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18-22 June & 22-26 October 2012

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Schedule of Seminars in Europe

June 2012 – Turin, Italy, Politecnico Campus at Lingotto

Date	Course ID	Title
18 – 19 June	98024	A Familiarization of Drivetrain Components
18 – 19 June	C0410	Leading High Performance Teams
18 – 19 June	C1215	Vehicle Dynamics for Passenger Cars and Light Trucks
18 – 19 June	C0608	Managing Engineering and Technical Professionals
18 – 20 June	C0314	Turbocharging Internal Combustion Engines
19 – 21 June	C0707	Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems
20 June	C0305	Fundamentals of Automotive All-Wheel Drive Systems
20 – 22 June	C0415	Advanced Vehicle Dynamics
20 – 22 June	C1009	Gasoline Direct Injection (GDI) Engines
20 – 22 June	C0620	Strategic Leadership
21 – 22 June	C1113	High Performance Differentials, Axles, & Drivelines

SAVE €100 – register by 14 May 2012

October 2012 – Birmingham, UK

Crowne Plaza Birmingham City Centre

1 – 2 October	C0316	Accelerated Test Methods for Ground and Aerospace Vehicle Development
1 – 2 October	C0914	Improving Fuel Efficiency with Engine Oils
1 – 3 October	86034	Weibull-Log Normal Analysis Workshop
3 – 4 October	C1118	ARP4754A and the Guidelines for Development of Civil Aircraft and Systems

Paragon Hotel Birmingham Ltd.

8 – 9 October	C0502	Advanced Diesel Particulate Filtration Systems
8 – 9 October	C0022	Tolerance Stack-Up Analysis

SAVE £100 – register by 27 August 2012

October 2012 – Turin, Italy, Politecnico Campus at Lingotto

22 – 26 October	ACAD03	Diesel Engine Technology Engineering Academy
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SAVE €100 – register by 20 September 2012

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For schedule updates, additional information, and to register for any of these courses –
www.sae.org/training/europeseminars

A Familiarization of Drivetrain Components

18 – 19 June 2012

I.D.# 98024

Designed to help you visualize both individual components and the entire drivetrain system - without reference to complicated equations - this seminar focuses on the terms, functions, nomenclature, operating characteristics and effect on vehicle performance for each of the drivetrain components. Attendees will receive an introduction to the various components of the drivetrain, including the clutch or torque converter, manual or automatic transmission, driveshaft, axle, wheel ends, and brakes. This course also provides insight into: the structure and function of each component; vehicle integration; and related noise, vibration and harshness issues. You will be equipped to evaluate the space requirements, mounting needs, clearances required, and effect on vehicle response for each component. Attendees will receive a copy of James Halderman's book, *The Automotive Technology, 4th Ed.*

Learning Objectives

Upon completion of this seminar, you will be able to:


- Discuss both practical and technical aspects of smoothing clutch operation by incorporating cushion and torsional dampers.
- Compare different types of transmission synchronizers, automatic transmission torque converters, hydraulic clutch operation and epicyclic gear trains.
- Describe the interaction of gear ratios and vehicle performance as related to engine horsepower and torque curves.
- Explain phasing and mounting of propeller shafts as related to torsional excitation and secondary couple loads
- Review different types of differentials.
- Compare common misconceptions of limited slip devices to their actual performance.
- Recognize four-wheel drive systems and the need for an inter-axle differential.
- Appraise electronic control of torque through braking and clutching devices.
- Evaluate the total drivetrain package as a system.

Who Should Attend

This seminar is intended for engineers now working with passenger car, sport utility, truck, bus, industrial, and off-highway vehicles who have had minimal prior experience with the total drivetrain.

Instructor: Joseph Palazzolo

See Mr. Palazzolo's biography on page 4.

	Registration:		
	Fees	Before 14 May	After 14 May
	Non-member	€1,245	€1,345
	Classic Member	€1,123	€1,223
	Premium Member	€1,061	€1,161
	Elite Member	€1,000	€1,100
1.3 CEUs			

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonial

"Excellent overview of the entire drivetrain, but includes some detail and practical insight instead of being too broad and overgeneralized."

Scott A. Van Luvender

Applications Engineer
Acadia Polymers

Leading High Performance Teams

18 – 19 June 2012

I.D.# C0410

Product development is organizationally a complex undertaking that requires effective coordination within a company and between companies. During product development, teams are confronted with a number of ongoing organizational challenges and there is a high potential for conflict between participants in the process.

This course addresses teamwork and other "soft-side" factors that largely determine whether product development programs are successfully completed on schedule. The content is relevant for both OEMs and suppliers.

Learning Objectives

By attending this seminar, you will be able to:


- Explain the importance of effectively managing 'soft-side' issues that cause problems and delays during product development programs
- Employ successful practices of chartering and launching teams
- Implement techniques to successfully lead and facilitate effective teams
- Effectively troubleshoot problems on a team and employ techniques to remain productive
- Implement proven tips for conducting effective team meetings

Who Should Attend

Engineers and business people involved in various product development team activities will find the subject matter practical and useful. The content is of particular value to professionals from engineering, manufacturing, purchasing, quality, marketing, and finance functions in ground vehicle OEMs and suppliers.

Instructor: Joseph Doyle

Joseph Doyle is the principal of Strategic Insights, consulting firm, specializing in executive leadership. Dr. Doyle has served as an adjunct professor and lecturer at the University of Michigan Dearborn's School of Business, taught Engineering Administration at the University of Detroit's Graduate School of Engineering and Business Strategy at Oakland University's School of Business Administration. He holds a B.S. in Mathematics and Physical Science from Eastern Michigan University, a M.Ed. in Educational Evaluation and Research from Wayne State University and a Ph.D. in Organizational Behavior from the University of Michigan.

	Registration:		
	Fees	Before 14 May	After 14 May
	Non-member	€1,125	€1,225
	Classic Member	€1,003	€1,103
	Premium Member	€941	€1,041
	Elite Member	€880	€980
1.3 CEUs			

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonials

"This seminar provides simple, yet powerful leadership tools you can apply immediately to your programs."

Lindsey Bair

Product Engineer
Hayes Lemmerz International, Inc.

"Great course; I can't wait to get back to work and start using the techniques I've learned. The instructor was able to provide real world examples that helped understand each area of this course."

Todd Freeman

Associate Technical Specialist (Quality) Honda Manufacturing of Alabama

"Fountain of crucial concepts amid essential leadership techniques."

