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- Transmission/Drivetrain
- General Management and Leadership
- Professional and Legal Issues
- Diesel Technology
- SI Engine
- Vehicle Dynamics
- Product Engineering Tools and Methods

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This resource guide is designed specifically to help companies address their learning needs through a variety of SAE Professional Development options.

**Options**

For 8 - 100+ employees, SAE works with companies like yours to design and deliver customized training at your site.

Through SAE Corporate Learning Solutions you can:

- Select an existing SAE course for delivery at your site
- Subscribe to a single online, on demand course for one or many employees
- Purchase a corporate subscription to the entire library of over 50 online courses (more than 350 hours of content available)
- Customize a learning experience to address your specific business needs

**Advantages**

With as few as eight employees who have the same learning need, SAE Corporate Learning Solutions offers multiple advantages:

- **Variety** — Choose from a comprehensive course list of over 300 titles.
- **Personalization** — If you can’t find the specific topic you need or if the course content does not exactly match your requirements, SAE can customize a training program. We can also integrate online learning for a “blended solution.”
- **Quality** — SAE courses are conducted by leading academic and industry instructors. All courses and instructors undergo a review and approval from objective industry experts. This assures course content is relevant and accurate.
- **Convenience** — We schedule the instructor, supply the comprehensive course materials for each attendee, and coordinate other administrative details like instructor travel and accommodation or online connections.

- **Cost Effective** — The instructor comes to you! No staff travel expenses and no time away from the office, save time and money. Also, our extensive network and existing course list makes our pricing extremely competitive!
- **Timeliness** — SAE International is the world’s leader in mobility engineering knowledge. Our programs are developed and refined to stay ahead of industry trends; and we offer only the most up-to-date and knowledgeable instructors.

**What is included in a Corporate Learning Solutions Program?**

- **Customization** — Most courses can be tailored to address your company’s specific business or training objectives. Often this involves incorporating company data, generating case problems, or developing completely new content.

- **Administrative Coordination** — SAE staff contracts with the instructor, supplies all course materials, and provides attendance and post-course evaluation forms. All you do is provide the facility and audio-visual equipment!

- **Pre-training Communication with the Instructor** — SAE arranges communication with the instructor and relevant company representatives to review the learning objectives and ensure understanding of the scheduled training. This is another opportunity to gear the program to your specific needs.

- **Continuing Education Units** — SAE awards Certificates of Completion with IACET approved Continuing Education Units (CEUs) to all attendees. One CEU is granted for every 10 learning contact hours.

**Contact SAE Corporate Learning:**

1-724-772-8529 or corplearn@sae.org
What determines the Corporate Learning Solutions cost?

- The length of the program (number of days or hours of learning contact time)
- The learning materials. Some courses include textbooks or other learning aids
- The number of attendees
- Any customization required
- The instructor’s travel expenses or connection fees

These variables are used to calculate a base fee, which is typically based on 10 attendees. The fee increases proportionally as more attendees are added. Companies are additionally responsible for instructor travel expenses or connection fees, transfer fees, and living expenses.

What amenities does your company provide?

- A suitable meeting room or classroom
- Audio-visual equipment and computers (if required)
- Refreshment breaks and meals (if desired)
- Information on local hotels and airports along with directions to your facility

Explore State Resources for Training Dollars

Often states and local economic development groups have grant dollars available for training. Contact your state’s Department of Labor or other groups in your area to research funds available for your organization.

For example, Michigan residents can visit www.michigan-works.org and enter their zip code to find local offices and Michigan Works! contacts in the area.

**ACCREDITATIONS**

The IACET CEU

SAE International is recognized as an Authorized Provider by the International Association for Continuing Education and Training (IACET). All SAE Professional Development seminars, e-Seminars, web seminars, and engineering academies meet eligibility requirements for IACET Continuing Education Units (CEUs) according to the ANSI/IACET 1-2013 Standard. To receive CEUs, attendees are required to be engaged in the entire class and demonstrate mastery of the learning objectives by successfully completing a knowledge assessment.

Many organizations offer some form of continuing education credit, but only the IACET CEU is held to the strict, research-based IACET Criteria and Guidelines for Continuing Education and Training. Only IACET Authorized Providers, who undergo a strict application and site-review process, can award the IACET CEU. IACET Authorized Providers are required to re-apply and be reauthorized every five (5) years.

The Continuing Education Unit (CEU) was created by IACET as a measurement of continuing education. One (1) IACET CEU is equal to ten (10) contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction. Under IACET’s care, the IACET CEU has evolved from a quantitative measure to a hallmark of quality training and instruction. For more information on IACET, visit www.iacet.org.

To obtain official transcripts, please contact SAE Customer Service at 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada)

ACTAR Approved SAE Courses

Some SAE courses have been approved by the Accreditation Commission for Traffic Accident Reconstruction (ACTAR) for Continuing Education Units (CEUs). In addition, the ACTAR CEUs are also listed with the course description.

ACTAR approved courses feature the ACTAR icon.

Upon completion of any of these courses, accredited reconstructionists should contact ACTAR, 1-800-809-3818, to request CEUs. As an ACTAR approved course, the fee for the CEUs for each course is $5.00.
LEARNING FORMATS

A LEARNING FORMAT TO FIT EVERY NEED
SAE offers a variety of learning formats to accommodate diverse learning styles. Explore classroom, live and online, or online and on demand courses. Many courses are offered in multiple formats so be sure to watch for the icons that identify the format for each course.

Seminars or workshops available as similar live, online Web Seminars will feature both icons and the course description for the Web Seminar will be listed immediately following the classroom title.

Live, online or classroom courses that have a similar course offered online and on demand will include both icons – watch for those descriptions or notes on where to get additional information.

SEMINARS AND WORKSHOPS
SAE International offers over 200 seminar and classroom titles in 100 separate technology and business skill topics. These seminars and workshops range from one-to three-days and are led by highly-qualified, industry or academic experts. SAE live, classroom courses are interactive and encourage skill-development and problem solving. Each course includes comprehensive course materials to assist the learner in implementing the knowledge gained in the course.

Additionally, we offer nearly all courses throughout the year at the SAE International Office in Troy, Michigan; or at sights across the US and the world including SAE International Engineering Events.

ENGINEERING ACADEMY
SAE’s award-winning Engineering Academy format is an intensive “boot camp” experience that immerses attendees in a focused technology area. The Engineering Academy is a comprehensive training experience on core engineering topics. Multiple instructors team up to provide interactive lecture, discussion, and practice – all designed to aid learning and application.

The Engineering Academy is perfect for newly hired engineers or those changing technical disciplines who need to quickly develop a new skill set in order to become productive on the job. The Engineering Academy format earned the prestigious Award of Excellence from the American Society of Association Executives.

For a current schedule of upcoming Academies, visit training.sae.org/academies

SAE E-LEARNING
Learners can take advantage of the convenience and cost effectiveness offered by e-Learning from SAE. SAE maintains a growing menu of learning products delivered online. These programs are listed throughout the catalog. Look for the icons that denote live online or online on demand.

Live, Online courses
Informative and content-rich, SAE live, online courses are instructor-led programs delivered via the internet and telephone. Schedules and budgets can make it difficult to attend a classroom offering so SAE has developed this alternative format to deliver technical courses directly. Participants can log in to the live event from anywhere there is a telephone and a PC with Internet access. Delivered in one or a series of 90 to 120-minute sessions, Web Seminars feature audio delivered by telephone,
web-based presentations, interactive question-and-answer, and course-specific online forums for posting of supplemental materials, networking and course activities. Comprehensive course materials are also provided in PDF format. CEU’s are awarded when course requirements have been met. Look for the live, online icon throughout the catalog.

**Online, On demand courses**

Avoid travel expenses and time out of the office, and make learning fit into your schedule. Access one of our online, on demand courses right from your desktop through the internet. There are more than 50 courses with over 300 hours of online content. Many of our online, on demand courses are based on classroom offerings or are captured recordings of our most popular Web Seminars. We also provide short-courses designed to bring team members quickly up-to-speed on a specific subject or topic. Look for the symbol in the course description to identify those titles that are delivered online and on demand.

Your company can subscribe to the entire collection for just a few employees or all of the programs for every employee. Please contact the Corporate Learning Solutions hotline, 1-724-772-8529 for additional information or to receive a proposal.

**Online, on demand courses INCLUDE:**

- **e-Seminars** – self-paced online courses based on our most popular instructor-led seminars
- **Fast Tracks** – Faster, targeted learning in short-duration online courses
- **Web Seminar RePlays** - a selection SAE Web Seminars are archived and providing anytime access to instructor-led online programs
- **CALISO International Standards Courses** - a series of online courses provide information on international standards including ISO 9001, ISO 14001, ISO/TS 16949, ISO 19011 including Auditor and Lead Auditor training insights and best practices; six sigma and Sarbanes-Oxley
- **Metallurgy Online Courses** - in partnership with Industrial Metallurgists, Inc.
- **Ford Online Courses** - six of Ford’s most popular online courses on powertrain and problem solving topics extend Ford engineering knowledge across the global industry

There are varying equipment requirements for the different online, on demand options. Visit the webpage for each course to determine if your system meets the course equipment requirements.

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**CATALOG KEY**

You will see the following icons alongside the course descriptions. These icons indicate:

- delivery formats available for the course
- the course is part of an SAE certificate
- that it is an ACTAR approved course

Many courses are available in multiple formats. See page X to get more information on the learning formats offered by SAE. In addition to finding courses that fit your technology need, look for courses with icons that fit the way you want to learn.

- **Classroom** – indicates the course is an instructor-led seminar or workshop offered in a classroom setting
- **Live, online** – indicates the course is an instructor-led web seminar offered live and online via telephone and internet connection
- **Online, on demand** – indicates the course is available online anytime the participant would like to access the course through the internet
- **Certificate** – indicates the course is part of an SAE International curriculum-based, multi-course certificate. See a list of the multi-course certificates on page XII
- **ACTAR logo** – indicates the course is an ACTAR approved course. For more information on ACTAR and ACTAR accredited courses, see page IX
Show the industry the depth of your organization’s expertise. SAE offers focused topic-specific credentialing programs for engineers and other professionals in ground vehicle and aerospace. Shine a light on their knowledge and expertise through SAE Credentialing.

Your team can earn an SAE Certification by passing industry-created and vetted exams. Get more information at training.sae.org/credentialing

How does it work?

- **Complete** established eligibility requirements (typically educational background and work experience)
- **Pass** an industry-developed, vetted, and proctored exam that tests mastery of an industry-defined body of knowledge
- **Earn** your industry recognized credential endorsing your experience and knowledge of the technology, and establishing a solid foundation on which to build a successful career.

Certifications must be maintained over 3-year period of time by fulfilling established maintenance requirements.

Or, expand their knowledge and build your organization’s reputation as an expert through industry-advised Certificate of Competency programs.

How does it work?

- **Complete** a course in a focused content area
- **Pass** an industry-vetted exam that verifies your understanding of the material
- **Earn** a Certificate of Competency or Certificate of Mastery

SAE Certification or Certificate of Competency – how does it benefit the ENGINEER?

- Validates their mastery of industry-driven training and learning objectives or confirms mastery of an industry-generated body of knowledge
- Imparts international recognition of experience and skills
- Provides a portable credential that is recognized across industry
- Demonstrates their commitment to continued growth and improvement

What is the value to the ORGANIZATION?

- Recognizes the capabilities of your people and enhances your company’s credibility with the industry as a supplier OR OE through an independent assessment
- Contributes to the hiring and promotion process – quickly illustrates the capabilities and experience of potential new hires or those you’d like to advance
- Encourages employee commitment to growth and opportunity
- Supports the promotion of professional competence

SAE currently offers the following Credentialing Programs:

**Vehicle Electrification (VE) Program**: offering a Certificate of Competency, Certified Vehicle Electrification Professional (CVEP) and Certified Vehicle Electrification Engineer/Scientist (CVESS). Vehicle Electrification (VE) Certification is designed to validate a mastery of knowledge essential to VE safety and all major VE systems.

**Design Review Based on Failure Modes (DRBFM) Program**: offering a Certificate of Competency, DRBFM Professional Certification and DRBFM Expert Certification. The DRBFM program focuses on competency and application of philosophy, preparation, change point FMEA, design review, and actions results and feedback.
SAE INTERNATIONAL ALSO OFFERS CURRICULUM-BASED, MULTI-COURSE CERTIFICATES IN SPECIFIC TECHNICAL AREAS.

Intended to provide a guide towards deeper knowledge in a specific area, SAE’s multi-course certificates outline required courses that offer foundational knowledge of the subject. Some certificate programs also feature additional electives designed to broaden your exposure to more specific aspects of the technology studied.

In addition to the Continuing Education Units (CEUs) awarded, successful completion heightens your expertise within the field and earns you an SAE credential recognizing your achievement.

PLUS—completion of many of the multi-course certificate programs equates to graduate credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems and Kettering’s 40-credit M.S in Mechanical Engineering. Visit training.sae.org/collegecredit for more information.

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate.

NEW! Accident Reconstruction Certificate Program

Professionals become more proficient in the practice of vehicle crash/accident reconstruction by successfully completing this certificate program from SAE. Required courses guide one through crash reconstruction methods, vehicle dynamics, and event data recorder (EDR) technology then completion of three elective courses suit the individual’s specific technical interest area.

The following are required courses:
- **Vehicle Crash Reconstruction Methods** (I.D.# C1417)
- **Vehicle Dynamics for Passenger Cars and Light Trucks** (classroom I.D.# 99020 or online on demand I.D.# PD130702ON)
  - OR **Applied Vehicle Dynamics** (I.D.# C0414)
- **Applying Automotive EDR Data to Traffic Crash Reconstruction** (I.D.# C1210) OR **Accessing and Interpreting Heavy Vehicle Event Data Recorders** (I.D.# C1022)

Choose three electives:
- **Advanced Vehicle Dynamics for Passenger Cars and Light Trucks** (I.D.# C0415)
- **Chassis and Suspension Component Design for Passenger Cars and Light Trucks** (I.D.# 95025)
- **Hydraulic Brake Systems for Passenger Cars and Light Trucks** (I.D.# C0509)
- **High-Performance Brake Systems** (I.D.# C0718)
- **Introduction to Brake Control Systems: ABS, TCS, and ESC** (classroom I.D.# C0315 or online on demand I.D.# PD130501ON)

* Tire and Wheel Safety Issues* (I.D.# C0102)
* The Tire as a Vehicle Component* (I.D.# C0101)
* Injuries, Anatomy, Biomechanics & Federal Regulation* (I.D.# 85049)
* Commercial Vehicle Braking Systems* (classroom I.D.# C0233 or online on demand I.D.# PD130611ON)
* Introduction to Heavy Truck Tire, Steering, and Suspension Dynamics* (I.D.# C1209)
* Fundamentals of Automotive All-Wheel Drive Systems* (I.D.# C0305)
* Fundamentals of Heavy Truck Dynamics* (I.D.# C0837)
* Applying Automotive EDR Data to Traffic Crash Reconstruction* (if not taken as a required course – I.D.# C1210)
* Accessing and Interpreting Heavy Vehicle Event Data Recorders* (if not take as a required course – I.D.# C1022)

**Diesel Technology Certificate Program**

This certificate equips engineers with a solid understanding of diesel engines, emissions and aftertreatment strategies, and related components including fuel injection and air management. The program requires completion of courses that address these areas and offers further depth through a menu of electives.

The required courses are:
- **Diesel Engine Technology** (classroom: I.D.# 93014 or online, on demand: I.D.# PD130812ON)
- **Common Rail Diesel Fuel Injection** (I.D.# C0920)
- **Turbocharging Internal Combustion Engines** (I.D.# C0314)

Choose one elective:
- **Diesel Engine Noise Control Web Seminar or Web Seminar RePlay** (I.D.# WB1041; PD331041ON)
- **Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems** (I.D.# C0235)
- **Exhaust Gas Recirculation (EGR) for Diesel Engines** (I.D.# C1214)
- **Selective Catalytic Reduction for Diesel Engines** (I.D.# C0913)
- **Variable Valve Actuation Design and Performance Impact on Advanced Powertrains** (I.D.# C1332)

Completion of the **Diesel Engine Technology Engineering Academy** can be used as a substitute for **Diesel Engine Technology** and one elective.
General Management and Leadership Certificate Program

This program focuses on four core management and leadership competencies: management capability, team leadership, project management, and finance providing a basis for growth into a leadership or management role.

All of the following courses are required:

- Managing Engineering & Technical Professionals (I.D.# C0608)
- Engineering Project Management (I.D.# 99003)
- Principles of Cost and Finance for Engineers (I.D.# C0828)
- Leading High Performance Teams (I.D.# C0410)

Attending the Engineering Management Academy serves as a substitute for Managing Engineering and Technical Professionals, and Leading High Performance Teams required courses.

Product Engineering Tools and Methods Certificate Program

This program focuses on the study, development, management and implementation of product engineering principles, methodologies and techniques. When used properly, these tools and methods become powerful productivity enhancers reducing product development time and cost through improved communication, documentation, problem-solving, and quality.

