how to use EnSight to post-process **CONVERGE** data. You will learn about the EnSight workflow; the options for reading data, post-processing, animation, plotting, and exporting results; and the new features in EnSight 10.2. Although this class will focus on post-processing data from internal combustion engines, the information in this class will be pertinent to other applications as well. Note that this course will not include batch post-processing or Python scripting, both of which will be covered in the advanced EnSight class. This basic course is intended for those with little or no prior formal training or experience with EnSight and for those needing a refresher. During class you will have time for hands-on practice. There will be time at the end of the class for individual assistance, so bring your datasets and questions.

### ADVANCED ENSIGHT 10.2
8am-5pm

EnSight Desktop for **CONVERGE** is licensed by Convergent Science for all

**CONVERGE** customers. In this advanced training course you will learn about batch post-processing and Python scripting. This course assumes knowledge of the EnSight workflow and the options for reading data, post-processing, animation, plotting, and exporting results. This course is intended for those who have been using EnSight for at least one year or who have taken the Basic EnSight course. In this course we will use EnSight 10.2 (the latest version), and we will discuss changes in EnSight 10.2 including realistic rendering, raytracing, and materials and lighting. During class you will have time for hands-on practice. There will be time at the end of the class for individual assistance, so bring your datasets and questions. Note that this course will require EnSight Standard for **CONVERGE**, EnSight Standard, or EnSight HPC (i.e., this course will use features that are not available in EnSight Desktop).

### INTERNAL COMBUSTION ENGINE MODELING IN CONVERGE
8am-5pm

This course is the first day only of the two-day introductory training course Internal Combustion Engine Modeling in **CONVERGE**. You will learn about the **CONVERGE** workflow and the options for boundaries, regions, initialization, and grid control. During this course you will have time to practice setting up the

boundaries and regions, as well as the initialization and grid control options, for a typical IC engine case in **CONVERGE** Studio v2.3. Note that this course will not include surface preparation or physical models for spray, combustion, turbulence, or other processes.

## THURSDAY, SEPTEMBER 29

### ADVANCED COMBUSTION MODELING
8am-12n

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

## ADVANCED CONJUGATE HEAT TRANSFER MODELING
8am-12n

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 simplify the process of predicting the temperatures in solids that are dependent on fluid interfaces, e.g., heads and valves in engines. This workshop will discuss conjugate heat transfer modeling in **CONVERGE**, including supercycling, which accounts 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, and valve/seat contact resistance in engines, which is critical to accurate prediction of valve and head temperatures.

## USER-DEFINED FUNCTIONS
1pm-3pm

In this workshop we will explore the vast array of user-defined functions (UDFs) that can be used to adjust existing models, implement new models, direct **CONVERGE** to calculate additional quantities, or initialize or reinitialize physical variables. We will discuss the different types of UDFs that **CONVERGE** supports as well as the process of compiling the UDFs and the necessary header files.

## ADVANCED FLUID-STRUCTURE INTER- ACTION MODELING
1pm-3pm

Rigid body fluid-structure interaction (FSI) modeling describes how the presence of one or more immersed objects affect the flow field and how the forces from the surrounding fluid influence the dynamics of the object. In this workshop we 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**. We will consider several examples (a pressure relief valve, a spool valve, and an injector armature) that highlight the current capabilities of FSI modeling in **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.

## GENETIC ALGORITHM OPTIMIZATION
1pm-3pm

This workshop will focus on model optimization in **CONVERGE**, including Genetic Algorithm (GA) optimization and Design of Experiments 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 (e.g., model setup, parameter and range selection,

and search space considerations) and advanced applications such as geometry modification.

## CONVERGE + GT-SUITE COUPLING
3pm-5pm

**CONVERGE** and GT-SUITE can be coupled in a variety of ways. This workshop will discuss two coupling options. 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. 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.

## VOLUME OF FLUID MODELING
3pm-5pm

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



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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. One option in **CONVERGE** v2.3, which is based on the mass fraction VOF, is VOF-spray one-way coupling. In this option **CONVERGE** collects detailed fluid flow information near the nozzle exit during a VOF simulation and then uses this information to inject parcels for Lagrangian spray calculations. 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.

## ADVANCED SEALING

3pm-5pm

**CONVERGE** contains a sealing tool, which 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 a variety of cases, including two-stroke engines, Wankel engines,

components connected by pins and bearings, pumps, and rotating machinery. We will give an overview of the sealing algorithm and explain the geometric approach used to recreate the sealed surface from the boundaries and seal definitions. We will discuss best practices for surface preparation and case setup, and we will demonstrate examples of applying seals to a check valve, a two-stroke engine, a Wankel engine, crankcase components, a gerotor pump, and a supercharger.

## FRIDAY, SEPTEMBER 30

## ADVANCED SURFACE PREPARATION TOOLS IN CONVERGE STUDIO

8am-12pm

**CONVERGE** Studio v2.3 contains powerful new tools for cleaning even geometries with significant problems. In this workshop we will discuss the advantages and limitations of 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 requested by many clients, can fix a variety of geometry problems at the click of a button. Finally, the Surface Wrapper tool can create watertight models by wrapping the existing geometry to create a new surface.

## ENGINE AFTERTREATMENT MODELING

8am-12pm

This workshop will focus on Urea/SCR engine aftertreatment modeling in **CONVERGE**. We will discuss urea decomposition and hydrolysis to ammonia, and we will describe how to set up urea-water spray 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 modeling to obtain 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 plans for improved engine aftertreatment modeling.