D. Stern

Vice President Engineering
Workhorse Custom Chassis

Vehicle Dynamics for Passenger Cars and Light Trucks

18 – 19 June 2012

I.D.# C1215

This seminar will present an introduction to Vehicle Dynamics from a vehicle system perspective. The theory and applications are associated with the interaction and performance balance between the powertrain, brakes, steering, suspensions and wheel and tire vehicle subsystems. The role that vehicle dynamics can and should play in effective automotive chassis development and the information and technology flow from vehicle system to subsystem to piece-part is integrated into the presentation. The dynamics of the powertrain, brakes, steering, suspension and wheel and tire subsystems and their interactions are examined along with the important role of structure and structural parameters related to vehicle dynamics. Physical experiments, applicable to vehicle dynamics are also introduced. Attendees will receive the Bosch Automotive Handbook and *The Automotive Chassis: Engineering Principles* by Reimpell, Stoll and Betzler.

Learning Objectives

By attending this seminar, you will be able to:

- Summarize how vehicle dynamics is related to the voice of the customer
- Identify important vehicle system parameters useful for effective application of vehicle dynamics to chassis development
- List and explain parameters that effect vehicle performance relative to drive-off, braking, directional control and rollover
- Identify physical measurements needed to effectively apply vehicle dynamics to passenger cars and light trucks
- Define the value of vehicle dynamics simulation in the development and evaluation of vehicles
- Explain the balance required between ride, directional control and rollover and the essential process for this balance to be obtained for marketplace vehicles

Who Should Attend

Automotive engineers and quality professionals who work in product design, testing, quality, process or development will benefit from attending.

Instructor: Timothy Drotar

Timothy Drotar is currently a product development engineer at Ford Motor Company where he specializes in chassis systems and vehicle dynamics for passenger cars and light trucks. He also has developed engineering training in suspension and steering. Previously, he worked for Saturn Corporation in product engineering. Tim is a member of the Course Industry Advisor Board for Chassis Systems Design at Kettering University, and a member of SAE and SCCA. He holds a B.S. in Mechanical Engineering from Lawrence Technological University and a M.S. in Mechanical Engineering from the University of Michigan.



Registration:

Fees	Before 14 May	After 14 May
Non-member	€1,615	€1,715
Classic Member	€1,444	€1,544
Premium Member	€1,358	€1,458
Elite Member	€1,272	€1,372
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonials

"The seminar reinforced and increased my knowledge of vehicle dynamics. It also gave me a better understanding of how the entire chassis system works together."

Marco A. Bianchini

Senior Product Engineer
ZF-Sachs Automotive

"A great overview of how all chassis components contribute to overall vehicle dynamics."

Steve Urquhart

EngineerGeneral Motors Corporation



Managing Engineering & Technical Professionals

18 – 19 June 2012

I.D.# C0608

In the fast paced and competitive environment of today's global economy, the work of technical professionals is often the difference between success and failure in an organization. Providing leadership for engineers is uniquely challenging, and the transition from working engineer to first-line technical supervisor is one of the most difficult career challenges that an engineer may face. First-time engineering supervisors and mid-level managers who wish to sharpen their skills and learn new techniques for guiding, coaching, and motivating working engineers, technicians, and designers will find this seminar valuable. A mix of lecture and attention-grabbing exercises are used to develop intense and lasting learning results.

Learning Objectives

By attending this seminar, you will be able to:

- Describe the basic value proposition of management: what managers bring to an organization that makes them worthwhile
- Avoid the most common errors that supervisors and managers make
- Describe the evolution of management thought, and utilize the latest proven concepts for improving the performance of people in complex organizations
- Explain the issues that drive the psychology of effective leadership and develop greater emotional intelligence
- Implement strategies to enhance your skills in meeting management, coaching, and performance review that are essential in today's professional workplace

Who Should Attend

Engineers and technical professionals who are either recently promoted into a management position, or have some experience as a manager but would like to learn how to become more effective will benefit from attending this workshop. The concepts and skills developed during this interactive experience will be of interest to those involved in product development, manufacturing, service, or quality engineering, and all related technical activities in automotive, aerospace, manufacturing, and off-highway industries.

Instructor: Eric Timmis

Eric Timmis is the owner of BusinessAContactSport.com, a training and consulting company dedicated to business process improvement, focusing on value and quality management implementation, program/project management training, and the integration of strategic partnership relationships between departments and organizations.



Registration:

Fees	Before 14 May	After 14 May
Non-member	€1,545	€1,645
Classic Member	€1,381	€1,481
Premium Member	€1,298	€1,398
Elite Member	€1,216	€1,316
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonials

"This class is not just for learning management, but understanding managers as well."

Erik Hakala

Test Engineer
SMR Automotive Systems USA

"This is the best possible way to invest 3 days in making an engineer into a manager."

Steven M. Parrish

Communications Lead Engineer
General Dynamics/Land Systems

Turbocharging Internal Combustion Engines

18 – 20 June 2012

I.D.# C0314

This seminar covers the basic concepts of turbocharging of gasoline and diesel engines, including turbocharger matching, charge air and EGR cooling, and associated controls. The limitations and future possibilities of today's systems and details on how emerging technologies will impact engine/vehicle performance will be covered. The primary focus is on the turbocharger-engine interface rather than detailed turbocharger aerodynamics and design. Advanced technologies such as variable geometry and multi-stage turbocharging, high and low pressure loop EGR systems, assisted turbocharging and turbocompounding are discussed. Students will have the opportunity to perform hands-on exercises to gain an appreciation of parametric effects in a wide range of engines.

Learning Objectives

By attending this seminar, you will be able to:

- Describe the thermodynamic principles governing the turbocharging of internal combustion engines
- Articulate the critical contribution of turbocharging to modern day diesel engine performance and emission control
- Determine the possible benefits of turbocharging for specific gasoline and heavy and light duty diesel engine applications
- Estimate the appropriate turbocharger characteristics for specific applications based on engine system requirements
- Describe the limitations of current technologies and evaluate new technologies and their possible role in meeting future engine/vehicle system challenges
- Apply the basic principles of matching turbocharger with engine and optimizing overall system for desired performance and emissions

Who Should Attend

This seminar is designed for engineers, managers, and other technical personnel from OEM and support industries concerned with the design and development of optimized diesel and spark ignition engine systems, including performance, fuel economy and emissions for passenger car, light truck and heavy duty engines. Some background in thermodynamics, IC engine performance and emissions will be helpful.