All of the following courses are required:

- Design of Experiments (DOE) for Engineers Web Seminar (I.D.# WB0932) OR classroom seminar - Design of Experiments for Engineers (DOE) (I.D.# C0406)
- Finite Element Analysis (FEA) for Design Engineers Web Seminar (I.D.# WB1241)
- Fundamentals of Geometric Dimensioning & Tolerancing (GD&T) Web Seminar or Web Seminar RePlay (live, online: I.D.# WB0933; online, on demand I.D.# PD330933ON) OR classroom seminar - Geometric Dimensioning & Tolerancing (I.D.# C0133)
- Tolerance Stack-up Fundamentals Web Seminar or Web Seminar RePlay - (live, online: I.D.# C0842; online, on demand I.D.# PD330842ON) OR classroom seminar - Tolerance Stack-Up Analysis (I.D.# C0022)
- Root Cause Problem Solving: Methods and Tools Web Seminar or Web Seminar RePlay (live, online: I.D.# WB0931; online on demand I.D.# PD330931ON)

Choose one elective:

- Accelerated Test Methods for Ground and Aerospace Vehicle Development (classroom: I.D.# C0316 or online, on demand: I.D.# PD130524ON)
- All three advanced web seminar/web seminar rePlay titles in the Geometric Dimensioning & Tolerancing Series (I.D.#s WB1319, WB1320, & WB1321)
- Design for Manufacturing & Assembly (DFM/DFA) (I.D.# 92047)
- Design Review Workshop (I.D.# C1306)
- Finite Element Analysis for Design Engineers - Hands-on FEA Workshop (I.D.# 93006)
- Introduction to Design Review Based on Failure Modes (DRBFM) Web Seminar or Web Seminar RePlay (live, online I.D.# WB1047; online, on demand I.D.# PD331047ON)
- Introduction to Failure Mode and Effects Analysis for Product and Process (I.D.# C1201)
- Robust Design (I.D.# C1201)
- Statistical Tolerance Design (I.D.# 88033)
- Weibull-Log Normal Analysis Workshop (I.D.# 86034)

Professional and Legal Issues Certificate Program

This program focuses on legal and risk management issues critical for engineers to master to facilitate the successful design and deployment of products from a safety and reliability perspective.

All of the following courses are required:

- Patent Law for Engineers (I.D.# 88007)
- Product Liability and The Engineer (I.D.# 82001)
- The Role of the Expert Witness in Product Liability Litigation (I.D.# 92054)
- Program and Risk Management (I.D.# C0409)

SI Engine Certificate Program

This certificate is designed to familiarize engineers with key spark ignition engine components and technologies and how they function as a system. By completing the certificate, engineers can acquire fairly deep engine expertise and, at the same time, earn an SAE credential.

All of the following courses are required:

- Basics of Internal Combustion Engines (classroom: I.D.# C0103 or online, on demand: I.D.# PD130944ON)
- Internal Combustion Systems: HCCI, DoD, VCT/VVT, DI and VCR (I.D.# C0613)
- Turbocharging Internal Combustion Engines (I.D.# C0314)
- Powertrain Selection for Fuel Economy and Acceleration Performance (I.D.# C0243)

Choose one elective:

- Gasoline Direction Injection (GDI) (I.D.# C1009)
- Combustion and Emissions for Engineers (I.D.# 97011)
- Automotive Heat Transfer (I.D.# C1230)
- Introduction to Commercial and Off-Road Vehicle Cooling Airflow Systems (classroom: I.D. #C0738 ; live online: I.D.# WB1240; or online on demand: I.D.# PD331240ON)
- Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems (I.D.# C0235)
- Piston Ring Design/Materials (I.D.# 86009)
- Compact Heat Exchangers for Automotive Applications (I.D.# 97002)
- Fundamentals of Automotive Fuel Delivery Systems (I.D.# C0203)
- Variable Valve Actuation Design and Performance Impact on Advanced Powertrains (I.D.# C1332)
Transmission/Drivetrain Certificate Program

This program familiarizes engineers with key drivetrain components and how those components function as a system. By completing the certificate, engineers can increase their expertise within the drivetrain body of knowledge and, at the same time, earn the SAE Certificate of Achievement.

All of the following courses are required:

- **A Familiarization of Drivetrain Components** (classroom: I.D.# 98024 or online, on demand: I.D.# PD130555ON)
- **Fundamentals of Automotive All-Wheel Drive Systems** (classroom: I.D.# C0305 or online, on demand: I.D.# PD130556ON)
- **Fundamentals of Modern Vehicle Transmissions** (classroom: I.D.# 99018 or online, on demand: I.D.# PD130419ON)
- **Introduction to Gears** (I.D.# C0822)
- **High-Performance Differentials, Axles, & Drivelines** (I.D.# C1113)
- **Powertrain Selection for Fuel Economy & Acceleration Performance** (I.D. # C0243)

Vehicle Dynamics Certificate Program

Designed to equip engineers with key vehicle dynamics and handling theory and application from a systems perspective, the objective of this program is for engineers to understand the interaction and performance balance between the major vehicle subsystems. The program design requires completion of fundamental and advanced-level vehicle dynamics theory and application courses with three elective courses that best suit an individual’s interest areas or engineering emphasis.

All of the following courses are required:

- **Vehicle Dynamics for Passenger Cars and Light Trucks** (classroom: I.D.# 99020 or online, on demand: I.D.# PD130702ON)
- **Fundamentals of Heavy Truck Dynamics** (I.D.#C0837)
- **Advanced Vehicle Dynamics for Passenger Cars and Light Trucks** (I.D.#C0415)

Choose three from these electives:

- **Applied Vehicle Dynamics** (I.D.# C0414)
- **Fundamentals of Steering Systems** (I.D.# C0716)
- **Introduction to Brake Control Systems: ABS, TCS, and ESC** - (classroom: I.D.# C0315 or online, on demand: I.D.# PD130510ON)
- **The Tire as a Vehicle Component** (I.D.# C0101)
- **Tire and Wheel Safety Issues** (I.D.# C0102)
- **Chassis & Suspension Component Design for Passenger Cars & Light Trucks** (I.D.# 95025)
- **Commercial Vehicle Braking Systems** (I.D.# C0233)
- **Heavy Vehicle Ride Comfort Engineering** (I.D.# C0948)
- **Hydraulic Brake Systems for Passenger Cars and Light Trucks** (I.D.# C0509)
- **High-Performance Brake Systems** (I.D.# C0718)

Get more information on the curriculum-based, multi-course certificates at training.sae.org/credentialing/certificate/

Here's how you obtain your SAE Certificate

Once you complete all required courses in any of the certificate programs, contact SAE Customer Service, 1-877-606-7323 (or 1-724-776-4970 outside U.S. & Canada) or email: customerservice@sae.org and request your Certificate. Your SAE transcript will be reviewed to verify completion of required courses and your Certificate will be mailed to you within 30 days.

SAE Certificate Programs can also be conducted at your company site for groups of employees. For a price quote, call our Corporate Learning Solutions hotline, 1-724-772-8529.
MyLearn.sae.org houses information on all of SAE’s professional development opportunities including live classroom, live online, and online, on demand. Use MyLearn.sae.org to quickly locate learning solutions designed to meet the educational and training needs of technical professionals in your organization.

MyLearn.sae.org offers learners:
• Access to transcripts
• The option to plan and schedule training and to register or purchase any course
• Ability to enroll in certificate or certification programs
• A spot to check out what’s new in SAE professional development activities,
• And download a full catalog of programs

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SAE International offers you education and training resources in the areas that are shaping the mobility industry and your career.

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- Online courses that supply the technical content you expect without the expense of travel or time away from your office
- Customized onsite training designed for your organization’s specific needs

Stay current on the latest technology, increase your knowledge, and positively affect your organization’s bottom line with professional development from SAE International.

Visit training.sae.org to view all SAE International professional development opportunities, schedules and course information.
CHASSIS AND VEHICLE DYNAMICS

Includes vehicle and truck dynamics, ride and handling, tires, suspension, and braking systems.

VEHICLE DYNAMICS AND HANDLING

Advanced Vehicle Dynamics for Passenger Cars and Light Trucks

3 Days
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.

Participants should bring a scientific calculator to participate in the classroom workshops.

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.

Prerequisites

Participants must have a working knowledge of the fundamentals of vehicle dynamics acquired through sufficient work experience or by participating in seminars such as the SAE seminars Vehicle Dynamics for Passenger Cars and Light Trucks (I.D# 99020, page 9)
### CHASSIS AND VEHICLE DYNAMICS

#### Topical Outline

**DAY ONE**
- Modeling Primary Ride Dynamics
  - 4-degree of freedom (DOF) primary ride model
  - 2-DOF primary ride model
- Modeling Vehicle Handling Dynamics
  - Developing the cornering compliance model
  - Developing the transfer function
- Introduction to Vehicle Dynamics CAE
  - Types of models
  - Strengths/Limitations
  - Commercial software packages
- Measurement and Simulation of Suspension Kinematics and Compliance (K&C)
  - Objectives of the K&C test
  - Definitions
  - Measurement equipment
  - Common tests
  - Simulation of the K&C test
- Measurement and Simulation of Primary Ride
  - Primary vs. Secondary Ride
  - Physical measurements
  - Common primary ride metrics
  - Olley Criteria for primary ride
  - Primary ride simulation
  - CarSim™ Exercise - Primary Ride Simulation

**DAY TWO**
- Measurement and Simulation of Acceleration and Braking
  - Steady state acceleration test and metrics
  - Steady state braking test and metrics
  - Simulation of steady state acceleration and braking
- Measurement and Simulation of Steering
  - On-center steering test and metrics
  - Low-g swept steer test and metrics
  - Simulation of steering tests
  - CarSim™ Exercise - Steering
- Measurement and Simulation of Open Loop Handling
  - Definition of open loop
  - Steady state open loop tests -- High-g swept steer
  - Transient open loop tests -- Step steer; Brake/throttle release in a turn; Fishhook; Sine with dwell
  - Simulation of open loop handling tests
  - CarSim™ Exercise - Open Loop Handling

**DAY THREE**
- Measurement and Simulation of Closed Loop Handling
  - Definition of closed loop
  - Steady state closed loop tests -- Constant radius
  - Transient closed loop tests -- Lane change; Slalom
  - Simulation of closed loop handling tests
  - CarSim™ Exercise - Closed Loop Handling
- Design of Experiments (DOE) Applied to Vehicle Dynamics Development
  - What is DOE
  - Why use DOE
  - Terminology
  - Types of DOE’s
  - Example - Screening DOE for primary ride
  - Example - Response Surface Method (RSM) DOE for Transient Handling
- Vehicle Dynamics Summary

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<th>Richard Lundstrom and Timothy Drotar</th>
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### Chassis & Suspension Component Design for Passenger Cars & Light Trucks

3 Days  
I.D.# 95025

Just as the chassis and suspension system provides an ideal framework for the automobile, this popular SAE seminar provides an informative framework for those involved in the design of these important systems. Emphasizing the fundamental principles that underlie rational development and design of suspension components and structures, this course covers the concepts, theories, designs and applications of automotive suspension systems.

#### Learning Objectives

By attending this seminar, you will be able to:
- Identify the types of suspensions and structures and their design differences from concept to prototype, theory to application; static and dynamic load conditions; and suspension modeling
- Describe the chassis design process and various suspension system interactions through demonstrations, video and audio devices and computer simulation
- Illustrate how an algorithm for a complete design cycle of the chassis works
- Explain the various chassis suspension analyses and designs that need to be performed and verified during development
- Recognize Magic Numbers in suspension design and the Suspension Design Factors (SDF)
- Analyze, predict, and evaluate the design parameters and performance characteristics for ride and handling quality control behavior of ground motor vehicles as a result of suspension design
- Reference a unique set of lecture notes related to suspension design
Who Should Attend
This seminar is designed primarily for engineers involved in vehicle ride, handling, chassis design, suspension, steering and brake design for passenger cars and light trucks.

Topical Outline
DAY ONE
• Survey
• General Overview
• Tires and Wheels
• Ride and Ride Design Criteria
• Handling and Handling Design Criteria
• Vehicle Dynamics Terminology
DAY TWO
• Roll Rates, Roll Motion
• Dynamic Transfer During Cornering
• Understeer Coefficient
• The Design of Springs, Stabilizer Bars, Shock Absorbers, Bushings, Control Arms
• Links, Semi-Active Damper, and Control Links
• Static Analysis and Design of Suspensions
• Suspension Terminology
DAY THREE
• Fore/Aft Dynamic Load Transfer Analysis
• Dive, Lift and Squat
• Steering Systems
• Active and Semi-Active Suspension
• CAD/Static, Dynamic and Proving Ground Testing
• Suspension Design Cycle
• Magic Number in Suspension Design
• Concluding Remarks

Instructor: Pinhas Barak
Fee $1655 2.0 CEUs
• Steering Mechanism
• Forces and Moments
• Steering Vibrations
• Steering Effects
• Maneuverability

DAY TWO
• Suspension Dynamics and Kinematics
  • Introduction to Suspension Systems
  • Spring Elements; Damper Elements
  • Advanced Suspensions
• Heavy Truck Dynamics
  • Dynamics Basics
  • Center of Gravity (CG) Calculations
  • Roll Dynamics; Frame Dynamics
  • Load Transfer
  • Aerodynamics Loads
• Vehicle Dynamic Elements
  • Suspension Dynamics
  • Nonlinearities in Suspension
  • Resonance of Axle Hop
  • Bounce and Pitch of Rigid Body
  • Roll Response
  • Frame Bending
  • Cab Mounting System
  • Position of Fifth Wheel
  • Driver’s Seat
  • Loading
  • Trailer Effects
• Perception of Ride
• Human Body Response to Vehicle Vibrations
• Case Studies: Contemporary Topics in Heavy Truck Dynamics
  • CASE 1: Practical Evaluation of Truck Suspension Kinematics and Dynamics
  • CASE 2: Dynamic Influence of Frame Stiffness on Heavy Truck Ride
  • CASE 3: Effect of Panhard Rod Cab Suspensions on Heavy Truck Ride Measurements
  • CASE 4: Simulation Analysis of Suspension and Driveline Dynamic Coupling and their effect on Truck Ride
• Seminar Evaluation and Conclusion

Instructor: Mehdi Ahmadian
Fee $1675 2.0 CEUs

Fundamentals of Steering Systems
2 Days
I.D.# C0716

Design and development of a modern steering system influences vehicle response, driver controllability, comfort, safety and fuel economy. In this interactive seminar, participants will analyze the steering system, from the steering wheel to the road wheel. The seminar will cover the anatomy and architecture of the lower steering system (wheel end suspension geometry, linkages and steering gear), its effect on vehicle response, and how a force at the contact patch is translated to a torque in the steering wheel. The anatomy and architecture of the upper steering system (steering column and intermediate shaft), including the topic of non-uniformity and the role of the upper steering in the occupant protection system will also be explored.

Significant time will be devoted to the generation of power assist, either by way of a conventional hydraulic power steering (HPS) or electrically power assisted steering (EPAS). Topics include system anatomy/architecture as well as the effect of the system on fuel economy. The seminar will finish with a discussion of common steering objective tests and how the kinematics, compliances, friction and power assist affect steering response and torque feedback. Students will have the opportunity to participate in exercises throughout the seminar, culminating in a final project where they will calculate an assist curve for both a HPS and an EPAS system.

Learning Objectives

By attending this seminar, you will be able to:
• Identify common steering and suspension system architectures
• Compare and contrast different types of steering gears
• Describe the function of the steering column and intermediate shaft subsystem
• Describe the influence of system tuning on steering response and torque feedback
• Compare and contrast different types of power assist systems
• Describe the effect of power steering on fuel economy
• Calculate important parameters that affect steering response and torque feedback

Who Should Attend

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

Prerequisites

Participants must have a working knowledge of the fundamentals of vehicle dynamics acquired through sufficient work experience or by participating the SAE seminars Vehicle Dynamics for
Topical Outline

DAY ONE
- Introduction
  - Elements of the steering system
  - Coordinate systems
- The Lower Steering System
  - Kingpin axis -- Front versus rear steer; Caster angle and kingpin inclination; Caster trail and scrub radius; Steer arm
  - Class exercise - Calculate moment about the kingpin axis for cornering and parking loadcases
  - Linkages/steering geometry -- Rack and pinion; Haltenberger; Parallel linkage
  - Steering gear anatomy and architecture -- Rack and pinion; Recirculating ball
  - Friction and compliances
  - Class exercise - Calculate pinion torque for cornering and parking loadcases
- The Upper Steering System (steering column & intermediate shaft)
  - Anatomy and architecture
  - Non-uniformity
  - Sources of friction and torsional compliance
  - Role of the upper steering system in the occupant protection system

DAY TWO
- Power Assist Systems
  - Conventional hydraulic power assist
  - Electro-hydraulic assist
  - Electric power assisted steering
  - Speed sensitive steering
- Vehicle Level Considerations
  - Steering response -- Effect of steering ratio on response gain
  - Steering feel/torque feedback -- Common steering tests and metrics; Effect of friction, compliances, and steering column non-uniformity
  - Class exercise - Calculate a power steering assist curve for hydraulic or electric power assisted steering system
  - Error states (nibble/wheelfight, pull/drift)
  - Power steering system effect on fuel consumption

Instructor: Timothy Drotar
Fee $1285 1.3 CEUs
The Pneumatic Tire, a 700-page E-book on CD, edited by Joseph Walter and Alan Gent, is included in the course material.