## ADVANCED EMISSIONS MODELING

1pm-3pm

**CONVERGE** contains two detailed soot models – particulate mimic (PM) and particulate size mimic (PSM). Although it is computationally expensive to run a three-dimensional simulation with a detailed soot model and the SAGE detailed chemistry solver, **CONVERGE** contains acceleration strategies to
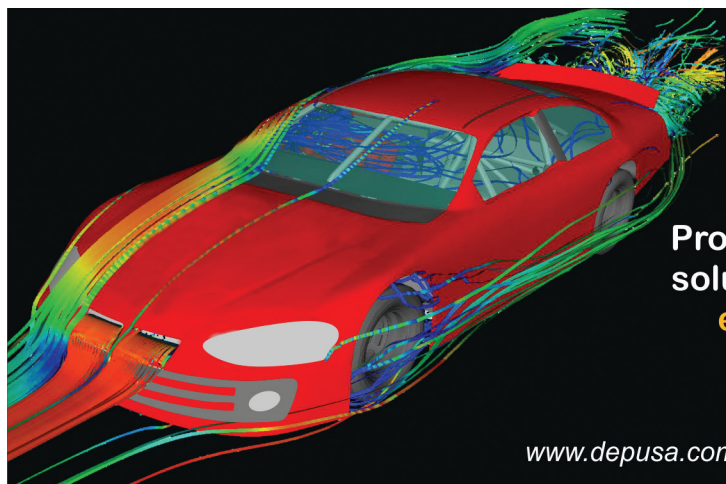
make it feasible to include detailed soot modeling in engine simulations. In this workshop we will discuss the methodologies of these models, acceleration strategies for detailed soot modeling coupled with gas-phase chemistry, and the effects of important soot parameters. We will also discuss other emissions models (e.g., NOx) and give recommendations for these models.

## HEAT TRANSFER MAPPING
1pm-3pm

In this workshop we will discuss mapping **CONVERGE** CFD results to different surface files for uncoupled heat transfer analysis in third party software. We will discuss the **CONVERGE** htc_map utility, including the methodology of cycle averaging, details of the mapping method, how the geometry is aligned for surfaces, and best practices for mapping. We will review an example of a heat transfer analysis and explain how to bring the spatial temperature boundary condition prediction back to **CONVERGE**. Additionally, we will briefly discuss the best practices for heat transfer prediction in **CONVERGE** CFD simulations.

## NUMERICAL METHODS
1pm-3pm

In **CONVERGE** you can select a solver for each governing equation. In this workshop we will describe the differences between the pointwise successive over-relaxation (SOR) algorithm and the biconjugate gradient stabilized (BiCGSTAB) method. We will also explain preconditioning and discuss when it might be useful. We will use examples to discuss trade-offs between the different methods and when each option may be appropriate.

## ADVANCED TOPICS IN INTERNAL COMBUSTION ENGINE MODELING
3pm-5pm

In this workshop we will discuss several of the unique features of **CONVERGE** that yield efficient and accurate simulations of internal combustion engines. With optimized cell counts via Adaptive Mesh Refinement and fast flow and detailed chemistry solvers, you can extend your simulation domain to include multiple cylinders to analyze cylinder-to-cylinder variation, run multiple cycles to understand cycle-to-cycle variation, and capture propagating pressure waves to resolve engine knock. We will discuss published cases and how to set up similar cases in **CONVERGE**.

## TOOLS FOR SAGE DETAILED CHEMISTRY
3pm-5pm

**CONVERGE** includes a variety of tools to complement the SAGE detailed chemistry solver. In this workshop we will discuss the zero-dimensional ignition delay, mechanism reduction, one-dimensional laminar flame speed, and mechanism merge tools.
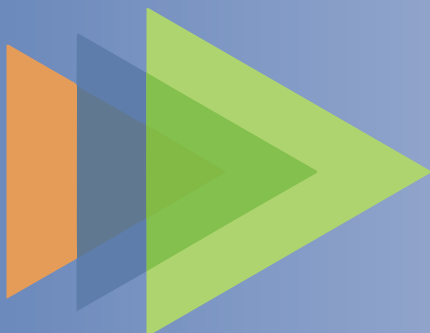
## RADIATION MODELING
3pm-4pm

Radiative energy transfer is important in high temperature simulations that include gases and surfaces that emit, absorb, and scatter radiative energy. In this workshop we will discuss the theory of the Discrete Ordinates Finite Volume Method, 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 ultra-violet radiation.

## SCRIPTS FOR SIMULATION ANALYSIS AND FILE MANAGEMENT
4pm-5pm

In this workshop we will introduce utilities for people who use **CONVERGE** on a Linux-based platform. We will discuss scripts that expedite I/O file management, assist in monitoring **CONVERGE** jobs, and parallelize CPU-intensive post-processing tasks.

# NETWORKING EVENTS

**MONDAY,** 6PM–8PM

## WELCOME RECEPTION
EDGEWATER SKY BAR

Stop by the Sky Bar at The Edgewater hotel as we kick off the 2016 **CONVERGE** User Conference! All attendees are welcome. Food and beverages will be served.

**TUESDAY,** 6:30PM–10PM

## CONVERGE CASINO NIGHT
EDGEWATER HOTEL, GRAND BALLROOM

Network with your peers and find out how lucky you are at the **CONVERGE** Casino! Join us for an extraordinary evening of games, live music, and the chance to win prizes. Food and beverages will be served.

**WEDNESDAY,** 6:30PM–9:30PM

## TRIVIA NIGHT
EDGEWATER SKY BAR

Test your knowledge of strange facts and random trivia at Trivia Night. This event will be hosted by Geeks Who Drink and teams will be selected at random draw. Food and beverages will be served.

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# CONVERGENT SCIENCE

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