Instructors: Arjun D. Tuteja & S. M. Shahed

Dr. Arjun D. Tuteja has over 28 years of industry experience, mostly in advanced development of diesel engine systems. Dr. Tuteja has managed projects dealing with advanced diesels, stratified charged engines, aftertreatment systems, air systems, analytical modeling, and alternate fuels. He holds three patents on aftertreatment systems. Dr. Tuteja has a B.S. degree in Mechanical Engineering from India and an M.S. and Ph.D. degrees from the University of Wisconsin-Madison.

Dr. S. M. Shahed is Corporate Fellow at Honeywell Turbo Technologies where he has developed and applied advanced boosting technology to reduce emissions and improve the fuel economy of gasoline and diesel engines. Dr. Shahed is an SAE International fellow and served as the 2002 president of SAE International. He has received several prestigious international awards including the I.Mech.E James Clayton Award, the SAE International Horning Memorial Award and Arch Colwell Award, and the University of Wisconsin Distinguished Service Citation. Dr. Shahed holds a B.E. degree from India and an M.S. and Ph.D. from the University of Wisconsin-Madison.



Registration:

Fees	Before 14 May	After 14 May
Non-member	€1,545	€1,645
Classic Member	€1,381	€1,481
Premium Member	€1,298	€1,398
Elite Member	€1,216	€1,316
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonial

"Provides a good basic understanding of turbo history and where it is going in the future. Well worthwhile."

Robert Purdy

Technical Development Specialist
Wecast Industries

Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems

19 – 21 June 2012

I.D.# C0707

This course is designed to provide a fundamental understanding of how and why OBD systems function and the technical features that a diagnostic should have in order to ensure compliant and successful implementation. Fundamental design objectives and features needed to achieve those objectives for generic on-board diagnostics will be covered. The course will also explore the relationship of the OBD system with the underlying control system. Note that because of proprietary considerations, this class does not provide details of algorithm design, algorithm performance, or algorithm application. The class will cover general OBD algorithm designs and the features required to promote sound OBD system design.

Learning Objectives

By attending this seminar, you will be able to:

- Articulate the underlying design objectives of on-board diagnostic systems
- Use the latest California Air Resources Board On-Board Diagnostic Regulation for Light and Medium Vehicles to find and apply OBD requirements
- Apply the design features that all diagnostics need for successful implementation
- Design diagnostics to comprehend variation
- Successfully implement algorithms to track in-use rates in accordance with the CARB OBD II Regulation
- Use SAE J1979 to implement generic scan tool support in diagnostic design
- Implement OBD design requirements in control system design

Who Should Attend

This course is ideal for engineers involved in the design or control of on-board diagnostic systems for light and medium duty on-road vehicles. Examples will be geared toward spark ignition engines and light and medium duty regulations. Engineers involved in engine and transmission hardware, or engineers new to the area of OBD system design will obtain a better understanding of the design of OBD systems.

Instructor: John Van Gilder

John Van Gilder is currently a Technical Fellow, OBD II Development, in the General Motors Powertrain Group where he is responsible for implementing statistical techniques in OBD design; model based on-board diagnostic design, development of OBD requirements for new powertrain systems, and in-use assessment of OBD systems. He has organized and presented at numerous SAE International OBD and Powertrain Controls technical meetings. Mr. Van Gilder has a B.S.E. in Engineering Physics from the University of Michigan, a M.S.E. in Nuclear Engineering from the Bettis Atomic Power Laboratory and a M.S.E. in Reliability Engineering from Kettering University and is a Professional Engineer in the state of Michigan.



Registration:

Fees	Before 14 May	After 14 May
Non-member	€1,555	€1,655
Classic Member	€1,390	€1,490
Premium Member	€1,307	€1,407
Elite Member	€1,224	€1,324
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Fundamentals of Automotive All-Wheel Drive Systems

20 June 2012

I.D.# C0305

This seminar provides an introduction to the fundamental concepts and evolution of passenger car and light truck 4x4/all-wheel drive (AWD) systems including the nomenclature utilized to describe these systems. Basic power transfer unit and transfer case design parameters, component application to system function, the future of AWD systems, and emerging technologies that may enable future systems are covered. This course is an excellent follow-up to the "A Familiarization of Drivetrain Components" seminar (which is designed for those who have limited experience with the total drivetrain and offered 18 – 19 June 2012; see description on page 1).

Learning Objectives

By attending this seminar, you will be able to:

- Identify front wheel drive and rear wheel drive vehicle architectures
- Identify part time, full time, and on demand all-wheel drive systems
- Explain the benefits of all-wheel drive over two-wheel drive
- Quantify all-wheel drive traction and mobility benefits
- Describe auxiliary axle disconnect systems
- Explain basic vehicle dynamics performance and the effect of AWD on performance
- Identify couplers vs. biasing devices and their basic function
- Describe the differences between mechanical and electrical implementation in AWD systems
- Describe basic control strategies and logic
- Discuss advanced propulsion concepts and systems

Who Should Attend

This seminar is designed for engineers (working with passenger cars, light trucks, and SUVs) who need to master AWD componentry, and the function and effect of those components. Engineers new to the 4WD/AWD field, as well as managers, marketing personnel, purchasing professionals and others interested in all-wheel drive fundamentals will benefit from this seminar.

Instructor: Joseph Palazzolo

Joe Palazzolo is employed as Chief Engineer – Geared Products at GKN Driveline Torque Technology Group where he manages the mechanical design and development of new automotive gearboxes, torque transfer devices, concepts, and integration into production applications. He is an active SAE International member, chaired the SAE International All-Wheel Drive Standards Committee, received the SAE International Forest R. McFarland Award for distinction in professional development and education and also achieved the SAE Master Instructor designation. Mr. Palazzolo is the award winning author of High-Performance Differentials, Axles & Drivelines. He holds a Bachelor's degree in Mechanical Engineering from Cleveland State University and a Master's degree in Automotive Engineering from Lawrence Technological University.



Registration:

Fees	Before 14 May	After 14 May
Non-member	€625	€725
Classic Member	€553	€653
Premium Member	€516	€616
Elite Member	€480	€580
0.7 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonials

"Although a complex topic, this seminar provided a one day overview of many of the latest devices in the automotive drivetrain arena that are currently in the market."

Steven J. Wesolowski

Director of Global Strategies
Dana Corporation

"The course content exceeded my expectations and left me much more confident in my understanding of driveline systems."