Learning Objectives

By attending this seminar, you will be able to:

- Explain the force and moment generating behavior of tires as related to construction, materials, and operating conditions
- Predict vehicle response based on tire characteristics using basic laws of mechanics supplemented by experimental results as necessary

Who Should Attend

This course is designed principally for technical professionals in the automobile, tire, and wheel industries and their suppliers. In addition, some case studies and examples involve truck, agriculture, and aircraft tires.

Topical Outline

- Introduction
  - Brief history of tires and wheels
  - Types of tires
  - Tire construction features
- Longitudinal Tire Properties
  - Braking and driving forces
  - Rolling resistance
- Lateral Tire Properties
  - Cornering force
  - Camber thrust
  - Ply steer and conicity forces
- Combined Longitudinal and Lateral Forces
  - Friction ellipse
  - Load transfer in cornering
- The Tire as a Spring
  - Linear vs. non-linear springs
  - Rolling vs. non-rolling behavior
  - Tire frequency response
- Tire and Wheel Non-Uniformities
  - Force and moment variations
  - Low speed/high speed effects
  - Tire manufacturing issues
- Influences of Tire Properties on Vehicle Response
  - Vehicle stopping distance
  - Vehicle ride
  - Vehicle handling
  - Vehicle high speed performance
  - European vs. North American requirements
- Future Technological Developments
  - Run-flat tires
  - Cordless cast tires
  - Intelligent tires

instructor: Joseph D. Walter
Fee $755 .7 CEUs
Tire and Wheel Safety Issues

1 Day
I.D.# C0102

One of the most important safety critical components on cars, trucks, and aircraft is the pneumatic tire. Vehicle tires primarily control stopping distances on wet and dry roads or runways and strongly influence over-steer/under-steer behavior in handling maneuvers of cars and trucks. The inflated tire-wheel assembly also acts as a pressure vessel that releases a large amount of energy when catastrophically deflated. The tire can also serve as a fulcrum, both directly and indirectly, in contributing to vehicle rollover. This seminar covers these facets of tire safety phenomena. Engineering fundamentals are discussed and illustrated with numerous practical examples and case studies of current public interest. The Pneumatic Tire, edited by Joseph Walter and Alan Gent, is included in the course material.

Learning Objectives
After completing this seminar attendees will be able to:
• Describe the most important performance parameters and operating conditions of pneumatic tires related to safety.
• Use fundamental equations of engineering science to predict and/or explain tire-vehicle interactions related to safety.

Who Should Attend
This course is designed principally for technical professionals in the automobile, tire, and wheel industries and their suppliers. In addition, some case studies and examples involve truck, agriculture, and aircraft tires.

Topical Outline
• Introduction
  • Vehicle accident statistics
  • The role of the tire in accident prevention/causation
  • Tire construction features
  • Tire failure modes
• Tire Grip and Related Phenomena
  • Tire-road friction characteristics; Tire braking forces
  • Factors influencing vehicle stopping distance
  • Combined braking and cornering
  • Hydroplaning
  • High speed behavior and standing waves
• Brake Performance
  • Front wheel/rear wheel lock-up
  • Braking efficiency
  • Anti-lock braking and other systems
• The Tire as a Pressure Vessel
  • Burst pressure
  • Energy release in punctured tires
  • Wheel issues

Vehicle Dynamic Basics for Off-highway Trucks

1 Day
I.D.# C1239

The vehicle-terrain interaction in an off-road environment creates unique challenges for designers of both wheeled and tracked off-road vehicles. Not only should vehicle designers have a working knowledge of the fundamentals of on-road vehicle dynamics, they should also have the specialized knowledge of the vehicle dynamic characteristics found in construction, agriculture, and military off-road vehicles.

This one-day seminar concentrates on the basics of off-highway trucks and the differences with their on-highway counterparts. Emphasized in the course are the practical and theoretical aspects of off-highway trucks as it relates to various components and subsystems, including tires, steering system, and suspensions. The course will also highlight how various components and subsystems dynamically interact with each other, and how their collective interaction is manifested in the overall vehicle dynamics.

This seminar presents the specialized aspects of off-highway truck dynamics and assumes participants already have an understanding of heavy truck dynamics, either as presented through the SAE Fundamentals of Heavy Truck Dynamics (I.D.# C0837, page 5) seminar or experience gained through on-the-job training.

Learning Objectives
By attending this seminar, you will be able to:
• Describe the theory and practice of off-road truck dynamics
• Define the dynamics of various off-road truck sub-systems and components including tires, steering system, and suspension
• Identify how sub-systems and components interact with other sub-systems and components to effect the dynamics of off-road trucks
• Describe the effects of loading, weight transfer, and grade on off-road truck dynamics

Who Should Attend
This seminar will benefit design, manufacturing, and customer support engineers in the heavy off-road truck industry, most notably the original equipment manufacturers and their suppliers. Managers and marketing staff, as well as individuals in government agencies and educators in academic institutions that have a need for understanding heavy off-road vehicle dynamics will also benefit from attending this seminar.

Prerequisites
Attendees should have an understanding of the fundamentals of heavy truck dynamics. For individuals that are new to the discipline of heavy-truck dynamics, the SAE Fundamentals of Heavy Truck Dynamics (I.D.# C0837, page 4) seminar will provide the necessary introduction required to fully understand the concepts presented in this seminar.

Topical Outline
• Tire Dynamics
  • Bias-ply and Radial Tires
  • Dynamics of high-aspect ratio tires
  • Tire Dynamics in rigidly-mounted axles
  • Effect of operation on tire temperature
  • Effect of overloading the tire
• Steering System
  • Turn Center and Turning Radius
  • Ackermann steering for off-road vehicles
  • All-wheel steering dynamics; Offtracking
  • Effect of steering arrangement on tire life
• Suspensions
  • Suspension kinematics and dynamics
  • Common off-highway suspension configurations
  • Dynamic and kinematics attributes of off-highway suspensions
  • Rigidly mounted axles
  • Effect of suspension on vehicle: Ride; Handling; Stability
• Off-highway Truck Dynamics
  • Effect of off-centered loads: Laterally off-centered loads; Longitudinally off-centered loads
  • Effect of dynamic weight transfer; Effect of steep grades
  • Vehicle rollover dynamics

Instructor: Mehdi Ahmadian
Fee $745 .7 CEUs
CHASSIS AND VEHICLE DYNAMICS

Topical Outline

DAY ONE

- The Role of Vehicle Dynamics in Passenger Car and Light Truck Product Development
- Vehicle Dynamics and the Voice of the Customer
  - Use of QFD to manage vehicle dynamics performance in drive-off, braking, ride and handling
  - Thinking systemically about automotive chassis design and development through the logic of vehicle dynamics
- Effective Metrics for Vehicle Dynamics
  - Vehicle system, subsystem and piece-part metrics used to link vehicle dynamics to vehicle system design and development: bounce frequencies, lateral acceleration gain, understeer gradient, roll gradient, roll stiffness, etc.
- Elementary Tire Patch Forces and Moments at the Tire Contact Patch During Steady Braking, Steady Cornering and Steady Drive-Off Maneuvers
- Acceleration (Drive-Off) Performance
  - Basic powertrain system anatomy and architecture
  - Power limited and traction limited drive-off including powertrain system dynamics required to produce vehicle motive force at the tire patch
  - Road load considerations: aerodynamic resistance, rolling resistance, grade resistance
- Performance prediction in acceleration and fuel economy

DAY TWO

- Braking Performance
  - Basic brake system anatomy and architecture
  - Braking dynamics: braking forces, weight transfer, center of weight, brake force distribution, stability
  - Pedal force gain, brake proportioning, braking efficiency, anti-lock braking systems
  - Tire - road limitations
  - Federal requirements for braking performance
  - Brake system performance prediction
- Ride Fundamentals
  - Input excitation signals: road roughness, vehicle sources (tire/wheel system, driveline and engine)
  - Vehicle response properties: suspension isolation, tire vertical stiffness, spring rate ratio, suspension stiffness, ride rate, suspension damping, pitch and bounce frequencies
  - Quarter vehicle and pitch plane ride simulations
  - Ride performance prediction based on flat ride criteria

DAY THREE

- Cornering Fundamentals
  - Low speed turning
  - High speed cornering: tire forces, Bundorf bicycle model, understeer gradient, characteristic speed, lateral acceleration gain, yaw velocity gain, side-slip

- Suspension effects on cornering: tire cornering stiffness, camber thrust, roll steer, lateral force compliance steer, aligning torque, lateral load transfer, steering system
- Experimental methods for vehicle handling development
- Suspension Systems
  - Suspension system anatomy and suspension system performance requirements relative to drive-off, braking, ride and handling
  - Solid live axles, twist beam suspensions and independent suspensions
  - Side view pitch poles and pitch axis considerations: anti-squat and anti-dive suspension geometry, wheel travel and caster geometry
  - Role axis considerations: roll center location, roll axis geometry and location, wheel travel and toe geometry, wheel travel and camber geometry
- Steering Systems
  - Steering system anatomy, architecture and performance requirements
  - Steering geometry, wheel geometry, steering system forces and moments, steering ratio, steering compliance
  - Experimental methods for steering system performance evaluation and development
- Roll-Over Fundamentals
  - Vehicle system roll-over prevention requirements
  - Elementary and suspended vehicle simulations
  - Suspension system and steering system considerations

Instructor: Richard Lundstrom
Fee $1795 2.0 CEUs

Vehicle Dynamics for Passenger Cars and Light Trucks e-Seminar

15 Hours
I.D.# PD130702ON

A similar course is available as a live classroom seminar—Vehicle Dynamics for Passenger Cars and Light Trucks – see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this four and a half hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This course offers more than fourteen hours of instruction and simulations divided into nineteen video modules;
**CHASSIS AND VEHICLE DYNAMICS**

*The Automotive Chassis: Engineering Principles* by Reimpell, Stoll and Betzler; a coordinated handbook that includes a resource guide and SAE papers and paper collections.

View the complete course description and a video demo at training.sae.org/eseminars/vehicledynamics.

**What You Will Receive:**

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf’s, subject to DRM)
- The Bosch Automotive Handbook (hardback)
- The SAE Papers (downloadable, .pdf’s):
  - 970091
  - SP-355
  - 760713
  - 760710
- Online Pre-test (self-test, immediate results)
- Online Post-test (self-test, immediate results)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

**Instructor:** Richard Lundstrom  
**Fee $695**  
**1.5 CEUs**

*SAE VEHICLE DYNAMICS CERTIFICATE PROGRAM*

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

Designed to equip you with key vehicle dynamics and handling theory and application from a systems perspective, the objective of this program is for you to understand the interaction and performance balance between the major vehicle subsystems. The program design requires completion of fundamental and advanced-level vehicle dynamics theory and application courses with three elective courses that best suit your specific interest areas or engineering emphasis. View the list of required and elective courses and more information on enrolling in this SAE certificate program--training.sae.org/certificate/vehicle_dynamics

**BRAKES AND BRAKING SYSTEMS**

**Brake Friction Materials: Testing, Quality and Selection**

1 Day  
1.D.# C1020

The choice of brake friction materials varies per application, but each must have the appropriate coefficient of friction and be able to disperse large amounts of heat without adversely affecting braking performance. This seminar provides an introduction to brake lining raw materials and formulation, manufacturing, quality control and testing and covers the critical elements that must be reviewed before arriving at a lining selection decision. Different classes of friction material and their use will be defined.

**Learning Objectives**

By attending this seminar, you will be able to:

- Describe the principles of friction
- Define the basic elements of friction material formulations
- Identify the difference between OE and after-market friction materials
- Identify appropriate tests to distinguish the differences between friction materials
- Interpret friction material test results

**Who Should Attend**

Engineers and technicians working for friction material manufacturers, and suppliers to friction material industries, brake system designers, quality control auditors, product development engineers, application engineers, lab/bench/vehicle test technicians, managers/friction material sales and marketing will all gain valuable insight.

**Topical Outline**

- Principles of Friction Materials
- Lining Coefficient of Friction
- Formulation/Compounding Friction Material
- Manufacturing Friction Material
- General Asbestos/Non-asbestos Friction Material Characteristics
- Friction Material Testing
- Edge Code
- Bench & Vehicle Tests
**CHASSIS AND VEHICLE DYNAMICS**

- Wheel Dust Test
- Government Regulations
- OE and After-market Friction Material Lining Selection
- Issues Facing Friction Material Industries
  - Copper in brake pads
  - CA intended regulations
- Workshop

### Brake Noise Problem Resolution

1 Day  
I.D.# C0831  

Brake noise is one of the highest ranked complaints of car owners. Grunts, groans, squeaks, and squeals are common descriptions of the annoying problem which brake engineers spend many hours trying to resolve. Consumer expectations and the high cost of warranty repairs are pushing the optimization of brake NVH performance. This course will provide you with an overview of the various damping mechanisms and tools for analyzing and reducing brake noise. A significant component of this course is the inclusion of case studies which will demonstrate how brake noise squeal issues have been successfully resolved.

#### Learning Objectives

By attending this seminar, you will be able to:

- Describe the various brake shim damping mechanisms
- Compare the various brake shims available in the market place
- Describe the various tools available to reduce brake noise
- Utilize lessons learned in various brake noise problem case studies

#### Who Should Attend

The course is designed for a wide range of personnel from the brake test engineer who seeks to understand more about brake NVH to the experienced brake NVH/design engineer who wishes to know more about potential solutions. Anyone involved in the resolution of brake noise problems will find this course helpful.

#### Prerequisites

Participants should be familiar with brake hardware, basic terminology, and brake NVH measurement and testing. Previous attendance at the SAE seminars *Hydraulic Brakes for Passenger Cars and Light Trucks* (ID# C0509) and *Brake, NVH, Measurement, and Testing* (ID# C0802) or equivalent experience and knowledge are highly recommended.

### Instructor:

Mohammad Vakili  
Fee $775 .65 CEUs

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**Topical Outline**

- Brief Review of Brake Noise
  - Types of brake noises
  - Frequency range
  - Source/path/receiver
- Principles and Applications of Brake Shims
  - Damping
  - Role and purpose of brake shims
  - Different types of brake shims
  - Brake shims damping mechanisms
- Tools for Brake Noise Analysis/Reduction
  - Brake noise categorization
  - Solution strategy
  - Investigative tools -- Testing; Simulation
- Squeal
  - Brake pad design optimization
  - Pressure distribution optimization
  - Low frequency squeal
- Moan/Groan
  - After-stop noise program -- Problem identification; Transmission of the road to the lab; Measurement systems; Root cause analysis; Solution
- Questions and Answers Session

#### Instructor:

Eric Denys  
Fee $765 .7 CEUs

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**Brake Testing for Passenger Cars and Light Trucks**

2 Days  
I.D.# C1050  

This data-driven and test standard-driven seminar provides details of the different elements required to successfully manage, execute, and understand brake test results related to passenger cars and light duty trucks. The course covers: US and European self-certification or type approval testing; common; overview of ISO 15484; and main test procedures for performance, NVH, wear and durability using SAE, ISO, JASO, and JIS test protocols.

To better understand brake testing, the course provides a “brake testing toolbox” with key definitions, calculations, and descriptions of typical test sections, control methods, and brake applications used in different vehicle and laboratory testing. Attendees will gain practical experience through hands-on exercises and short workshops. Each test module includes detailed explanations and examples of test setup, inertia calculations, test conditions, main test sequence, results assessment, and best testing practices.

### Instructor:

Eric Denys  
Fee $765 .7 CEUs

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• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
Learning Objectives

By attending this seminar, you will be able to:
• Identify and utilize existing brake regulations, certification programs, and test standards for brake system development
• Identify key elements for a brake testing program regarding performance, durability, and NVH
• Specify the conditions and explain the results from different types of test sections and brake control during laboratory testing
• Calculate correctly brake test parameters and vehicle-level values
• Determine and evaluate summarized and in-stop brake test results
• Identify best testing practices to reduce test variability

Who Should Attend

The seminar is ideal for technical or engineering managers, test supervisors, test engineers, and application/product engineers involved in brake program management, test coordination and execution, product sourcing and vendor selection, quality assurance and product development.

Topical Outline

DAY ONE
• Brake Standards Development Organizations and Entities (regulations, type approvals, OE and tier-1, aftermarket)
  • US Department of Transportation and UNECE
  • OE, tier-1, and aftermarket testing
  • Industry consortia and working groups
• FMVSS vs. ECE Protocols and Testing
  • Self-certification vs. type approval
  • FMVSS 105/135 vs. ECE R13
• Laboratory Brake Testing Process and Elements
  • “Brake Testing Toolbox - Part 1”
    • Vehicle dynamics applied to brake testing
    • Inertia calculation (per SAE J2789) and dynamometer inertia simulation
    • Friction coefficient calculation and parameters (summarized and time-based)
    • Summary and in-stop test values
    • Vehicle floor-checks and parameters for vehicle and dynamometer testing
  • “Brake Testing Toolbox - Part 2”
    • Test sections: burnish; effectiveness; baseline, fade and recovery; parking brake; and driving route or circuit simulation
    • Brake applications: pressure, torque, deceleration, drags, modulated, profiles, pressure-lock, and ramp applications
• Hands-on Exercise and Test Cases Evaluation
• Performance Test Procedures and Techniques - Part I
  • Dynamometer tests (SAE J2784, SAE J2522, ISO 26867, JASO C406)
    • Inertia, test parameters, and setup for different test sections
    • Best testing practices for improved repeatability and reproducibility
    • Data review and test results evaluation

DAY TWO
• Performance Test Procedures and Techniques - Part II
• Hands-on Exercise and Test Cases Evaluation
• NVH Test Procedures and Techniques
  • Dynamometer tests (SAE J2521 with optional sections and city driving simulations)
  • Noise data review (waterfall, WAV files, noise indexes, noise peak finding functions, EKB noisy events) and test results evaluation
  • Inertia, test parameters, and setup for different test sections
  • Best testing practices for improved repeatability and reproducibility
  • Data review and test results evaluation
• Hands-on Exercise and Test Cases Evaluation
• Wear Test Procedures and Techniques
  • Dynamometer tests (SAE J2707 and city driving simulations)
  • Inertia, test parameters, and setup for different test sections
  • Best testing practices for improved repeatability and reproducibility
  • Data review and test results evaluation
• Hands-on Exercise and Test Cases Evaluation
• Overview of Other Tests, Procedures and Techniques (structural integrity, crack/strength, DTV, hot judder, corrosion removal)
  • Dynamometer tests (SAE, ECE, and common industry examples)
  • Inertia, test parameters, and setup for different test sections
  • Best testing practices for improved repeatability and reproducibility
  • Data review and test results evaluation
• Hands-on Exercise and Test Cases Evaluation
• Conclusions, and Seminar Takeaways

Instructor: Carlos Agudelo
Fee $1225 1.3 CEUs
CHASSIS AND VEHICLE DYNAMICS

Commercial Vehicle Braking Systems
3 Days
I.D.# C0233

A similar course is available online, on demand – Commercial Vehicle Braking Systems e-Seminar – see course info below.

Increased public pressure to improve commercial truck safety and new stopping distance regulations have intensified the need to better understand the factors influencing heavy vehicle braking performance. To assist individuals and their organizations in preparing for these new truck braking standards, this seminar focuses on understanding medium-duty hydraulic brake systems and heavy-duty air brake systems and how both systems’ performance can be predicted, maintained and optimized. The function and application of the major brake system components will be explained and attendees will discover how brakes, tires and roadways interact as a system. Federal braking regulations for both hydraulic and air brake vehicles will also be covered. Attendees will receive the text, Commercial Vehicle Braking Systems: Air Brakes, ABS and Beyond written by Leonard C. Buckman.

Learning Objectives
By attending this seminar, you will be able to:
• Design safe and efficient braking systems
• Test and measure braking performance
• Maintain and troubleshoot braking systems
• Comply with state and federal regulations on brakes
• Describe the brake implications of accident investigation

Who Should Attend
This seminar is designed for engineers and technicians who are involved in the design, development and testing of heavy vehicle brakes. Fleet personnel involved with safety and brake system specification and maintenance, driver-trainers, and truck accident investigators will also find this course of value.

Topical Outline
DAY ONE
• Medium Truck Hydraulic Brake Actuation Systems
• Heavy Truck, Bus & Trailer Air Actuation Systems
• Brake Actuation Components - Function, Advantages/Disadvantages, Applications
• Foundation Brakes - Cam, Wedge, Air Disc, Hydraulic Disc

DAY TWO
• Braking Performance Fundamentals
• Maintenance and its Impact on Performance
• Brake Force Distribution
• Heavy Vehicle Dynamics and Tire Characteristics
• Thermal Considerations
• Tractor - Trailer Brake Compatibility
• Truck & Tractor Air Antilock Braking Systems

DAY THREE
• Trailer Air Antilock Braking Systems
• Hydraulic Antilock Braking Systems
• Electronic Data Communication
• Automatic Traction Control Systems (ATC)
• Electronically Controlled Braking Systems (ECBS or “Brake-by-Wire”)
• Electronic Stability Control and Roll Stability Control - Extended Applications of Electronics in Braking
• Brake Testing Procedures
• NHTSA and FMCSA Commercial Vehicle Brake Regulations

Instructor: Paul Johnston
Fee $1665 2.0 CEUs

Commercial Vehicle Braking Systems e-Seminar
18 Hours
I.D.# PD130611ON

A similar course is available as a classroom seminar – Commercial Vehicle Braking Systems – see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the above seminar), this 22 hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course offers an overview and 17 modules on video, course exercises, and a coordinated handbook.

View the complete course description and a video demo at training.sae.org/eseminars/cvbs.

What You Will Receive:
• 365 Day access through MyLearn.sae.org
• Links to streaming video modules
• Course Handbook (downloadable .pdf’s, subject to DRM)
• Online Pre-test & Post-test (self-test, immediate results)
• CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Leonard C. Buckman
Fee $695 1.8 CEUs

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High-Performance Brake Systems

2 Days
I.D.# C0718

While most passenger car brake systems are quite robust and reliable under typical operating conditions, high-performance driving and/or racetrack operation generally require alternative design solutions to optimize consistency and longevity. Whether it is brake fluid fade, cracked rotor discs, chronic knockback, or insufficient brake pad life, the stresses of motorsports can pose unique challenges to even the very best brake system designs. Consequently, ceramic rotors, six-piston calipers, adjustable balance bars, and titanium backing plates have all made their way onto the high-performance brake system scene, but what is the right answer for your application?

This seminar has been designed to assist you in answering that very question. The day begins with a concise yet thorough analysis of brake system design factors relevant to all types and categories of high-performance vehicles. The principles of energy conversion, gain, balance, and deceleration are discussed and supported with straightforward mathematical models, allowing attendees to realize the compromises that must be considered when designing from a system perspective.

From selecting an appropriate brake pedal ratio through the calculation of caliper effective piston area, the second portion of the seminar dives into the details of brake system component design. Based upon the principles learned earlier in the day, attendees will quickly realize that just as with proper system design, brake system component design is an exercise in managing engineering trade-offs. As a result, the material presented will not disclose what components to choose as much as how to choose them.

Day two of the seminar concludes with a design exercise that will allow attendees to put into practice several of the key concepts learned throughout the seminar. Detailed course notes and illustrations are provided along with a copy of High-Performance Brake Systems: Design, Selection, and Installation for on-the-job reference.

Learning Objectives
By attending this seminar, you will be able to:
• Estimate brake system energy capacity
• Approximate brake system gain requirements
• Calculate vehicle deceleration
• Establish brake proportioning for ideal balance
• Determine pedal ratios, booster output, and hydraulic system gain
• Discuss the differences between brake fluid chemistries

Who Should Attend
This course has been developed for individuals involved in the specification, design, installation, maintenance, and performance of brake systems and their associated components in high-performance and/or racing applications; however, the fundamental principles and design considerations presented apply to all facets of brake system engineering. In addition to individuals involved directly in brake system design, this course can be valuable to those responsible for chassis design, suspension tuning, tire optimization, and overall vehicle dynamics in high-performance applications.

Topical Outline
DAY ONE
Module 1: Energy Conversion
• The Conservation of Energy
• Types of Energy
• Energy Transformation
• Calculating Brake System Temperatures

Module 2: Tires
• Brake Forces & Tire Slip
• The Mu-Slip Curve
• Calculating Maximum Deceleration

Module 3: Gain
• Gain & Force Distribution
• Brake Component Gain
• Brake System Gain
• Calculating Stopping Distance
• Compliance

Module 4: Brake Balance
• Brake Force and Corner Weight
• Static and Dynamic Weight Distribution
• Ideal Brake Balance
• Why Ideal Brake Balance Matters

Module 5: Apply System
• Brake Pedal Design & Function
• Brake Booster Design & Function
• Master Cylinder Design & Function
• Balance Bar Design & Function
• Proportioning Valve Design & Function

Module 6: Brake Fluid & Hoses
• Boiling Points and Water Adsorption
• DOT Ratings
CHASSIS AND VEHICLE DYNAMICS

• Hydraulic Circuit Design
• Brake Hose Design & Function

DAY TWO
Module 7: Calipers
• Caliper Design & Function
• Taper Wear and Piston Count
• Caliper Mounting
• Caliper Body Design
• Knockback

Module 8: Brake Pads
• Brake Pad Design & Function
• Brake Pad Fade
• Friction Material Categories & Chemistries
• Friction Mechanisms

Module 9: Rotors
• Rotor Design & Function
• Rotor Cooling
• Solid & Vented Rotors
• One-Piece & Two-Piece Rotors
• Cross-Drilled Rotors & Slotted Rotors

Module 10: Design Exercise
• Brake Force Analysis
• Deceleration Analysis
• Weight Transfer Analysis
• Brake Balance Analysis

Instructor: James Walker, Jr.
Fee $1225 1.3 CEUs

Hydraulic Brake Systems for Passenger Cars and Light Trucks

3 Days
I.D.# C0509

Hydraulic brake systems, one of the most important safety features on many road vehicles today, must meet manufacturer and customer requirements in addition to Federal Motor Vehicle Safety Standards. This course will analyze automotive braking from a system’s perspective, emphasizing legal requirements as well as performance expectations such as pedal feel, stopping distance, fade and thermal management. Calculations necessary to predict brake balance and key system sizing variables that contribute to performance will be discussed. Major components of a brake system, including calipers, boosters, master cylinders, drum brakes, and park brakes will be presented in detail highlighting the many design variations. An overview of the chassis control components and operating principles will be presented with an emphasis on ABS, traction control and stability control.

Learning Objectives
By attending this seminar, you will be able to:
• Design a brake system in compliance with Federal Motor Vehicle Safety Standards
• Calculate the ideal brake balance for a vehicle under any loading condition
• Calculate the actual brake balance and brake output for a selected set of brake components and evaluate the effects of changing component parameters
• Determine the effects of variation in component parameters on the system performance
• Describe the basic function of major brake components
• Describe various chassis control systems and their role in vehicle safety
• Determine the appropriate design variation for a particular application

Who Should Attend
This course is designed for engineers interested in, or responsible for, the specification, prediction and validation of braking system performance. It will also benefit engineers responsible for brake component design by providing insight into the interaction of components and the contribution to system level performance metrics.

Topical Outline

DAY ONE
• System Level Requirements
  • Emphasis on FMVSS 135 and ECE 13 -- Effects of requirements on design; Tradeoffs with other system requirements; Partial system considerations; Loading conditions
  • Stopping Distance -- Actual vs. magazine; Contributions of subsytems; Effects of driver
  • Thermal management -- Conservation of energy; Abuse schedules; Mountain descents; Design for max speed vs. high use
  • NVH & pedal feel -- Metrics and criteria; Objective techniques

• Brake Balance and System Output Calculations
  • Ideal brake force derivation
  • Actual brake output
  • Effects of variation, planned and unplanned

DAY TWO
• Workshop - The student will design a brake system for a vehicle of their choice and predict the performance to key system level targets
• Component Functional Review
  • Brake pedal assembly -- Variable ratio; Adjustable; Composite
  • Brake booster options -- Vacuum; Hydroboost; Active
  • Master cylinder
CHASSIS AND VEHICLE DYNAMICS

- Fluid, pipes, and hoses
- Proportioning and metering valves
- Disc brakes -- Fixed; Floating; Multi-piston; Vented; 2-piece

DAY THREE
- Component Functional Review (continued)
  - Drum brakes -- Leading-trailing; Duo-servo; Self-adjusting; Static Brake
  - Parking Brakes -- Foot vs. hand; Cables and tensioning; Drum-in-hat; Caliper mechanisms
- Workshop - The student will determine the effects of component variation on their design from Day 2
- Anti-lock Braking Systems
  - Mechanization
  - Performance
  - Dynamic rear proportioning/electronic brake force distribution
- Advanced Concepts and Technology
  - Panic brake assist
  - Hybrid/regenerative braking
  - Brake-by-wire
  - Electric parking brake

Instructor: Thomas J. Hall
Fee $1605 2.0 CEUs

Introduction to Brake Control Systems: ABS, TCS, and ESC

2 Days
I.D.# C0315

A similar course is available online, on demand – Introduction to Brake Control Systems e-Seminar – see course info below.

Once reserved for high-end luxury vehicles, electronic brake control systems are quickly becoming standard equipment on even the most inexpensive cars and trucks. Today, nearly every new vehicle benefits from the optimized braking, enhanced acceleration, or improved stability that these systems provide. This comprehensive seminar introduces participants to the system-level design considerations, vehicle interface requirements, and inevitable performance compromises that must be addressed when implementing these technologies.

The seminar begins by defining the tire-road interface and analyzing fundamental vehicle dynamics. Following an in-depth study of system electronics, hydraulic hardware, and sensor requirements, the participants learn about the control strategies employed by anti-lock brakes (ABS), dynamic rear proportioning (DRP), traction control (TCS), and electronic stability control (ESC) with strong emphasis placed on vehicle dynamic response. The seminar concludes with a study of unique applications, a look forward to advanced brake control system integration, and an overview of Federal Motor Vehicle Safety Standard 126. Over 500 pages of detailed course notes and illustrations are provided for on-the-job reference.

Learning Objectives

By attending this seminar, you will be able to:
- Analyze brake system design parameters and their vehicle performance effects
- Evaluate the compromises between stability, steerability, and stopping distance
- Discern the discrete mechanical components required for ABS
- Specify fundamental ABS performance attributes
- Estimate dynamic brake balance and explain the benefits of DRP
- Reconcile TCS performance expectations vs. method of implementation
- Interpret ESC metrics and ultimate dynamic limitations
- Discuss opportunities for advanced brake control system integration
- Comprehend federal requirements for the performance of ESC

Who Should Attend

This course has been developed for engineers involved in all fields related to the design or development of vehicle dynamics, vehicle braking systems, powertrain systems, chassis systems, or suspension systems. In addition, this course can be valuable to those with component design responsibilities in brake, chassis, suspension, or tire disciplines.

Individuals new to the field of brake control systems will benefit most from the material; this introductory course is not intended for individuals with significant experience with brake control systems. In addition, please note that because of proprietary considerations this class does not provide details of algorithm design, algorithm performance, or algorithm application. Instead, the course places strong emphasis on vehicle dynamic responses.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. A basic knowledge of college algebra, college physics, and a familiarity with vehicle brake and suspension systems is required.

Topical Outline

DAY ONE
- Tire-Road Interface Characteristics
  - Defining slip
  - Longitudinal mu-slip relationship
  - Longitudinal vs. lateral slip capacity
  - The friction circle
- Hydraulic Brake System Overview
CHASSIS AND VEHICLE DYNAMICS

- What do braking systems do?
- How does each component contribute?
- What are the underlying fundamental relationships?
- How does this apply to brake control systems?
- Stability, Steerability, Stopping Distance
  - Define stability, steerability, stopping distance
  - Illustrate with mu-slip curves
  - Illustrate with friction circle
- Mechanization of ABS
  - ECU functions and components
  - HCU functions and components
  - ABS hold, release, and apply functions
  - Diagnostics and warning lamp considerations
- ABS Sensor Overview
  - The role of sensors
  - Wheel speed sensors
  - Brake apply state sensors
  - Longitudinal accelerometers
- ABS Performance
  - ABS objectives and strategies
  - Basics of ABS wheel control
  - ABS performance on homogeneous surfaces
  - ABS performance under other conditions

DAY TWO
- DRP Performance
  - Weight transfer and brake proportioning
  - Proportioning valve design and performance
  - DRP strategies, wheel control, and performance
  - DRP benefits, design compromises, and limitations
- Mechanization of TCS and ESC
  - Additional ECU functions and components
  - Additional HCU functions and components
  - Pressure build sequence
- TCS and ESC Sensor Requirements
  - The role of sensors
  - Steering angle sensors
  - Brake pressure sensors
  - Lateral accelerometers and yaw rate sensors
- TCS Performance
  - TCS objectives and strategies
  - Basics of TCS wheel control
  - TCS performance under various conditions
  - Driveline architecture interactions
- ESC Performance
  - The physics of turning
  - ESC objectives and strategies
  - Basics of ESC wheel control
  - ESC performance
  - Driveline architecture
- Special Conditions and Considerations
  - 4x4 and off-road considerations
  - Racing and high-performance considerations
- Impact of vehicle modifications
- Advanced Integration (handout only - no presentation)
  - Adaptive cruise control (ACC)
  - Panic brake assist (PBA)
  - Brake-by-wire (BBW)
- Federal Motor Vehicle Safety Standard 126
  - ESC definitional requirements
  - ESC dynamic performance test
  - Stability and responsiveness requirements
  - Industry rollout requirements
  - Federal Register preamble requirements
- Learning Assessment

Instructor: James Walker, Jr.
Fee $1305 1.3 CEUs

Introduction to Brake Control Systems e-Seminar

9.5 Hours
I.D.# PD13050ION

A similar course is available as a classroom seminar—Introduction to Brake Control Systems—see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this nine and a half hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into 13 video modules, accompanied by a handbook.