Mark Schulte

Senior Sales Engineer
Stoneridge, Inc

Advanced Vehicle Dynamics for Passenger Cars and Light Trucks

20 – 22 June 2012

I.D.# C0415

This interactive seminar will take you beyond the basics of passenger car and light truck vehicle dynamics by applying advanced theory, physical tests and CAE to the assessment of ride, braking, steering and handling performance. Governing state-space equations with transfer functions for primary ride and open loop handling will be developed & analyzed. Building on the analysis of the state space equations, common physical tests and their corresponding CAE solutions for steady state and transient vehicle events will be presented. The “state-of-the-art” of vehicle dynamics CAE will be discussed. Common lab and vehicle tests and corresponding metrics used to assess chassis system and vehicle performance will be discussed in great detail. Hands-on workshops using CARSIM™; vehicle dynamics simulation software will help reinforce the material. Significant time will also be dedicated to the use of design of experiments (DOE) as a tool to assist in the analysis and optimization of chassis systems for multiple vehicle responses.

Learning Objectives

By attending this seminar, you will be able to:


- Apply vehicle dynamics theory to practical evaluation and measurement
- Use governing state space equations and transfer functions to determine the effect of key parameters on primary ride and open loop handling
- Describe the current “state-of-the-art” of vehicle dynamics CAE
- Articulate various types of vehicle dynamics models
- Recognize kinematics and compliance (K&C) lab tests commonly used to quantify chassis system performance
- Identify and evaluate important K&C metrics used in vehicle dynamics development
- Identify and utilize important vehicle tests commonly used in industry to evaluate ride, steering and handling performance
- Relate chassis system characteristics to vehicle dynamic performance
- Utilize vehicle dynamics CAE software for the simulation of common physical lab and vehicle tests
- Apply design-of-experiments (DOE) to vehicle dynamics development

Who Should Attend

This seminar is designed for automotive engineers in the vehicle dynamics, chassis, suspension, steering and braking fields who work in product design, development, testing, simulation or research.

Instructor: Timothy Drotar

See Mr. Drotar’s biography on page 2.

 Registration:		
Fees	Before 14 May	After 14 May
Non-member	€1,495	€1,595
Classic Member	€1,336	€1,436
Premium Member	€1,256	€1,356
Elite Member	€1,176	€1,276
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Strategic Leadership

20 – 22 June 2012

I.D.# C0620

As a strategic leader, it is your responsibility to ensure that your organization is moving in the right direction. Executives and high-level managers must have the practical insight necessary to address competitive business challenges. Each segment of this three day course is designed to impart simple, but powerful lessons that will equip participants to more fully engage in strategic discussions, ask pertinent questions, facilitate critical decisions and shape high performing organizations. In addition, the course provides students with a personal leadership profile that illustrates their strengths and potential limitations. Participative exercises assist emerging executives with practical and effective methods of gaining organizational credibility and avoiding common errors in strategic leadership.

Learning Objectives

By attending this seminar, you will be able to:


- Describe the role and responsibilities of strategic leadership
- Manage the critical factors that drive the success and failure of business strategies
- Anticipate the longer term impact of strategic initiatives
- Attain credibility and support as you assume the helm of a new operation
- Avoid common errors made by leaders in transitioning to higher levels of responsibility
- Select the most effective approaches when framing strategic decisions
- Think strategically and systemically as you plan organizational change
- Influence the emergence of a more positive and functional corporate culture
- Eliminate turf battles, dropped balls and organizational duplication of effort
- Analyze and correct dysfunctional organizational dynamics
- Manage the strengths and limitations of your personal leadership style

Who Should Attend

This seminar is designed for executives, senior level managers, and engineering managers or technical specialists who are called upon to formulate or provide input into strategic decisions and business strategies.

Instructor: Joseph Doyle

See Dr. Doyle’s biography on page 1.

 Registration:		
Fees	Before 14 May	After 14 May
Non-member	€1,485	€1,585
Classic Member	€1,327	€1,427
Premium Member	€1,247	€1,347
Elite Member	€1,168	€1,268
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonials

“The ability to lead and make sound business decisions requires a complexity of knowledge and skills. This course is a very good road map in negotiating a difficult highway.”

Don Coker

President

Intelligent Products Systems

“This was an excellent seminar [for] preparing engineering professionals and technical specialists for future/current leadership roles within the organization.”

Steve Rodia

Technical Specialist - Project Leader
Honda Manufacturing of Alabama

For schedule updates, additional information, and to register for any of these courses –
www.sae.org/training/europeseminars

Gasoline Direct Injection (GDI) Engines

20 – 22 June 2012

I.D.# C1009

The quest for more efficient, smarter, and environmentally cleaner liquid-fueled spark ignition (SI) reciprocating engines is more alive and intense now than ever before. GDI SI engines have overcome many of the original limitations and are now becoming commonplace. This seminar will provide a comprehensive overview of GDI engines. Mixture preparation and the combustion process, with an emphasis on strategies for both homogenous and stratified charge operation and control, including issues related to the direct injection of gasoline into the combustion chamber, and fuel injection system requirements for optimal spray characteristics will be explored. Emission of pollutants, fuel economy and effects of some key design and operating parameters will also be covered. The seminar concludes with an overview of a select list of production and prototype GDI engines.

Learning Objectives

Upon completion of this seminar, you will be able to:


- Describe the rationale behind the GDI engine operation
- Analyze the important processes in GDI engines
- Explain liquid atomization, sprays, and injector requirements for successful GDI operation
- Utilize the technology and the logic behind gasoline direct injection
- Estimate and predict effects of key engine design and operating conditions on performance, combustion, and emission in GDI engines
- Communicate effectively with engineers working on fuel injection, combustion and emission aspects of the GDI engine in your firm or with customers
- Effectively contribute to the design of critical components such as combustion chambers, injectors, and emission reduction strategies
- Explain and utilize trade-offs between increasing engine performance and maintaining low emission characteristics

Who Should Attend

This seminar is valuable for engineers, technical and project managers, researchers, and academicians. Engineers working on the design of components for high efficiency and performance of GDI engines and those directly and indirectly involved in mixture preparation and emission reduction from these engines will benefit from this course. Environmental engineers desiring to expand their understanding of fuel spray formation, combustion and emissions from GDI engines and engineers active in the development and application of software for the modeling and design of combustion chambers, fuel spray dynamics, and combustion and emission issues will benefit.

Instructor: Bruce Chehrudi

Dr. Chehrudi has over twenty years of technical and leadership experiences including Chief Engineer at Advanced Technology Consultants, Principal Scientist appointment at the Air Force Research Laboratory (AFRL) ERC, Chief Scientist at Raytheon STX, Visiting Technologist at Ford's Advanced Manufacturing Technology Development (AMTD) center, tenured Professor of Mechanical Engineering at Kettering University and University of Illinois. Dr. Chehrudi has a PhD from Princeton University.