View the complete course description and a video demo at training.sae.org/eseminars/brakecontrolsystems.

What You Will Receive:
- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf’s, subject to DRM)
- Online Pre-test & Post-test (self-test, immediate results)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: James Walker, Jr.
Fee $535 1.0 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.
Introduction to Brake Noise, Vibration, and Harshness

1 Day
I.D.# C1337

Brake Noise, Vibration, and Harshness (NVH) is recognized as one of the major problems currently faced by the automotive manufacturers and their suppliers, with customers warranty claims of more than $100 million per year for each manufacturer. With increasing consumer braking performance expectations, automotive OEM's and suppliers need the ability to predict potential problems and identify solutions during the design phase before millions of dollars have been spent in design, prototyping, and manufacturing tooling. This seminar provides an introduction to brake NVH, including a concise summary of the various brake NVH problems, current lab and vehicle measurement techniques and SAE global standards which are utilized to characterize the noise correctly in order to get the best option/solutions quickly. The information provided will serve as an excellent foundation for understanding and characterizing brake NVH issues and is an excellent primer to the SAE seminar Brake Noise Problem Resolution (ID# C0831, page 12), also taught by instructor Eric Denys.

Learning Objectives

By attending this seminar, you will be able to:
• Describe NVH and brake NVH
• Identify the various brake NVH problems
• Describe the components of a brake NVH dynamometer
• Configure and perform dyno and vehicle brake NVH tests measurements
• Utilize SAE J2521, the only international standard for brake NVH dynamometer evaluation
• Interpret basic noise and vibration data in the time and frequency domain
• Explain the premise behind various SAE Standards related to brake NVH

Who Should Attend

The information in this course is relevant to a wide audience, from the brake test technician who seeks to understand more about NVH and brake NVH, to the experienced brake NVH engineer who wishes to know more about the details of the tests performed and the meaning of the results. Brake development and brake component engineers who are not familiar with brake NVH will also find the course beneficial.

Topical Outline

• Basics of Noise and Vibration
  • Basic terminology
  • Spectral analysis
  • Modal analysis
  • Sound radiation
  • Basics of Brake NVH
  • Different types of brake noise
  • Why do brakes make noise?
  • Source, path, and receiver description
• Basic Dynamometer Testing
  • Test set-up
  • SAE J2521 - Disc and Drum Brake Dynamometer Squeal Noise Matrix
  • Data analysis and reporting
• Vehicle Brake Testing
  • Basic instrumentation
  • Data analysis and reporting
  • SAE J2625 - Automotive Vehicle Brake Squeal Test Recommended Practice
• Brake SAE NVH Standards Currently Released and Under Development
  • SAE J2598 - Automotive Disc Brake Pad Natural Frequency and Damping Test
  • SAE J2786 - Automotive Brake Noise and Vibration Nomenclature
  • SAE J2933 - Verification of Brake Rotor Modal Frequencies
  • SAE J3001 - Brake Insulator Damping Measurement Procedure
• Introduction to Brake NVH Problem Resolution

Instructor: Eric Denys
Fee $745 .7 CEUs

Vehicle Braking Performance: Braking Confidence and Pedal Feel Fast Track

51 Minutes
I.D.# PD230912ON

Braking confidence and pedal feel are important braking performance attributes that should be optimized to achieve customer satisfaction with a vehicle's braking system. The relationship between the input force and travel provided by the driver to achieve the desired vehicle deceleration is as core to the vehicle personality or DNA as ride, handling, or driveability. This Fast Track will cover the main concepts and methods needed for tuning brake systems to desired pedal force and travel characteristics.

Major topics include:
• Introduction to Braking Confidence
• Input Force to Vehicle Deceleration Relationship
• Input Travel to Vehicle Deceleration Relationship
• Parametric Analysis
CHASSIS AND VEHICLE DYNAMICS

- Environmental Effects
- Emerging Trends Affecting Braking Confidence

Is this Fast Track for you?
The Vehicle Braking Performance: Braking Confidence and Pedal Feel Fast Track would be of value to anyone involved in the validation of a braking system, either in the development of the validation plan or the execution of the validation plan. This course would also be of value to those involved in vehicle marketing -- a detailed understanding of the metric’s generation and contributing effects will insure that promotion and comparison is done in a qualified manner.

What You Will Receive
- Three months of online access to the 51 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Thomas J. Hall
Fee $152

Vehicle Braking Performance: Stopping Distance Fast Track
1 Hour
I.D.# PD230826ON

Stopping Distance is one of the most common metrics of a vehicle’s braking performance and one of the most critical attributes of accident prevention and minimization. The measurements are used within the development of the vehicle and are a critical aspect of accident prevention, accident reconstruction, and overall occupant and pedestrian safety management. This one-hour online short course reviews the methods used to measure and report stopping distance and analyzes the associated formulations to determine the braking forces created by a wheel brake and necessary to achieve a desired distance. Vehicle and driver contributions to the overall stopping event are examined

Major topics include:
- Calculation of Stopping Distance
- Common Procedures Used to Assess Stopping Distance
- Performance Metrics Compared to Target Avoidance
- Determination and Generation of Forces Necessary to Stop a Vehicle
- Contributions and Limitations

Is this Fast Track for you?
The Vehicle Braking Performance: Stopping Distance Fast Track would be of value to anyone involved in the validation of a braking system, either in the development of the validation plan or

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Become more proficient in the practice of vehicle crash/accident reconstruction by successfully completing this certificate program from SAE. Required courses guide you through crash reconstruction methods, vehicle dynamics, and event data recorder (EDR) technology. Then select three electives that suit your individual technical interest area. Completing the SAE Accident Reconstruction Certificate Program grants you eight credits towards the SAE/Kettering University 20-credit Certificate in Autonomous Systems or Kettering’s 40-credit M.S. in Mechanical Engineering. Visit training.sae.org/collegecredit for more information. View the list of required and elective courses and more information on enrolling in this SAE certificate program--training.sae.org/certificate/accident_recon

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ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

Includes electronics, vehicle electrification, modeling and simulation, data sensors, automotive lighting, and control systems.

ELECTRONICS & ELECTRICAL CONTROL SYSTEMS

A Holistic Introduction to Commercial Telematics
2 Days
I.D.# C0947

The technical difficulty, time, and costs associated with deploying a successful telematics system are often underestimated. This seminar provides participants a comprehensive overview of the various technologies that make up a telematics system as a whole and provides the information necessary to help drive intelligent decisions that have long-term benefits.

This two-day seminar will begin with a review of the origins, technologies, and systems used in creating and operating modern-day telematics systems. The main technologies will be broken down into five categories, all of which are required to operate in unison in order for the system to be successful. This will include automotive technologies necessary to gain access to vehicle operating data, wireless technologies to establish communications, navigation technologies to introduce location, antennas that enable wireless, and data management to manage and make data useful. A series of practical examples will allow attendees the opportunity to work through each of the functional technologies and implement a simple telematics solution. The seminar will conclude with a discussion of the issues that drive a cost vs. buy decision on the specific elements in the telematics value chain, as well as various applications currently being deployed and the exploration of future applications within the telematics market. Attendees are encouraged to bring a laptop computer with a dual-boot Linux operating system installed.

Learning Objectives
By attending this seminar, you will be able to:
• Distinguish the various technologies used in telematics systems
• Assess the difficulty, time, and costs required to deploy a functional telematics solution
• Evaluate alternatives and make decisions on where to spend development dollars, and when to rely on outside resources
• Construct and demonstrate a simple telematics system
• Recognize the role current and future telematics technologies will play in our collective future

Who Should Attend
Engineers at all levels wanting to gain a better understanding of the fusion of technologies involved in telematics systems will benefit from this seminar. Also benefiting are OEMs looking for a competitive advantage and field data that will improve their product development system. Fleet operators looking to increase business productivity, better manage their assets, meet regulatory requirements more efficiently, and improve asset utilization will also benefit from the technical information presented.

Topical Outline
DAY ONE
• Telematics Overview
  • Definition
  • Historical Origins -- One size does not fit all
• Telematics Technologies
  • Overall System Architecture
ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

- Automotive -- Vehicle Bus architecture; Protocols; Power requirements; Regulatory requirements; Proprietary barriers
- Wireless -- Providers/ISP's; Terrestrial; GSM; CDMA; FM-RDS; WAN/PAN; 802.11; Zigbee; WiMax; Bluetooth; SATCOM; LEO; GEO
- Navigation -- GPS; Galileo; Everything Else
- Antennas -- The black magic
- Data Management -- Hosting/Servers; Databases; Scalability; NOC; Availability; Backup; Security; ASP
- Getting Started -- Basic System Architecture; Environment Setup; Powering up and getting familiar with the system

DAY TWO

- Practical Example #1
  - Vehicle Bus -- Standard messages; Capturing all data; Filtered messages; Capturing specific messages
- Practical Example #2
  - Navigation -- Capturing GPS stream; Combining GPS data with bus data
- Practical Example #3
  - Establishing network communications -- Basic communication setup; Terminal monitoring of network communication; Sending GPS/Bus data to server
- Practical Example #4
  - Send a formatted message to back-end application -- Display results on map
- Receive and decode formatted message from server -- Send specific vehicle bus data (request)
- Cost-Value / Cost-Performance
- Make vs. Buy: Hardware; Software; Back office
- Future Implications and Applications
  - Insurance -- Black Boxes; Usage based insurance
  - Safety & Security -- People; Products; RFID
  - Compliance/Regulation -- Intelligent highways; Sarbanes-Oxley
- Closing and Evaluation

Instructor: Emad Isaac
Fee $1225 1.3 CEUs

Acquiring and Analyzing Data from Sensors and In-Vehicle Networks

2 Days
I.D.# CO522

The acquisition of test data is required throughout the product’s life cycle - in prototype performance evaluation, reliability/durability testing, duty-cycle analysis, end of line testing, and service and aftermarket product areas. Both lab and on-road testing is needed for components, sub-systems and entire vehicles. As in-vehicle networks become increasingly more sophisticated in terms of the number of controllers, the speed at which they communicate, and the number of parameters available, they are a virtual goldmine for the test engineer. If the data is already available on the vehicle network, the engineer may only need to add any missing sensors (or possibly none at all).

After reviewing the traditional approach of acquiring data directly from sensors, the course will focus on the newer approach of obtaining data from the in-vehicle network for both automotive and heavy duty vehicles. Attention is given to the complications of taking data from the in-vehicle network and how to overcome them, current trends and applications, wireless data acquisition (Wi-Fi and cellular), GPS, relevant technical standards, and how to simultaneously acquire network data with direct sensor measurements. Both PC-based and logger (flight recorder) data acquisition will also be covered. In addition, a practical guide for analysis and presentation techniques will be covered along with examples.

Learning Objectives

By attending this seminar, you will be able to:
- Explain what it takes to acquire data from both in-vehicle networks and sensors
- Compare and contrast acquiring data from both in-vehicle networks and directly from sensors
- Understand OBD-II, the CAN protocol and other common vehicle protocols
- Identify an unknown OBD-II network protocol
- Define the four database types that relate in-vehicle network messages to scaled engineering parameters
- Review vehicle messages and convert the messages to scaled engineering parameters using various automotive and heavy duty protocols and message types
- Demonstrate how sample rate has a major effect on your data beyond the obvious and show how to select the optimum sample rate
- List the four domains that are available to present your data to enhance understanding of the data
- Avoid common pitfalls of acquiring and analyzing good data
- Choose the best analysis techniques to better understand and present test data
- Compare benefits of acquiring data with a PC vs. a stand-alone data logger (without a PC in the vehicle)

Who Should Attend

Any engineer, scientist or technician who wants to learn the fundamentals to acquire and analyze test data will benefit from this course. Typical attendees include: R&D engineers, test engineers and technicians, fleet owners, government agencies, and aftermarket product developers. The assumption is that the in-vehicle network is working properly and the emphasis is on...
how to maximize the information that can be obtained from the vehicle’s network.

**Topical Outline**

**DAY ONE**

- Acquiring Data Directly from Sensors
  - Sensor Inputs: Sensor overview, single-ended vs. differential inputs, proper ranging of the channels, zeroing offsets and signal conditioning.
  - Data Acquisition: Analog-to-digital converters (A/D), time and amplitude resolution, pre- and post-triggering, time synchronous averaging, sample rate, aliasing, frame length and number of frames in a data file.
- Frequency Domain
  - Analyzing data in the frequency domain with the Fast Fourier Transform (FFT) is a valuable tool to optimize sample rate, which affects many factors such as data quality (aliasing), time and frequency resolution, digital filtering, integration and differentiation. Analyzing and displaying the data in the revolution (angular) domain and order domain offer valuable insights into the data.
- In-Vehicle Data Acquisition
  - Comparison of in-vehicle data acquisition with sensor data acquisition.
  - Explanation of OBD-II and what it can and cannot do for you
  - Examination of files containing hex messages. Learn the steps required to convert to useful engineering parameters (e.g. engine RPM, wheel speed, ambient temperature). Message files will be shown from both heavy duty and automotive vehicles

**DAY TWO**

- In-Vehicle Data Acquisition - continued
  - Step-by-step procedure to acquire parametric data for both a PC and stand-alone loggers.
  - Explanation of why the database relating parameters and messages is the key and how to get this database information.
  - How to calculate fuel economy and fuel consumption from the in-vehicle network for automotive and heavy duty vehicles
  - Review of applicable standards and references.
  - How to identify unknown automotive protocols and learn about the various network protocols
  - Review of wireless data acquisition options, the advantages and disadvantages of them and the practical throughput rate for real-time data acquisition.
- Data Analysis Techniques
  - How to select the best numerical techniques and how to optimize their performance for digital filtering (including IIR and FIR filters), integration, differentiation, and correlation.
  - How combining logic, statistics and Z transform provides a powerful technique to find key points along a waveform. Make decisions such as pass/fail or perform intelligent monitoring to store only the data of interest optimizing storage space and analysis time.
  - How to time correlate data taken from different sources, such as from the in-vehicle network and directly from sensors.

<table>
<thead>
<tr>
<th>Instructor:</th>
<th>Richard Walter</th>
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<tr>
<td>Fee $1365</td>
<td>1.3 CEUs</td>
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**Automotive Lighting: Design and Technology**

2 Days  
I.D.# C0202  
Since the invention of the automobile, lighting has been an important subsystem on all ground vehicles. Automotive lighting is vital to passenger safety, comfort and vehicle styling. The technology used in automotive lighting has rapidly expanded to make the lighting more value added, safer and pleasing to customers. This seminar provides broad information about automotive lighting systems with emphasis on lighting functions, effectiveness, and technologies. The intent is to assist attendees to gain sufficient knowledge about automotive lighting and its importance in overall vehicle design and development. Since only the exterior lighting devices on the ground vehicles are regulated by the federal and local governments, and standardized by the SAE Lighting Committee and the international communities, this course will only address automotive exterior lighting.

**Learning Objectives**

By attending this seminar, you will be able to:

- Describe various automotive lighting technologies
- Articulate the legal aspects and implications related to automotive lighting
- Examine safety measurements used with lighting functions and human factors costs
- Discuss the latest advancements in lighting technologies and trends in lighting styling

**Who Should Attend**

This seminar is of benefit to a wide audience, including: Automotive body engineers responsible for lighting and vehicle interface and integration; vehicle stylists who are interested in lighting effects on vehicle cosmetics; regulatory personnel involved with the legal specifications of automotive lighting; marketing specialists who are interested in customers’ preferences based on the relationship of human vision and lighting; and newcomers in the automotive industry who need to obtain a general overview of lighting.
ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

Topical Outline

DAY ONE
- Introduction
- Fundamentals of Automotive Lighting
  - Light -- What is light; Definition of light; Types of light; Visible light; Generation of light
  - Light Measurements -- Basic concept; photometry and radiometry; Color of light; Terms of photometry; Photometry units comparison; Photometry and radiometry unit conversion; Photometry and radiometry calculations
- Lighting; Illumination Devices -- Functions of an illumination device; Types of illumination devices; Basic structure of illumination devices
- Classification of Automotive Lighting -- Forward lighting and signal lighting; Headlamps; Fog lamps (front and rear); Daytime running lamps; Stop & tail lamps; Turn signal lamps (front and rear); Other lamps
- Requirements for Automotive Lighting -- Regulations and industry standards; Performance; Testing
- Light Sources Used in Automotive Lighting
  - Basics of Light Source -- Incandescent; Discharge; Fluorescent; Solid-state; Electroluminescent; Light source comparison
  - Light Source Characteristics -- Light emitter geometry; Light output from a light source; Life; Light source operation and testing; Bulb accuracy levels
  - Types of Light Sources Used for Automotive Exterior Lighting -- Incandescent bulbs; Tungsten halogen bulbs; HID subsystem (burner, starter & ballast); Neon light source (emitter & ballast); LED source (LED package, circuit board & control device)
  - Major North America Automotive Light Source Suppliers -- Osram (OSI & OOS); Philips (including Lumileds); Others
- Automotive Lamp Photometry Design
  - Optical Design Principles -- Optics; Geometrical optics; Imaging optics; Non-imaging optics; Reflection; Refraction; Transmission; Dispersion
  - Light Control; Collections and Manipulations -- Light collectors; reflectors and lenses; Light manipulators (reflector optics, lens optics, diffusers, light guides and fiber optics, reflex); Etcendue

DAY TWO
- Optical Design for Automotive Lamps -- Automotive lamp configurations; Optical design step 1; feasibility study; Optical design step 2; setup strategy; Optical design step 3; design optics; Optical design step 4; simulations; Other considerations; Light source selection; CAE for optical design and simulation
- Automotive Lamp System Configuration
- Automotive Lamp System Design Overview -- System level specifications; Vehicle interface
- Automotive Lamp Thermal Analysis -- Purpose; Heat transfer; Empirical database; CFD lamp thermal model
- New Automotive Lighting Technologies
  - Advanced Optical Structures for Automotive Lamps -- Combination of projector & free-form reflectors (P&F) headlamps
  - Improved projector modules
  - Dual-Function HID (Bi-Xenon) Lamps -- System; Reflector type dual-function HID lamp; Projector type dual-function HID lamp
  - Distributive Lighting System (DLS); a Remote Lighting System Using Fiber Optics -- System; DLS headlamp application; Other DLS applications
  - Adaptive Forward-lighting System (AFS); an Intelligent Lighting System -- System; Desired beam pattern variations; Driving and environment condition measurements; AFS design option I; add beam contributor(s); AFS design option II; rotate headlamps; AFS design option III; vary component(s) in the headlamp
  - Night Vision System -- System definition; Infrared and IR cameras; Types of night vision systems; Examples of night vision systems

Instructor: Jianzhong Jiao
Fee $1225 1.3 CEUs

Automotive Lighting: LED Applications

1 Day
I.D.# C0727

Light Emitting Diode (LED), a new generation semiconductor light source often referred to as Solid-State Lighting (SSL), has been broadly adopted in illumination, display, visualization, and other areas due to its higher efficacy and longer life. LEDs, first introduced for automotive interior applications such as indicators, expanded to exterior applications including center high mounted stop lamps and other automotive signal lighting devices. Today, LED technologies are being used for night vision, occupancy detection, and many other automotive application areas. This seminar is designed to provide the attendee with an overview of LEDs and their applications in automotive lighting and illumination.

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Learning Objectives
By attending this seminar, you will be able to:
• Describe the basic LED configurations, characteristics, and classifications
• Assess LED and SSL technologies used in automotive applications
• Identify technical challenges and limitations of LEDs
• Select appropriate equipment for measurement of various conditions
• Evaluate LEDs for conformance to SAE standards
• Establish a basic design strategy for specific applications including forward lighting devices
• Manage a design activity to deal with thermal management

Who Should Attend
This seminar can be of benefit to a wide audience including LED automotive body and system engineers responsible for lighting and vehicle interface and integration; vehicle stylists who are interested in lighting effects on vehicle cosmetics and lighting developers and manufacturers; marketing specialists who are interested in customers’ preferences based on the relationship of human vision and lighting; and newcomers in the automotive industry who need to obtain a general overview of lighting.

Topical Outline
• Introduction
• LED - Definitions and Classifications
  • Types of LEDs
  • Basic LED characteristics
  • LED efficiency
  • Life and lumen maintenance
• LED Measurements and Standardization
  • Photometric measurements -- Light output measurements; Color of the light source; Measurements of LED life and lumen maintenance
  • Thermal measurements -- Thermal resistance and de-rating
  • Measurement equipment -- Photometric measurement and thermal management equipment
  • LED binning -- Luminous flux, voltage, and color bin
  • LED automotive lighting standards -- Signal lighting and forward lighting standards; Human factors evaluations for white LEDs
  • LED component standards -- Definitions; Industry trends
• LED Automotive Exterior Lighting Applications
  • LED lamp design basics
  • Photometric design requirements -- Basic design procedure; Design flow and optimization process
  • LED lighting system thermal and electronic design -- Why thermal management?; Effects of LED junction temperature; Cooling systems; LED bin selection; Electronic design - dual level lamps
• LED signal lighting design concepts and examples -- Direct lighting: with or without secondary optics; Indirect lighting: TIR - prism, light guide and light pipe
• LED headlamp design concepts and examples -- Comparison of light sources used for headlamps; Design restrictions and strategies
• LED Automotive Interior Applications -- Interior lighting basics (Types of interior lighting, Performance evaluations); LED applications (Backlight for display, Interior illumination, Occupancy detection)

Instructor: Jianzhong Jiao
Fee $725 .7 CEUs

Automotive Lighting: Testing and Requirements
1 Day
I.D.# C0618
It has not been commonly known that automotive exterior lights are safety devices and must comply with governmental regulations. Since the 1930s, the SAE Lighting Standards Committee has been actively working with the automotive industry OEMs, lamp makers, tier-two suppliers, and human factor experts to develop automotive lighting standards. These standards have been widely used or referenced by the U.S. federal or state governments in establishing and enforcing the lighting regulations. This seminar emphasizes the safety importance of automotive lighting devices and provides important information on lighting functions, standards or regulations, testing and evaluations.

Learning Objectives
By attending this seminar, you will be able to:
• Describe the legal aspects and implications related to automotive lighting
• Search for and use the lighting related standards for all exterior lighting devices
• Establish or assist with lighting tests and evaluations

Who Should Attend
Automotive engineers and product development personnel who are responsible for lighting design, manufacturing, quality assurance, installation, vehicle interface and integration will benefit from attending this seminar. Regulatory personnel who are involved with the legal specifications of automotive lighting and law enforcement agencies or individuals responsible for lighting regulations will find the information valuable and relevant as will testing engineers or technicians who are responsible for evaluating and verifying the compliance of lighting standards and regulations.
Prerequisites
Participants should have a technical background and some knowledge related to automotive lighting devices; an undergraduate engineering or related degree is preferred.

Topical Outline
- Introduction - SAE Lighting Standards Committee
  - Current organization
  - History
  - Duties, responsibilities and membership
- Definitions and Terminologies Used in Automotive Lighting
  - Illumination devices -- Functions; Types; Basic structure
  - Classification of automotive lighting - definitions and operations -- Forward lighting; Signal lighting; Auxiliary lamps
  - Automotive lighting terminology -- Terminology; Identification code; Inspection code
- Testing and Evaluations
  - General categories -- What needs to be tested; Photometry tests; Environmental tests; Electrical tests; On-vehicle tests; Special tests for selective devices using HID, LED, neon and other light sources
  - Testing equipment -- Photometry test equipment; Environmental tests equipment; Electrical tests equipment
  - Test methods: lighting sources, subsystems, and devices -- Light source test; Special test for subsystems; Device test
  - Material tests -- Weatherability; High deformation temperature (HDT); Optical characteristic; Chemical and physical behavior
  - Human factor evaluations -- What are human factors?; Headlamp safety - seeing distance; Driver’s comfort and glare; Signal detection
- Automotive Lighting Requirements
  - Industry standards and government regulations
  - SAE Requirements -- Classification; Component related requirements; Device related requirements
  - U.S. federal government requirements -- NHTSA; FVMSS 108; Petition and interpretation; Recalls
  - Comparison of SAE vs. U.S. federal regulations -- Light source and subsystem requirements; Photometry requirements for all lamps; General environmental requirements for all lighting devices; Additional environmental requirements for forward lighting devices; Additional environmental requirements for device functions - forward lighting and signal lighting devices; Technology specific requirements; Material requirements
  - International requirements -- Economic Commission for Europe (ECE); International Harmonization; Global Technology Regulations (GTR)

Instructor: Jianzhong Jiao
Fee $725 .7 CEUs

Autonomous Vehicle Positioning Systems
1 Day
I.D.# C1026

This seminar addresses vehicle positioning and navigation systems. The first part of the seminar provides an overview of the Global Positioning System (GPS) since it is the main location technology enabler for automotive location-based applications. The following topics will be discussed: coordinate reference frames, satellite constellation, signal structure, ranging observables, ranging error sources, error mitigation techniques, position velocity and timing (PVT), accuracy and availability for different modes of positioning that include open-loop, differential GPS (DGPS), real-time kinematic GPS (RTK), GPS dead-reckoning, augmentation of GPS with wheel speed sensors, inertial measurement units and compasses. Sensor fusion using a Kalman filtering technique will be included. GPS accuracy and availability performance in automotive driving environments, GPS vehicle installations (antenna, RF cable and GPS receiver), and bench-level and vehicle-level methods to evaluate GPS will be covered. An introduction to automotive navigation systems will be presented. Topics such as map database sources, route guidance calculations, and graphical user interfaces will be covered.

Learning Objectives
By attending this seminar, you will be able to:
- Specify the performance of GPS receivers and navigation systems
- Evaluate the performance of GPS receivers and navigation systems
- Integrate the GPS with other sensors via a Kalman filter to improve navigation availability
- Select the appropriate implementation of a vehicle navigation system based on your application requirements

Who Should Attend
This course is appropriate for engineers or managers who want a better understanding of the technologies involved in vehicle to vehicle and vehicle to infrastructure applications. Those interested in wireless communications application to vehicular environments, vehicle positioning systems used for connected vehicles, vehicular software architectures and security, and vehicle system applications such as active safety as they apply to automotive/commercial vehicles will find this course useful.

Other professionals who will benefit from this course include: managers seeking to evaluate technology/ regulation/standardization/business trends; fleet operators looking to increase business productivity, better manage their assets, meet regulatory requirements more efficiently, and improve asset utilization;
business stakeholders involved in controlling/exploiting data transmitted from/to vehicles; those involved with autonomous/ unmanned vehicles; and professionals interested in the perspective that the mobility, data security, and safety aspects of connected vehicle systems can enhance the reliability and control of driver-assisted vehicles.

Topical Outline

- Overview of GPS and Navigation Systems
  - Coordinate reference frames
  - GPS Satellite Constellation
  - GPS signal structure
  - Code and carrier ranging observables
  - GPS ranging error sources and mitigation techniques
  - Position accuracy dependence on satellite geometry and range error
- GPS Modes of Positioning
  - Open Loop GPS positioning with C/A code
  - Differential GPS carrier phase positioning with C/A code
  - Kinematic GPS positioning with C/A code and/or L1/L2 carrier phase
  - GPS performance examples in typical automotive environments
- GPS/INS Integration for Vehicles
  - IMU modeling and vehicle dead-reckoning errors
  - Introduction to the Kalman filter
  - Ground vehicle dynamics
  - Ground vehicle models
  - Estimation of vehicle navigation states
  - Estimation of vehicle parameters
  - GPS/INS simulation examples
- GPS Integration with other sensors
  - Digital Compass
  - LIDAR
  - UWB
  - Wheel speed sensors
  - Application examples

Control Systems Simplified

2 Days
I.D.# C0525

The advent of digital computers and the availability of ever cheaper and faster micro processors have brought a tremendous amount of control system applications to the automotive industry in the last two decades. From engine and transmission systems, to virtually all chassis subsystems (brakes, suspensions, and steering), some level of computer control is present. Control systems theory is also being applied to comfort systems such as climate control and safety systems such as cruise control or collision mitigation systems.

This seminar begins by introducing the highly mathematical field of control systems focusing on what the classical control system tools do and how they can be applied to automotive systems. Dynamic systems, time/frequency responses, and stability margins are presented in an easy to understand format. Utilizing Matlab and Simulink, students will learn how simple computer models are generated. Other fundamental techniques in control design such as PID and lead-lag compensators will be presented as well as the basics of embedded control systems. During this interactive seminar, attendees will utilize case studies to develop a simple control design for a closed loop system. And, with the aid of a simple positioning control experiment, students will learn the major components and issues found in many automotive control applications today.

Learning Objectives

By attending this seminar, you will be able to:
- Determine performance characteristics of open and closed loop systems such as time and frequency responses and stability margins
- Analyze compromises and select the best compromised solution between stability and closed loop performance metrics
- Model simple physical systems in MatLab/Simulink environment
- Analyze and design simple compensators in MatLab/Simulink environment
- Evaluate issues associated with digital control systems including effects of sampling time, word length, and throughput
- Explain the functions of various components found in today’s automotive embedded control systems including ECU I/O section, software/algorithim, power electronics, and sensors and actuators
- Communicate with control systems designers more effectively in terms of technical issues as well as toolsets, and functional needs
ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

Who Should Attend
This introductory course is designed for individuals with little or no background in control systems. Engineers, managers, and technical managers with backgrounds in systems, mechanical, electrical, or industrial engineering who work with vehicle chassis (suspension/brakes/steering), powertrains, comfort systems, vehicle dynamics, sensors/actuators, and diagnostics will find the seminar beneficial. Test engineers and technicians, patent attorneys, and business executives may also find this course valuable.

Topical Outline
DAY ONE
• Background Information
  • Examples and block diagrams -- Open and closed loop systems
  • Dynamic systems (time and frequency domains)
  • Stability
  • Compromises of a closed loop system
• Model Development
  • Modeling philosophies
  • Case study -- Problem description; Governing equations; Create a model based on transfer function; Create a model based on Simulink blocks
• Model Analysis
  • Case study -- Simulation issues (numerical integration); Linear analysis - frequency domain; Nonlinear analysis - time domain
  • Compensation (Controller Design) Methods
    • On-Off
    • Gain
    • PID
    • Lead-Lag
DAY TWO
• Control System Design
  • Case study -- Design philosophies; Time domain based design; Frequency domain based design
• Embedded Systems
  • Elements of embedded control systems
  • Experiment
  • Implementation issues
• Design Implementation
  • Case Study -- Digital issues; Experiment; Sensors and estimation; Software architecture;
• Advanced Subjects
  • Nonlinear/adaptive control
  • Robust control
  • Trends, tools and references

Instructor: Farhad Bolourchi
Fee: $1325
1.3 CEUs

Controller Area Network (CAN) for Vehicle Applications
2 Days
I.D.# C0120
A similar course is available online, on demand – Controller Area Network (CAN) for Vehicle Applications e-Seminar – see course info below.

The Controller Area Network has become the standard of choice for most automotive manufacturers. Approved for use as an ISO and EPA diagnostic network, its usage continues to grow. This seminar covers the theory and use of the CAN protocol, and its applications in the automotive industry.

Details on how the CAN protocol and other standards (J2411, J2284, J1939, ISO 11898, etc.) complement each other will be presented. Attendees will learn about CAN application layers; the latest J1939, J2284, J2411, and IDB standards, regulations, and implementation requirements; and details of device hardware and software interfaces. Also presented will be demonstrations using system development tools. The SAE standard, J1939 Recommended Practice for a Serial Control and Communications Vehicle Network, is included in the course materials.

Learning Objectives
By attending this seminar, you will be able to:
• Explain CAN protocol.
• Demonstrate how CAN is used in various automotive applications.
• Employ CAN-related standards and specifications.

Who Should Attend
This seminar is geared toward validation engineers, test engineers, embedded programmers, and those who are currently working (or will be in the future) with applications using CAN. Participants should have an undergraduate engineering degree.

Topical Outline
DAY ONE
• In-vehicle market overview
• General network topology overview
• CAN protocol;
• CAN controller programming
• CAN physical layers
• Overview of J2411, J2284, IDB, J1939, Diagnostics on CAN, etc.
DAY TWO
• J1939 in-depth review
• IDB in-depth review
• Demonstrations

Instructor: Mark Zachos
Fee: $1365
1.3 CEUs

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Controller Area Network (CAN) for Vehicle Applications e-Seminar

10.5 Hours
I.D.# PD130557ON

A similar course is available as a classroom seminar—Controller Area Network (CAN) for Vehicle Applications – see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this 10.5 hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This course offers an introduction, six modules, and a Gryphon demonstration on video, accompanied by a handbook with exercises.

What You Will Receive:

• 365 day access through MyLearn.sae.org
• Links to streaming video modules
• Course Handbook (Downloadable .pdf’s subject to DRM)
• The SAE standards, J1939 Recommended Practice for a Serial Control and Communications Vehicle Network and J1939/71 Recommended Practice for Vehicle Application Layer (.pdf, downloadable)
• Online Pre-test & Post-test (self-test, immediate results)
• CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Mark Zachos
Fee $625 1.1 CEUs

Developing In-Vehicle User Interfaces: Design Principles and Techniques

1 Day
I.D.# C1341

The In-Vehicle user environment is transitioning from fixed dedicated features to an extensible connected interface that can dramatically increase complexity faced by the driver. This course will provide a systematic design method to develop intuitive and safe vehicle interface solutions. Participants will learn user interaction design steps, tools, and the team synergies required to develop an interface from concept to the final product. The course will use exercises to practice interface design, with example interfaces to cover lessons learned. Participants will learn key interaction elements and principles to build a robust and flexible interface.

Learning Objectives

By attending this seminar, you will be able to:

• Describe the HMI user experience design flow from market research through hardware implementation
• Identify the range of usability issues specific to the vehicle environment and how they differ from desktop and mobile usability
• Articulate important human factors principles relevant to the automotive environment
• Utilize basic development tools and methods for interface design
• Explain how to integrate multiple user interfaces into a single unified interface

Who Should Attend

Those involved in vehicle user interaction systems (e.g., controls and displays for infotainment, navigation, smartphone integration, connectivity, HVAC, lights, etc.) in any functional role (e.g., product design, product development, product/market research and quality) will benefit from this seminar, including mechanical engineering, electrical engineering, software engineering, system engineering, product planning, research & development design.