 Registration:		
Fees	Before 14 May	After 14 May
Non-member	€1,495	€1,595
Classic Member	€1,336	€1,436
Premium Member	€1,256	€1,356
Elite Member	€1,176	€1,276
2.0 CEUs		

SAVE €100! Register for this course by 14 May and get €100 off your fee.

Testimonial

"It covers every possible attendee, from the one that wants only an overview to the one that needs the most deep detail of GDI engine. Worth the trip I made from Greece."

Savvas Savvakis

PhD Researcher
Aristotle University of Thessaloniki

High-Performance Differentials, Axles, & Drivelines

21 – 22 June 2012

I.D.# C1113

This comprehensive seminar introduces participants to the function and interfaces of axles and their individual components. As we modify cars for street performance or all out race applications, it is important to know the trade-offs in the drivetrain system. The theory and practice of axle systems is introduced along with a hands-on style approach to repairing and modifying axles for high performance applications. For this hands-on approach, actual hardware will be reviewed in an informal setting. Upon completion of the seminar, attendees will have a working knowledge of axles, hypoid gearing, and differentials (open and limited slip), along with typical performance enthusiast modifications for race teams and weekend warriors. The book, *High-Performance Differentials, Axles, and Drivelines*, by Joseph Palazzolo is included in the course materials.

Learning Objectives

By attending this seminar, you will be able to:

- Identify vehicle specific axle types
- Evaluate the differences between open and limited slip differential (LSD)
- Distinguish between the different torque transfer characteristics of the different LSD technologies
- Identify how to correctly set and adjust bearing preload and hypoid contact patterns
- Describe how to assemble and disassemble a differential
- Explain the steps to set-up a new gear set and bearings
- Recognize the difference required between typical passenger car applications and high-performance, race style axles

Who Should Attend

This seminar is intended for automotive engineers and mechanics who are working in the driveline area. This also includes performance shop mechanics and race teams that are modifying axles for specific on and off-road applications. Any performance-minded amateur, professional racer, or race team would also benefit from attending this seminar.

Instructor: Joseph Palazzolo

See Mr. Palazzolo's biography on page 1.



Registration:

Fees	Before 14 May	After 14 May
Non-member	€1,150	€1,250
Classic Member	€1,025	€1,125
Premium Member	€963	€1,063
Elite Member	€900	€1,000
1.3 CEUs		

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Birmingham, UK

1 – 5 October – Crowne Plaza Birmingham City Centre
8 – 9 October – Paragon Hotel Birmingham Ltd

Accelerated Test Methods for Ground and Aerospace Vehicle Development

1 – 2 October 2012

I.D.# C0316

This course covers the benefits, limitations, processes, and applications of several proven accelerated test methods including accelerated reliability, step stress, FSLT (Full System Life Test), FMVT (Failure Mode Verification Testing), HALT (Highly Accelerated Life Testing), and HASS (Highly Accelerated Stress Screening). A combination of hands-on exercises, team activities, discussion, and lecture are used throughout the course. Participants will also receive a copy of the instructor's book, *Accelerated Testing and Validation Management*, which includes numerous hands-on exercises and a CD with analytical spreadsheets. Attendees are requested to bring a calculator to the seminar.

Learning Objectives

By attending this seminar, you will be able to:


- Choose the accelerated test method for a given application
- Analyze accelerated testing results
- Explain how to accelerate one's current test methods
- Explain how to accelerate one's validation program
- Adjust accelerated test programs for business situations
- Describe how product development cycles can be reduced from 18 to 6 months

Who Should Attend

This seminar is designed for anyone involved in product design, life testing, reliability testing and validation for passenger cars, light trucks, heavy duty, off-highway or aerospace vehicles, including reliability engineers, validation engineers, design engineers and their managers. Individuals who need to achieve shorter time to market or higher quality through custom test plans will find this course to be especially valuable. Purchasers or users of testing or engineering services will also find this course to be valuable. There are no prerequisites for this course although a technical background is helpful.

Instructor: Alexander J. Porter

Alexander J. Porter is the Chief Engineer for Programs, Performance, and Durability for Intertek. Mr. Porter has three patents relating to accelerated testing equipment and has authored over 40 articles and technical papers on accelerated testing. His work in the past has included implementation of FEA in a laboratory setting and development of a thermal management system for an advanced data acquisition package developed by NASA's Dryden Flight Research Facility. Mr. Porter is a member of SAE International and IEEE. He holds a B.S. in aircraft engineering and an M.S. in mechanical engineering, both from Western Michigan University.

 Registration: Fees	Before 27 Aug	After 27 Aug
Non-member	£1,195	£1,295
Classic Member	£1,066	£1,166
Premium Member	£1,001	£1,101
Elite Member	£936	£1,036
1.3 CEUs		

Improving Fuel Efficiency with Engine Oils

1 – 2 October 2012

I.D.# C0914

This seminar will highlight the role of lubricants in improving fuel efficiency and provide strategies for selecting the best oil for a given application. A brief overview of the fuel consumption regulations and global perspective of passenger car lubricants and diesel oil specifications in North America, Europe and Asia and limitations and advantages of various methods to measure fuel consumption in a variety of bench tests, dyno tests and actual vehicles will be presented. Fundamentals of fluid lubrication regimes, detailed aspects of oil formulations which have significant effects on reduction in mechanical friction will be covered, and the performance characteristics of fresh oil versus used oil and lubrication of coated surfaces will be discussed. Finally, the impact of various emission control devices on overall diesel fuel consumption will be described.

Learning Objectives

By attending this seminar, you will be able to:


- Describe the effects of mechanical friction on engine efficiency
- Summarize the pros and cons of various test methodologies used to measure engine friction
- Articulate the limitations in various fuel consumption test methodologies
- Select oils based on frictional control performance
- Describe the role of oil degradation on fuel economy and engine wear
- Evaluate lubricant interactions with low friction surfaces

Who Should Attend

This seminar is designed for engineers, scientists, investigators and consultants involved in designing or optimizing mobile or stationary powertrains. Individuals interested in understanding the role of engine oils in reducing fuel consumption will find the seminar beneficial. Automotive decision makers will also benefit by gaining an understanding of the limitations of fuel economy testing methods.