Topical Outline

• Understanding User Interaction Design Team and Collaboration
  • Key resources;Design process
• Human Factors Principles Important to Vehicle HMI Design
  • Memory
  • Perception
  • Information processing
• The User
  • Learning curve
  • Perceived complexity
  • Easy to use
• Techniques of HMI Design and Development
  • User Interactions; HMI interaction architecture
  • Developing HMI use cases
  • User testing
• HMI Design Tools and Documentation Methods
  • Interaction animation and models
  • Flow diagrams
  • Graphic development

Instructor: John Kosinski
Fee $755 .7 CEUs
ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

Emissions-Related OBD Systems: A Design Overview
1 Day
I.D.# C0708

On-board diagnostics, required by governmental regulations, provide a means for reducing harmful pollutants into the environment. Since being mandated in 1996, the regulations have continued to evolve and require engineers to design systems that meet strict guidelines. This one day seminar is designed to provide an overview of the fundamental design objectives and the features needed to achieve those objectives for generic on-board diagnostics. The basic structure of an on-board diagnostic will be described along with the system definitions needed for successful implementation.

Please 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.

Individuals desiring a more in-depth look at On-Board Diagnostics should consider attending SAE seminar Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems (ID# C0707).

Learning Objectives
By attending this seminar, you will be able to:
• Articulate the underlying design objectives of on-board diagnostic systems
• Apply the design features that all diagnostics need for successful implementation
• Apply basic design techniques to deal with variation
• Use a diagnostic design template in the development of an on-board diagnostic

Who Should Attend
This course is designed for engineers involved in either the design or control of on-board diagnostic systems for engines or transmissions. Individuals working in the heavy duty industry will find the information relevant, but should note that the examples will be based on spark ignition engines and light and medium duty regulations. In addition, engineers involved in engine and transmission hardware will benefit by obtaining a better understanding of the design of OBD systems. Engineers new to the area of OBD system design and engineers involved in the design of control systems wishing to obtain a better understanding of OBD requirements will also find the course valuable.

Fundamentals of Shielding Design for EMC Compliance
1 Day
I.D.# C0835

It is important for electronic and hardware engineers to not only be knowledgeable of a product’s intended function and performance, but also its ability to perform within electromagnetic compatibility (EMC) limits. This seminar introduces practical shielding theory, design fundamentals, and configurations, including shielding products, common and differential modes, electromagnetic fields, and enclosure shielding. A segment on enclosure testing is presented in conjunction with an aperture attenuation modeling program (which is used to model attenuation characteristics at various frequencies and aperture size prior to expensive FCC/CE compliance or MIL-STD 461 testing). Honeycomb vent panels, plating attenuation comparisons, and galvanic compatibility per MIL-STD 1250 will also be discussed. Although the concepts presented in this seminar may be applicable to the automotive industry, the examples and standards presented are primarily focused on military and commercial vehicle applications.

Learning Objectives
By attending this seminar, you will be able to:
• Identify the basic characteristics of Common and Differential Mode
• Recognize E,H, and Plane wave fields, Surface current and “Skin effect” based on increased frequency
ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

- Specify Galvanic compatibility of various metal plating
- Specify industry standard shielding products for EMC compliance
- Evaluate waveguide effect of EMI/RFI shielded honeycomb ventilation panels
- Analyze aperture attenuation modeling for EMC design

Who Should Attend
This seminar will benefit engineers requiring an understanding of their electronic product or system’s electromagnetic impact on meeting commercial EMC and MIL-STD 461 requirements, as well as those engineers needing to incorporate shielding products into new or current product improvement designs.

Topical Outline
- EMC Fundamentals
  - Definitions
  - Maxwell equations
  - EMI and apertures
  - EMI environment and characteristics
- Practical Shielding Theory
  - Common / Differential modes
  - BLS Crosstalk / Radiated fields
  - Reciprocity
  - Emitter location effects
  - Partial shields
  - H, E, and PW fields
  - Shielding material testing
  - Absorption and reflection
- Shield Apertures
  - Skin depth
  - EM Leakage
  - Aperture calculation
  - Multiple apertures
  - RF current flow
- Aperture Attenuation Modeling Program
  - Aperture Calculations
  - PCB test data comparisons
  - Attenuation Modeling and Test Factor
- Honeycomb Vent Panels
  - Design - waveguide effect
  - Attenuation of various panels
  - Galvanic compatibility
  - EMC Shielding Products and Materials
  - Board Level Shields (BLS)
  - Gaskets (BeCu fingerstock, conductive fabric, conductive elastomer, wire mesh)
  - Ferrites Materials
  - RF Absorber
  - Shielding principles
  - EMC Shielding Specifications and Applications
    - MIL-STD 461 / 464 test specifications

- Shielding applications
- Question/Answer
- Session
- Learning assessment
- Group discussion on specific EMC design concerns and applications

Instructor: Michael J. Oliver
Fee $745 .7 CEUs

In-Vehicle Networking with LIN and FlexRay Applications

2 Days
I.D.# C0136
This two-day seminar covers the theory and practices of in-vehicle multiplex networking. Attendees learn about FlexRay and LIN SubBus, and other network standards. Attendees explore the latest OBD II regulations and implementation requirements, along with device hardware and software interfaces. Proprietary applications are discussed and system development tools are demonstrated.

Learning Objectives
By attending this seminar, you will be able to:
- Describe in-vehicle multiplex network architecture.
- Explain how multiplex networks are used in a wide range of automotive applications.
- Identify and use various standards and specifications related to in-vehicle networks.

Who Should Attend
Engineers who will be or currently are working with applications using multiplex networks, including validation engineers, embedded programmers, and test engineers.

Topical Outline
DAY ONE
- Introduction
- Overview of In-Vehicle Network Systems
  - On Board Diagnostics (OBD) Networks -- CARB, EPA, EURO
  - Control System Networks -- CAN Protocol
  - Deterministic System Networks -- FlexRay Protocol
  - Input/Output Device Networks -- LIN Protocol
- OBD Communications Specifications
  - SAE J1979
  - SAE J2012
  - SAE J1699-3
  - SAE J2534


**ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS**

- SAE J939-73
- ISO 15765-4
- ISO 14229
- CAN Bus Specifications
  - SAE J2284
  - ISO 15765
  - ISO 27145
  - SAE J1939

**DAY 2**
- FlexRay Networks
  - SAE, ISO, Other Specifications
  - Designing FlexRay Networks
  - Implementation of FlexRay Networks
- LIN SubBus
  - SAE J2602 Specification
  - LIN 2.x Specification
  - Designing LIN Networks
  - Implementation of LIN Networks
- Emerging Technology & Future Networks
  - Wireless
  - GbE
  - DSRC
- Vehicle Application Examples
  - LIN
  - FlexRay
- Session Review and Summary

**Instructor:** Mark Zachos

** Fee:** $1295 1.3 CEUs

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**Mechatronics: Introduction, Modeling and Simulation**

2 Days  
I.D.# C0949

Modern engineering challenges and their solutions are often multidisciplinary in nature. Systems in today’s vehicles integrate mechanical, electronic, hydraulic, as well as various other components all working together in a synergistic manner. While progress is being made in lowering the barriers between traditional engineering disciplines and formal education programs, this seminar is designed to provide engineers with mechanical or electrical engineering backgrounds the knowledge to effectively interact with colleagues from the other discipline in an efficient and productive manner.

This two day seminar is designed for the engineer with little or no mechatronics systems experience and will begin with an introduction to mechatronics principles and components, including sensors, actuators, control strategies, and instrumentation.

The instructor will then guide the participants through the analysis, synthesis and design of mechatronics systems through the use of modeling and simulation tools. Emphasis will be given to a unified energy flow approach to model mechatronics systems that are comprised of multidisciplinary components. A key element of this seminar is the use of computer simulation exercises to enhance and reinforce the learning experience. The instructor will conduct modeling and simulation exercises for this class using commercial vehicle and automotive mechatronics systems examples. Attendees desiring a more direct hands-on learning experience are encouraged to bring a personal laptop computer with the demonstration version of the 20-sim modeling simulation software installed prior to arrival.

The text, *Mechatronic Modeling and Simulation Using Bond Graphs*, authored by Shuvra Das is included with the seminar.

**Learning Objectives**

By attending this seminar, you will be able to:

- Identify multidisciplinary principles and applications of mechatronics systems
- Apply appropriate use of sensors, actuators and mechanisms in mechatronics applications
- Implement a structured approach to modeling mechatronics systems
- Select and utilize appropriate software modeling tools
- Simulate system dynamic behavior for different input conditions
- Interpret simulation results to determine system behavior in physically meaningful terms
- Identify and overcome barriers that can interfere with collaborative work across engineering disciplines on mechatronics projects

**Who Should Attend**

Mechanical and electrical engineers needing to develop a fundamental understanding of the other discipline, especially in the context of the synergistic design of products that are multi-disciplinary in nature, will benefit most from this seminar. Also benefiting are engineers in leadership positions that require a fundamental understanding of mechatronics systems and how the engineering disciplines must work together to ensure efficiency and productivity.

**Topical Outline**

**DAY ONE**

- Introduction to Mechatronics
  - System dynamics
  - Components -- Mechanisms; Sensors; Actuators
  - Signal conditioning
  - Microcontrollers
  - Control strategies
• Introduction to Mechatronic Modeling and Simulation
  • Modeling techniques
  • Bond graphs as a modeling technique
  • Drawing of power flow diagrams (bond graphs) and their meaning
  • Generalized basic elements
  • Representation of systems in terms of basic elements
  • Deriving system models from bond graphs

DAY TWO
• Modeling of Electrical, Mechanical, and Magnetic Systems
  • Modeling basics
  • Use of software tools to draw the bond graph model
  • System types and their behavior
  • Simulation -- Results and interpretation
• Mechatronics Modeling Examples
  • Sensors, actuators and systems
  • Examples and cases from: Earth moving equipment; Automotive; Machine tools
  • Other mechatronics applications
• Course Assessment and Summary

Learning Objectives
By attending this seminar, you will be able to:
• Describe how on-board Connected Vehicles applications utilize multiple services
• Create a simple OSGi service or application
• Explain open versus closed loop Connected Vehicles applications
• Demonstrate how ASN.1 encoding can be used to packetize various data structures

Who Should Attend
This course is appropriate for engineers or managers who want a better understanding of the technologies involved in vehicle to vehicle and vehicle to infrastructure applications. Those interested in wireless communications application to vehicular environments, vehicle positioning systems used for connected vehicles, vehicular software architectures and security, and vehicle system applications such as active safety as they apply to automotive/commercial vehicles will find this course useful.

Other professionals who will benefit from this course include: managers seeking to evaluate technology/ regulation/standardization/business trends; fleet operators looking to increase business productivity, better manage their assets, meet regulatory requirements more efficiently, and improve asset utilization; business stakeholders involved in controlling/exploiting data transmitted from/to vehicles; those involved with autonomous/unmanned vehicles; and professionals interested in the perspective that the mobility, data security, and safety aspects of connected vehicle systems can enhance the reliability and control of driver-assisted vehicles.

Topical Outline
• Software architecture and security in the context of connected vehicles
  • Basic concepts of software architectural design
  • Basic concepts of security and related safety issues in connected vehicles
  • Security strategies and systems and an overview of existing wireless security
  • Automotive telematics (blending of GPS and wireless telecommunications, including existing examples such as GM’s ONSTAR)
  • Review of basic concepts of autonomous (driverless) vehicles
• Local and short range communications for connected vehicles
  • Short-range wireless communication standards (e.g. Bluetooth, UWB, Zigbee)
  • Fundamentals of the OSGi (open services gateway initiative) Java-based middleware service platform for software development of wired and wireless networks
  • ASN1 (abstract syntax notation 1, used in the SAE J2735 standard) and similar type-length-value packetization techniques for transmitting data over networks

Software Architectures and Security for Connected Vehicular Systems
1 Day
I.D.# C1216
The connected vehicle of the future will contain features that fall into three mobile communication and vehicle sensing technology categories: telematics, autonomous systems, and local or short-range communication systems. Effective and safe functionality of these systems relies upon robust software and security protocols.

This class provides an overview of typical connected vehicle applications and services operating on-board the vehicle. The software systems, including protocols and packetization, are examined at an architectural level and not at a detailed programming level. A discussion at the architectural level provides a communication platform that can be used between a wide range of stakeholders (technical and non-technical). Important decisions that affect the detailed software design of applicable systems can subsequently be made earlier in the development process, and existing designs can be evaluated for usability in autonomous connected vehicles.

Instructor: Shuvra Das
Fee $1365 1.3 CEUs
ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS

- Propagation of traffic probe data through a network
  - IEEE 1609.2 security (based on IEEE 802.11) for WAVE (Wireless Access in Vehicular Environments) and DSRC (Dedicated Short Range Communications)
- End-to-end examples of vehicle-to-vehicle (VTV) and vehicle to infrastructure (VTI) interactions
- Existing systems/initiatives with applicability to connected vehicles
  - Open and closed loop software control techniques
  - Comparison of existing on-vehicle networking, e.g. Ethernet, CAN (Controller Area Network)
  - QNX real-time operating system
  - Existing vehicular and other mobility facilities/centers
  - Mobius software facilities for mobile/internet-based information distribution
- Connected Vehicle: DOT's 5-year connected vehicle research initiative to allow connected vehicles to exchange real-time road and traffic information
- Utilization of on-board sensors and wireless communications for Connected Vehicles
- Genivi alliance to provide in-vehicle infotainment (e.g. in-vehicle internet)

Instructor: Kiumi Akingbehin, Ph.D.
Fee $725 .7 CEUs

Understanding and Using the SAE J2534-1 API to Access Vehicle Networks

1 Day
I.D.# C0733

With the increase in vehicle electronics, the need to gather data from the vehicle has never been greater. From vehicle development, through vehicle test to vehicle validation, engineers are required to collect data from the vehicle’s network. The SAE J2534-1 API (Recommended Practice for Pass-Thru Vehicle Programming) gives engineers the tool to collect vehicle data from multiple network types including CAN, ISO15765, J1850, ISO9141 and Chrysler SCI, using standard J2534 interface devices. In addition, the aftermarket can access the vehicle’s OBDII information from the diagnostic connector. Using the SAE J2534-1 API, an engineer can write a single program that communicates on multiple protocols, uses an off-the-shelf interface device and is scaleable.

This course is designed to give you an understanding of the J2534-1 API, enabling you to create your own programs that accomplish your vehicle communication needs. In addition to learning how to use each of the J2534-1 functions, you will have the opportunity to write a program that collects messages off of the CAN vehicle bus and another program that reads trouble codes off of a J1850 vehicle.

Attendees will receive a copy of the SAE J2534-1 Recommended Practice for Pass-Thru Vehicle Programming.

Learning Objectives

By attending this seminar, you will be able to:
- Write programs that use the SAE J2534-1 compliant hardware to communicate with vehicles
- Reduce your dependency on proprietary vehicle communication hardware
- Increase your productivity by collecting the specific vehicle information you need when you need it
- Solve vehicle integration problems by capturing events from the vehicle network
- Protect your software investments by writing your application using a standard API

Who Should Attend

This seminar is designed for engineers involved with automotive design and development who need to write programs that interact with vehicles through the in-vehicle network. This includes engineers who validate OBDII, engineers developing and validating new electronic control modules, engineers writing reprogramming application, test engineers who log vehicle data, system integrators who need to validate system operation, and after-market engineers who add new functionality to vehicles. The seminar would also be helpful for people who develop end-of-line tests, service diagnostics or inspection and maintenance cells for vehicles.

Topical Outline

- What is the SAE J2534-1 PassThru API
  - Why use the SAE J2534-1 PassThru API
  - Overview of the SAE J2534-1 PassThru API
  - Overview of vehicle communication
  - History of the SAE J2534-1 PassThru API
  - Future of SAE J2534-1, J2534-2, J2534-3
- PassThru PC Setup
  - Using the registry to find devices
  - Loading the SAE J2534-1 DLL
  - PassThru Open and Close
  - PassThru Connect and Disconnect
    - PassThruConnect: protocols, connect flags, baudrates
    - PassThruDisconnect
  - Lab 1: PassThru on the PC: Simple SAE J2534-1 DLL
  - PassThru Read Messages and Write Messages
    - The PassThru message structure
    - PassThruReadMsgs: read, loopback and indication messages
    - PassThruWriteMsgs
  - PassThru Start Message Filter and Stop Message Filter

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Vehicle User Experience: Human Factors Principles and Techniques for Design, Research and Development

1 Day
I.D. # C1340

The automotive industry faces unprecedented growth in vehicle technologies and features that can dramatically affect the vehicle user experience. This course will provide an overview of principles and techniques for designing and developing vehicle interfaces which deliver optimal solutions while avoiding unintended consequences like driver distraction. Case studies and exercises will be used to identify best practices with key human factors design and research concepts that provide an intuitive, safe and effective user experience.