Instructor: Ewa A. Bardasz

Dr. Ewa A. Bardasz is a Fellow at The Lubrizol Corporation where she is currently responsible for overseeing technical activities related to lubricating novel combustion hardware, aftertreatment systems and emissions. She is experienced in the areas of crankcase lubrication, corrosion inhibition, engine testing, and exhaust emissions control. Dr. Bardasz holds over 25 patents, has published multiple technical and scientific papers, authored chapters for technical books and is a frequent invited speaker at conferences throughout the U.S. and Europe. She is the recipient of the SAE International Award for Research on Automotive Lubricants, and the Environmental Excellence in Transportation Award. Dr. Bardasz is a Fellow of SAE International and a Fellow of the Society of Tribologists and Lubrication Engineers (STLE) where she is also on the Board of Directors. Dr. Bardasz obtained a M.Sc. in Chemical Engineering from Warsaw Technical University and a PhD in Chemical Engineering from Case Institute of Technology.

 Registration: Fees	Before 27 Aug	After 27 Aug
Non-member	£1,125	£1,225
Classic Member	£1,003	£1,103
Premium Member	£941	£1,041
Elite Member	£880	£980
1.3 CEUs		

SAVE £100! Register for this course by 27 August and get £100 off your fee.

SAVE £100! Register for this course by 27 August and get £100 off your fee.

Testimonial

"This course provided some unique vehicle development techniques aimed at reducing time and discovery of product weakpoints."

Jakin Wilson

Engineer
Toyota Technical Center

Also available as an SAE-Learning program delivered online!
Accelerated Test Methods for Ground and Aerospace Vehicle
Development e-Seminar www.sae.org/e-seminars/atm

Weibull-Log Normal Analysis Workshop

1 – 3 October 2012

I.D.# 86034

RMS (Reliability-Maintainability-Safety-Supportability) engineering is emerging as the newest discipline in product development due to new credible, accurate, quantitative methods. Weibull Analysis is foremost among these new tools. New and advanced Weibull techniques are a significant improvement over the original Weibull approach. This workshop presents special methods developed for these data problems, such as Weibayes, with actual case studies in addition to the latest techniques in SuperSMITH®; Weibull for risk forecasts with renewal and optimal component replacement. Class work is used to reinforce key concepts, lectures are based on actual case studies, and personal computers and hands-on experiments are used to analyze dozens of Weibull & Log Normal problems. Students will be fully capable of performing basic and advanced RMS Engineering analysis with their own software on completion of the workshop. Attendees will receive the entire SuperSMITH®; package - a complete self-study course and combined software package containing: SuperSMITH®; Weibull, SuperSMITH®; Visual, The New Weibull Handbook® - 5th Edition and the PlayTIME™ Tutorial Booklet. A €960 value!

Optional Weibull Introduction

To accelerate your learning in this Workshop, you may want to complete the SAE online, short-course, Introduction to Weibull Engineering Fast Track. This highly recommended overview of Weibull engineering can improve your retention prior to taking the workshop or provide a great review afterwards.

Learning Objectives

By attending this seminar, you will be able to:

- Analyze design, development, production, and service failures
- Model product lifetime and reliability
- Evaluate calibration and maintainability plans
- Analyze inspection data
- Reduce test substantiation, time and costs

Who Should Attend

Engineers responsible for reliability, safety, supportability, maintainability, materials, warranties, life cycle cost, design, structures, instrumentation and logistics will find these Weibull techniques extremely useful.

Instructor: Wes Fulton

Mr. Wes Fulton is the Founder and CEO of Fulton Findings. Mr. Fulton has over 20 years of experience as a private programmer and developed SuperSMITH®; Visual, WeibullSMITH®, LogNormSMITH®, Normal+SMITH®, Visual*SMITH®, BiWeibullSMITH® and MonteCarloSMITH® analysis software. He received his B.S.M.E. from Georgia Tech and his M.S.M.E. from California State University at Long Beach.



Registration:

Fees	Before 27 Aug	After 27 Aug
Non-member	£1,885	£1,985
Classic Member	£1,687	£1,787
Premium Member	£1,587	£1,687
Elite Member	£1,488	£1,588
2.0 CEUs		

SAVE £100! Register for this course by 27 August and get £100 off your fee.

Testimonials

"Very excellent course! Great instructor with exceptional knowledge on subject."

Gregory J. Barron

Test Coordinator

DaimlerChrysler Corporation

"Highly recommended for reliability and quality engineers. Techniques learned are invaluable."

Ken Marx

Senior Quality Engineer

Robert Bosch Corporation



ARP4754A and the Guidelines for Development of Civil Aircraft and Systems

3 – 4 October 2012

I.D.# C1118

This two day seminar will provide attendees with an in-depth presentation of the guidelines introduced in the revised recommended practice for aircraft and systems development as well as the critical concepts used in aircraft and systems development processes for certification. The aircraft/systems development process and its interactions with the safety, hardware development and software development processes will be discussed along with the incorporated changes, with special emphasis on new material and development concepts. Additionally, the relationship and key interactions between the aircraft/system guidance material established in ARP4754A and the guidance material in DO-254 for hardware and DO-178B for software will be reviewed to ensure attendees gain insight into the expectations being established for aircraft certification. In addition to the seminar handout, a copy of the ARP4754A: Guidelines for Development of Civil Aircraft and Systems will be provided to each attendee.

Learning Objectives

By attending this seminar, you will be able to:

- Identify the changes between the legacy ARP4754 and ARP4754A,
- Explain the aircraft/systems development process and its interaction with the safety assessment process,
- Identify the key aircraft/systems development processes and their interrelationships,
- Discover and be able to apply new guidelines on Functional and Item Development Assurance Levels (FDAL & IDAL)
- Apply the new guideline material within your own company context.

Who Should Attend

This seminar is designed for engineers and other key personnel working in the design, development, and safety assessments of aircraft and aircraft systems.

Instructor: Eric M. Peterson

Eric Peterson is currently Vice-President of Systems and Safety for Electron International, Inc. He has over 35 years of experience in aerospace management, system design and analysis, development of hardware and software, and safety assessments for commercial and military flight critical avionic and fly-by-wire system applications. Mr. Peterson serves as vice-chairman of the SAE S-18 Aircraft & Systems Development and Safety Assessment committee and has provided key contributions to ARP4754A, ARP 4761, and ARP 5150. He is the recipient of the SAE International Forest R McFarland Award and is also a recipient of the SAE International Outstanding Contribution Award for his work in the development of Technical Standards. Mr. Peterson received his B.S. in Electrical Engineering from Montana State University.



Registration:		
Fees	Before 27 Aug	After 27 Aug
Non-member	£1,185	£1,285
Classic Member	£1,057	£1,157
Premium Member	£992	£1,092
Elite Member	£928	£1,028
1.3 CEUs		

SAVE £100! Register for this course by 27 August and get £100 off your fee.

Advanced Diesel Particulate Filtration Systems

8 – 9 October 2012

I.D.# C0502

This seminar covers many diesel particulate filters (DPF) related topics using fundamentals from various branches of applied sciences such as porous media, filtration and materials sciences and will provide the student with both a theoretical as well as an applications-oriented approach to enhance the design and reliability of aftertreatment platforms. Structure, geometry, composition, performance, applications and optimizations of DPFs are some of the main topics covered in this advanced level seminar. Computer simulation techniques for analysis and optimization of DPF performance are also demonstrated.

Learning Objectives

By attending this seminar, you will be able to:

- Discuss fundamental, moderate and advanced topics on DPF structure, geometry, composition, performance, applications and optimizations
- Formulate porosity, permeability, inertial loss coefficient, flow resistance descriptors, different particulate transport modes (diffusional, interceptive), etc. to develop models for predicting backpressure of DPF
- Recognize different modes of particulate filtration regimes in DPF
- Select, design, utilize and optimize DPF for various light duty and heavy duty aftertreatment applications
- Predict, via modeling and simulations, various important DPF performance features (backpressure, peak regeneration temperature, etc.) as well as to analyze their failure modes and thus enhance the reliability of diesel exhaust aftertreatment platform designs

Who Should Attend

This seminar is designed for engineers, scientists, investigators and consultants involved in researching, developing, applications, designing or optimizing diesel exhaust aftertreatment components and systems. Individuals from technical and regulatory institutions, OEMs, suppliers, emissions service companies, research facilities and universities will gain knowledge of diesel filter performance.

Instructor: Athanasios G. Konstandopoulos

Dr. Athanasios G. Konstandopoulos, recipient of the 2006 Descartes Laureate, is the founder and head of the Aerosol and Particle Technology Laboratory (APTL). Dr. Konstandopoulos, an SAE International® Fellow, has authored more than 70 scientific and technical papers and is a frequent invited speaker at conferences throughout the U.S. and Europe. His educational accomplishments include a Diploma in Mechanical Engineering from Aristotle University of Thessaloniki, an M.S. in Mechanical Engineering from Michigan Technological University and an M.S., MPhil and a Ph.D. in Chemical Engineering from Yale University.



Registration:		
Fees	Before 27 Aug	After 27 Aug
Non-member	£1,175	£1,275
Classic Member	£1,048	£1,148
Premium Member	£984	£1,084
Elite Member	£920	£1,020
1.3 CEUs		

SAVE £100! Register for this course by 27 August and get £100 off your fee.

Testimonial

"Excellent coverage of an emerging technology by a real expert in the area."

Henry Gysling

Technology Director
Air Flow Catalyst Systems

Tolerance Stack-Up Analysis

8 – 9 October 2012

I.D.# C0022

This course is designed to assist product design personnel in the creation of tolerance stacks for parts and assemblies that use Geometric Dimensioning & Tolerancing. Those who will benefit most are designers and engineers who are responsible for creating the GD&T callouts for engineering drawings and product models, and who want to be more confident in how the assigned geometric tolerances interact and stack up. The course begins with a quick review of Y14.5 concepts, and then introduces the benefits and uses of a tolerance stack spreadsheet. Participants then learn detailed procedures for performing tolerance stacks on parts and assemblies. The simple, manual spreadsheet method used throughout the course produces a straightforward documentation trail that is easily interpreted, and readily adaptable to any company's electronic spreadsheet program. Students receive extensive practice at creating stacks. Each attendee will receive a copy of the Tolerance Stack Analysis Using GD&T textbook and an Excel template for generating stacks.

Learning Objectives

By attending this seminar, you will be able to:

- Correctly calculate and apply bonus, shift, virtual condition, and resultant condition
- Perform and develop a tolerance stack-up analysis
- Correctly enter geometric feature control frame data into a tolerance stack

Who Should Attend

This course is intended for designers and engineers who are currently generally familiar with the principles, concepts and practices contained within Y14.5, and who are looking for a comprehensive step-by-step process for getting GD&T into a tolerance stack.

Instructor: John-Paul Belanger

John-Paul Belanger is president of Geometric Learning Systems, a consulting firm specializing in geometric dimensioning and tolerancing (GD&T). For over ten years, he has trained people throughout North America and Europe in the proper interpretation and application of GD&T per the Y14.5 standard by using practical examples. Mr. Belanger is certified by the American Society of Mechanical Engineers as a Senior GD&T Professional, and has worked with a wide range of companies in the automotive, aerospace, electronics, and other industries to apply tolerances and perform stack calculations. He holds a B.S. in aerospace engineering from the University of Michigan specializing in aircraft design and safety.



Registration:

Fees	Before 27 Aug	After 27 Aug
Non-member	£1,195	£1,295
Classic Member	£1,066	£1,166
Premium Member	£1,001	£1,101
Elite Member	£936	£1,036
1.3 CEUs		

SAVE £100! Register for this course by 27 August and get £100 off your fee.

Testimonial

"Excellent course. Definitely enhanced my ability to perform tolerance stack-ups."

Randy Zonca
Senior Designer
Bosch

Can't make the live class? A similar course is available as a Webinar delivered Online! Tolerance Stack-up Fundamentals Webinar

www.sae.org/pdevent/C0842



Seminar Registration and Fees

All course fees include a registration fee, education materials, and refreshment breaks. To register for a seminar go to www.sae.org/training/europeseminars, click on the course name and then the register button or call the SAE Europe Office at +32 2 740 2223. Courses in Italy are Euros only; courses in the UK are British pounds only. Credit card information or deposit account must accompany registration. Early enrollment is recommended due to limited class size and registration is on a first-come, first-served basis. Priority is established by date of receipt of payment. All fees exclude VAT (UK – 20%; Italy – 21%)

Location

Additional information on the seminar site, location, phone number and directions will be included your registration confirmation.

Time

Seminar hours are 08:30 to 16:30 unless otherwise indicated.

Hotel Information

Hotel arrangements and related matters are the responsibility of each registrant. Hotel information will be sent with seminar registration confirmation. It is recommended that you reserve your hotel room as early as possible (if applicable) to ensure availability.

Cancellations

If you cannot attend, you may send a substitute. A full refund is issued if you notify the SAE Europe Office +32 2 740 2223 at least four weeks prior to the start date of the seminar; an administrative fee of €100 (+ VAT) will be charged. Refunds will be issued in the same manner as original payment and will be made after the completion of the seminar. To cancel or arrange a substitute, contact the SAE Europe Office.

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Liability

In case of government intervention or regulation, military activity, strikes, or other circumstances that make it impossible or inadvisable for any of these courses to take place at the time and place provided, participants will only be reimbursed for the amount paid for registration. There shall be no future liability on the part of either party.

Travel

SAE is not responsible for the purchase of non-refundable airline/train tickets or the fees associated with cancelling or changing travel arrangements. Please contact SAE to confirm that the course is running before purchasing tickets. SAE retains the right to cancel a course until three weeks prior to the scheduled presentation date.

NOTE: SAE reserves the right to change instructors or cancel seminars. SAE cannot be held responsible for costs incurred other than the registration fee. Prices are subject to change; registrations are charged at the current price. Call for current pricing.

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Technology Topics:

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- Composite Material Technology
- Composite Treatment & Repair
- Engine Coolant Technologies
- Test Methodology (heat release analysis/design of experiments for engine optimisation)
- Accident Investigation

Diesel Engine Technology Engineering Academy

22 – 26 October 2012

**Politecnico Campus at Lingotto
Turin, Italy**

SAE Engineering Academies provide a comprehensive and immersive training experience, helping you become proficient and productive in a shorter period of time – whether you are a new engineer or newly assigned to Diesel Engine.

This Diesel Engine Technology Engineering Academy covers the engineering principles and practices necessary to effectively understand a modern diesel engine. Types of engines addressed include naturally aspirated, turbocharged, pre-chamber, open chamber, light duty, and heavy duty. It is an intensive learning experience comprised of lecture and structured practical sessions, including a team-solved case study problem. Attendees will receive a copy of the textbook, *Diesel Emissions and Their Control*, by lead instructor Magdi K. Khair and W. Addy Majewski.

Who should attend

Application engineers, design engineers, project managers or other professionals who work with, or are transitioning to, diesel engine design or development should not miss this training opportunity from nationally and internationally recognized experts in the technology.

Learning Objectives

By attending this Academy, you will be able to:

- Articulate basic diesel engine terminology and principles
- Describe the key features of the basic types of diesel engines
- Compare various diesel fuel injection systems and their components
- Analyze the effects of different fuels on engine performance and longevity
- Compare the function and applicability of various air management systems
- List the various emission standards and testing requirements
- Detail the elements of post-combustion emission control devices
- Discuss emerging diesel engine technologies

Registration:

Fees	Before 17 Sept	After 17 Sept
Non-member	€3,245	€3,345
Classic Member	€2,911	€3,011
Premium Member	€2,743	€2,843
Elite Member	€2,576	€2,676
4.0 CEUs		

SAVE £100! Register for this course by 17 September and get €100 off your fee.

For schedule updates, additional information, and to register for any of these courses –
www.sae.org/training/europeseminars

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In Conjunction with the SAE 2012 Powertrains, Fuels & Lubricants Meeting

Improving Fuel Efficiency with Engine Oils

17-18 September 2012

This seminar will highlight the role of lubricants in improving fuel efficiency and provide strategies for selecting the best oil for a given application.

www.sae.org/training/europeseminars

Combustion and Emissions for Engineers

17-19 September 2012

This seminar will bring issues related to combustion and emissions “down to earth,” relying less on mathematical terms and more on physical explanations and analogies.

www.sae.org/training/europeseminars

Stuttgart, Germany - Le Meridien Hotel

In Conjunction with the SAE 2012 On-Board Diagnostics Symposium - Europe

Emissions-Related OBD Systems: A Design Overview

12 November 2012

This one day seminar is designed to provide an overview of the fundamental design objectives and the features needed to achieve objectives for designing systems for generic on-board diagnostics.

www.sae.org/training/europeseminars

Diesel Engine Technology

ENGINEERING ACADEMY

June 4 – 8, 2012

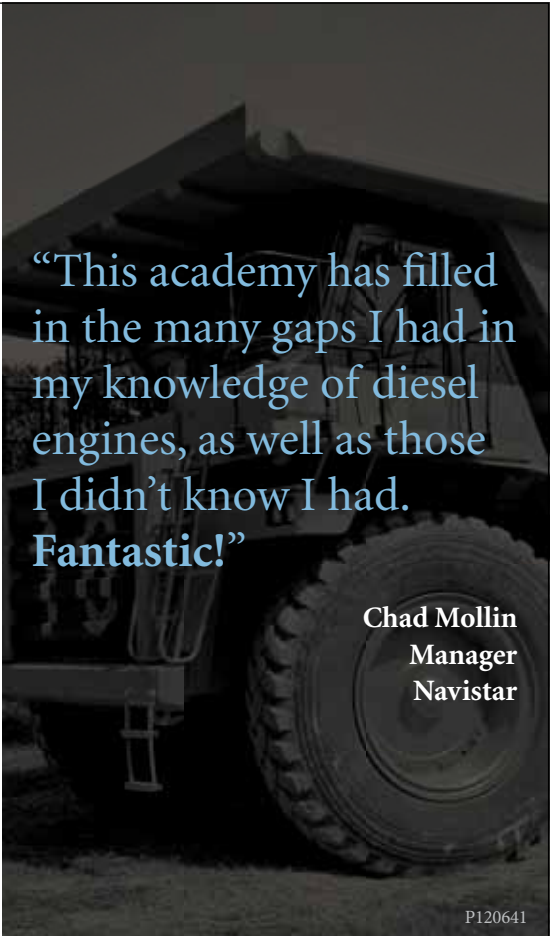
SAE Automotive Headquarters
Troy, Michigan, USA

October 22 – 26, 2012

Politecnico Campus at
Lingotto
Turin, Italy

For more information and to register:
www.sae.org/ACADEMIES

SAE International®



“This academy has filled in the many gaps I had in my knowledge of diesel engines, as well as those I didn’t know I had. Fantastic!”

Chad Mollin
Manager
Navistar

P120641



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September 18-20, 2012 • Malmo, Sweden

www.sae.org/pfl

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Session Topics:

- Combustion optimization
- Hybrid Powertrains
- Engine Downsizing
- Engine control
- Fuels and Fuel Efficiency
- Lubricants
- Advanced Fuel delivery
- Emissions reduction

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