Learning Objectives
By attending this seminar, you will be able to:
• Describe the range of user experience issues specific to the vehicle environment and understand how they are different from desktop and mobile usability
• Apply important human factors principles and techniques relevant to effective automotive user interface design
• Describe and use basic design and development tools and methods of interface design
• Understand how to assess the quality and applicability of specific research findings to your user experience design and development projects
• Perform research as efficiently and effectively as possible with available resources
• Describe and use basic measures and usability tests that can quickly reveal user experience issues early in the development process to avoid costly problems later on

Who Should Attend
Those involved in vehicle user interaction systems (e.g., controls and displays for infotainment, navigation, smartphone integration, connectivity, HVAC, lights, etc.) in any functional role (e.g., product design, product development, product/market research and quality) will benefit from this seminar, including mechanical engineering, electrical engineering, software engineering, system engineering, product planning, research & development and design.

Topical Outline
• The Vehicle User Experience
  • Special features of the vehicle context
  • User interfaces, user interaction and user experience
• Human Factors Principles for Vehicle User Experience Development
  • The cognitive and physical ergonomics distinction
  • Key concepts in attention, distraction, memory and perception
• Design Principles for Vehicle User Experience Development
  • Controls and Displays
  • Design Strategies
• Research Principles for Vehicle User Experience Development
  • Techniques, measures and methods for assessing user experience
  • Best practices in research
• Resources for Effective Vehicle Interface Design
  • Standards and best practices

Instructor: Michael Tschirhart
Fee $755 .7 CEUs
### Wireless Communications in the Autonomous Connected Vehicle

**1 Day**  
**I.D.# C1025**

Wireless communication is a key enabler for vehicle connectivity. This seminar provides participants with an engineering overview of the various technologies that comprise a wireless communication system as it relates to automotive and commercial vehicle applications. It is intended to develop the skill set necessary for an educated understanding of the challenges and opportunities related to Connected Vehicles and connected applications.

This lecture contains three sections:

- **Section One** provides an immersion in the fundamentals of wireless communications. It begins with the physics of the technical challenges caused by propagation (e.g., multipath, Doppler spread) and interference that can impact the communication budget link. Then, it will introduce the basic mitigation techniques (wireless channel: models, capacity, modulation, detection, diversity) and their performance measured in terms of signal to noise ratio (SNR) and error probability.

- **Section Two** addresses networking. It starts with the principles of wireless networks and reviews the TDMA and CDMA systems. It then discusses concepts related to Ad Hoc Networks including an overview of the Vehicular Area Network (VANET). It concludes with discussions on security issues and approaches relating to Mobile Ad Hoc Networks (MANET).

- **Section Three** describes how wireless communications techniques can be applied in vehicle to infrastructure (V2I) and vehicle to vehicle (V2V). It provides details in the most recent developments of the Dedicated Short Range Communications (DSRC) technology as well as related standardization topics (IEEE 1609, IEEE 802.11p, and SAE J2735). Module Three concludes with insights about how the cellular 4G/LTE (Long Term Evolution) technology can be used to accelerate the development of V2X communications (where X can stand for I as in Infrastructure, V as in Vehicle, P as in Pedestrian, C as in Cyclist, etc.).

### Learning Objectives

By attending this seminar, you will be able to:

- Describe the technical challenges relating to wireless communications
- Identify and compare the different components of a wireless communication system
- Develop a first-hand experience on connected vehicles through V2V and V2I demonstrations
- Identify the key automotive/commercial vehicle wireless communications forums dealing with standardization/regulation and business opportunities
- Recognize the role, both current and future, connected vehicle technologies will play in our collective future

### Who Should Attend

This course is appropriate for engineers or managers who want a better understanding of the technologies involved in vehicle to vehicle and vehicle to infrastructure applications. Those interested in wireless communications application to vehicular environments, vehicle positioning systems used for connected vehicles, vehicular software architectures and security, and vehicle system applications such as active safety as they apply to automotive/commercial vehicles will find this course useful.

Other professionals who will benefit from this course include: managers seeking to evaluate technology/regulation/standardization/business trends; fleet operators looking to increase business productivity, better manage their assets, meet regulatory requirements more efficiently, and improve asset utilization; business stakeholders involved in controlling/exploiting data transmitted from/to vehicles; those involved with autonomous/unmanned vehicles; and professionals interested in the perspective that the mobility, data security, and safety aspects of connected vehicle systems can enhance the reliability and control of driver-assisted vehicles.

### Topical Outline

#### Fundamentals of Wireless Communication

- Wireless Communications Overview
- Technical Challenges
  - Math tools
  - Mobile radio propagation
- Mitigation Techniques
  - Channel capacity
  - Digital modulation and detection
  - Performance of digital modulation over wireless Channels
- Diversity
- Recent Advances
  - Multiple antennas and space-time communications
  - Ultra-WideBand (UWB) technology

#### Wireless Networks

- Cellular Networks
  - Principles
  - TDMA-based
  - CDMA-based
- Ad Hoc Networks
  - Characteristics of MANETs
  - Vehicular Area Network (VANET)
  - Security issues V2X Communications
VEHICLE ELECTRIFICATION

Hybrid and Electric Vehicles: Current Production, Future Strategies Web Seminar and Web Seminar RePlay

2 Hours
Web Seminar I.D.# C0906
Web Seminar RePlay: I.D.# PD330906ON

Hybrids, and to a lesser extent, electric vehicles, have been on the road since 1997. Although just two hybrids were on the market in 2001, there are more than a dozen today, and the market is ramping up quickly, driven by fuel prices and constraints, environmental regulations, and customer demand. The commercial vehicle market is also rapidly embracing hybrid technology. This two-hour Web Seminar will highlight the passenger, light-duty, and heavy-duty hybrid and electric vehicles that are currently in production, offered for sale, or planned for near-term production. Asian, European, and North American manufacturers of hybrid and electric vehicles will be reviewed. Tier 1 suppliers of major hybrid and electric vehicle components will be covered as well.

Learning Objectives
By connecting with this web seminar, you will be able to:
• List the hybrid and electric vehicles that have been commercialized from 1997 to present

Who Should Attend
This Web Seminar will benefit executive, manager, marketing, or other passenger car and light duty industry professionals who need a comprehensive overview of past, current, and future hybrid and electric vehicle production. Those unfamiliar with the evolution of hybrid and electric vehicle development, yet whose job will be impacted by hybrid and electric vehicles in the future, will benefit also.

Topical Outline
• Hybrid and electric vehicle production, 1997-present
• Current Asian hybrid vehicle production
• Current US hybrid vehicle production
• Advantages and disadvantages of series hybrids
• Upcoming commercialization of series hybrids
• Market and regulatory drivers of HEV/EV production
• Fuel constraints
• US regulatory drivers; EU Regulatory Drivers
• “Green state” regulatory drivers
• Asia’s regulatory drivers
• Planned Asian hybrid and electric vehicle production
• Planned European hybrid and electric vehicle production
• Planned US hybrid and electric vehicle production
• Commercial hybrid and electric vehicle production
• Asian commercial hybrids; European commercial hybrids
• North American commercial hybrids
• Tier 1 suppliers and partnerships
• Internal-combustion engines (ICE)
• Energy storage systems
• Motors and power electronics

Instructor: Jack Rosebro
Fee $260 .2 CEUs
Hybrid Vehicle Systems Integration

1 Day
I.D.# C1125

Integration of hybrid electric components into a vehicle can be significantly complex. Detailed modeling, analysis, design and development are required to optimize the tradeoffs and balances between energy management, torque management, vehicle performance, vehicle drivability and vehicle safety. Management of component and system controls architecture and software integration is an increasingly involved and convoluted task. This seminar will address: how to establish essential vehicle requirements; development considerations for various vehicle systems and production/certification requirements. A strong focus will be placed on understanding the balances and tradeoffs associated with a hybrid electric system.

Learning Objectives

By attending this seminar, you will be able to:
• Describe and identify the basic hybrid components and architectures and explain the differences from conventional vehicles
• Identify how to define key vehicle system requirements and select and size system components that best meet those requirements
• Identify the main hybrid/EV development considerations for various vehicle system and performance topics
• Explain unique system validation, certification, service and manufacturing requirements.

Who Should Attend

Individuals who already have a basic understanding of hybrid system components who are seeking to increase their knowledge and understanding of hybrid vehicle system integration, including mechanical and electrical application engineers, systems integration engineers, performance managers, design and release engineers, project managers, and other individuals who are working with or transitioning to hybrid-electric powertrain development, will find this seminar particularly helpful.

Topical Outline

• Vehicle Development Process
  • Typical VDP overview
  • Hybrid and EV unique processes
• Establishing Vehicle System Requirements
  • Typical system requirements
  • Establishing architecture options
  • Selecting and sizing components
  • Evaluating tradeoffs
• System Development Considerations
  • Energy/power management
  • Torque management
  • Thermal management
  • Cabin comfort
  • Chassis (braking, vehicle dynamics, powertrain to chassis dynamics, ride and handling, steering)
  • HV/LV electrical systems (efficiency, integration, EMC, thermal)
  • Displays/information
  • Safety
  • Drivability/performance
  • NVH
  • Controls integration
• Production Certification Requirements
  • QRD and validation requirements
  • Emissions certification and diagnostic requirements
  • MVSS certification considerations
  • Service requirements
  • Manufacturing/assembly requirements

Instructor: Alexandra Cattelan
Fee $755 .7 CEUs

Introduction to Battery Pack Design, Integration, and Validation in China

2 Days
I.D.# C1236

New energy requirements for China’s vehicle market are significantly increasing battery system development. This rapid increase in battery development is elevating the importance of optimized battery system design, integration, and validation. Once the vehicle platform is determined, the vehicle must realize benefits from an optimized battery system design that includes enhanced acceleration speed, stable performance, long life, and desired range.

This comprehensive 2 day seminar introduces participants to system level design considerations, including battery and vehicle interface requirements, battery design and production validations, design changes and the inevitable performance compromises that must be addressed when implementing these technologies. This seminar begins with vehicle level battery requirements and analysis of the battery-vehicle interface followed by an in-depth study of system electronics, thermal management, performance, and CAN communication requirements.

Learning Objectives

By attending this seminar, you will be able to:
• Analyze battery system design parameters and their vehicle performance effects
• Evaluate the compromises between battery performance, life, and stability
• Specify the fundamental design validation standards, testing methods and acceptance criteria and design changes strategy
• Estimate from CFD and FEA simulation for thermal management and NVH design concept
• Discuss opportunities for advanced system integration

Who Should Attend
This seminar is intended for engineers involved in all fields related to the design or development of battery electronics, battery size selection, battery system integration, and validation.

Topical Outline
DAY ONE
• Pack Design
  • Customer Requirement Breakdown: Proposal
• Pack Testing and Validation
  • DV/PV
  • Outsourcing Testing
  • Testing Equipment
DAY TWO
• Pack Quality Control
  • Engineering methods for incoming materials
  • Engineering methods for shipping materials
  • Failure analysis
  • VAVE and Other Processes for Battery Companies

Instructor: Ying Wang, Ph.D.
Fee $1275 1.3 CEUs

Introduction to Hybrid and Electric Vehicle Battery Systems
2 Days
I.D.# C0626

Driven by the need for lower emissions, better fuel economy and higher efficiency, hybrid vehicles are appearing in many different configurations on today’s roadways. While the powertrain components such as the drive motor, motor controller and cooling system are somewhat familiar to the automotive industry, the battery systems are a relatively unfamiliar aspect. This seminar will introduce participants to the concepts of hybrid vehicles, their missions and the role of batteries in fulfilling those requirements. Battery topics including limitations, trends in hybrid development, customer wants and needs, battery system development timelines, comparison of electrochemistries and safety will be examined. Current offerings, cost factors, pack design considerations and testing will also be reviewed.

Students will have an opportunity to perform a battery pack analysis exercise using a real world application and are requested to bring a calculator to class.

Learning Objectives
By attending this seminar, you will be able to:
• Capture customer wants and expectations of the battery system
• Identify factors that drive power and energy requirements
• Determine test program structure
• Compare and contrast the newest relevant battery technologies
• Calculate estimates of electric range and quantify the assumptions
• Critically assess media claims of new battery discoveries

Who Should Attend
This seminar is primarily intended for vehicle systems engineers, battery system integration engineers, testing engineers, electrical engineers and thermal management engineers recently assigned to their roles or returning to hybrid or electric vehicle programs. It will also be beneficial to those involved in the specification, design, development, testing and planning of hybrid vehicle programs. Product planners and program managers will find the overview aspects helpful.

Topical Outline
DAY ONE
• Terminology, Definitions and Conventions
• Brief Review of the Hybrid Market
  • Market drivers and expectations
  • Market influences
  • Competing technologies
  • Customer expectations
• Review of Common Vehicle Product Offerings (battery descriptions, power, technology, size, architecture)
• Fundamentals
  • Fossil fuel vs. hybrid vs. electric
  • Source ragone plot
  • Efficiencies, weights
  • Cost of fuel (fossil vs. electrons)
• Role of Battery
  • ICE vs. electric systems
  • Energy vs. power
  • Expectations over vehicle lifetime
• Product Liability / FMEA
• Battery Development Cycle
  • You don’t know what you don’t know!
  • Why does it take so long and cost so much?
• Cost Factors
  • Scope of product: system vs. cells vs. sticks
  • $/kW vs. $/kWh
• System Considerations
• Electrochemistry Selection
• Safety
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**ELECTRICAL/ELECTRONICS AND ELECTRONIC SYSTEMS**

- Advance planning for safety tests
- Thermal runaway
- String configuration (series, parallel)
- Range Estimation (hybrid vs. electric)

**DAY TWO**

- Real-life Battery Analysis Exercise (using a contemporary vehicle as an example)
- Battery Pack Design Considerations
- Failure Modes
  - Wear-out
  - Power and energy degradation
  - High resistance / open circuit
  - Controller / signal malfunction
- Vehicle Trends
  - Plug-in hybrid
  - Battery electric
  - Demanding applications
  - Fuel cell hybrids
- Battery Trends
- Battery Warranty
- Battery Recycling

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**Plug-in Hybrids: Opportunities and Challenges Web Seminar and Web Seminar RePlay**

**2 Hours**

**Web Seminar: I.D.# C0905**

**Web Seminar RePlay: I.D.# PD330905ON**

The path to commercialization of plug-in hybrids is likely to require complex interactions between OEMs, battery manufacturers, electric utilities, and government, yet the plug-in hybrid is a still-developing technology. How do plug-in hybrids (PHEVs) differ from conventional hybrids? What are the advantages and challenges for vehicle manufacturers, public utilities, energy and environmental concerns, and end-users? What is the current state of plug-in hybrid development? Those unfamiliar with PHEV or vehicle-to-grid (V2G) technology, yet whose job will be impacted by plug-in hybrid vehicles in the future, will benefit from this two-hour Web Seminar.

**Learning Objectives**

By connecting with this Web Seminar, you will be able to:

- Describe the relevant differences between plug-in hybrid (PHEV) and conventional hybrid vehicles
- Identify fundamental charge-discharge strategies
- Explain the performance demands placed on PHEV energy storage systems and development trends in energy storage
- Recognize the enablers and barriers to mass commercialization of PHEVs
- Summarize infrastructure requirements as well as supply-side and demand-side incentives
- Explain the potential energy and emission benefits of PHEV and V2G synergies

**Who Should Attend**

This Web Seminar will benefit automotive and commercial vehicle industry professionals who want to understand the rapidly-changing development of plug-in hybrids, as well as proposed legislation that may affect that development, and surrounding infrastructure that will play a supporting role in PHEV commercialization.

**Topical Outline**

- Plug-in hybrid (PHEV) architectures
  - Gasoline-electric plug-in hybrids
  - Diesel-electric plug-in hybrids
  - Fuel cell plug-in hybrids
- Plug-in hybrid (PHEV) charge-discharge strategies
  - Series plug-in hybrids
  - Parallel plug-in hybrids
  - Series-parallel plug-in hybrids
  - Charge-sustaining (CD) strategies
  - Charge-depleting (CD) strategies
  - Blended charge-discharge strategies
- Plug-in hybrid (PHEV) energy storage systems
  - State of energy storage chemistries today
  - Influence of all-electric range
  - Influence of charge-discharge strategies
- State of plug-in hybrid development today
  - Conversion of existing hybrid vehicles
  - Passenger and light-duty vehicles
  - Heavy-duty vehicles
  - Interaction between plug-in hybrids and the electrical grid
    - Charging considerations
    - Infrastructure considerations
    - PHEVs and grid demand
- Vehicle-to-grid (V2G)
  - How V2G works
  - State of V2G development today
  - What’s needed to enable large-scale commercialization V2G
- Government incentives toward development of PHEVs
  - Supply-side incentives
  - Demand-side incentives

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**Instructor:** Erik Spek  
**Fee:** $1315  
**1.3 CEUs**

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**Plug-in Hybrids: Opportunities and Challenges Web Seminar and Web Seminar RePlay**

**2 Hours**

**Web Seminar: I.D.# C0905**

**Web Seminar RePlay: I.D.# PD330905ON**

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  - Supply-side incentives
  - Demand-side incentives

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**Instructor:** Jack Rosebro  
**Fee:** $260  
**.2 CEUs**

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RELATED TRAINING SOLUTIONS
Some of our courses apply to more than one technology category. Consider these related courses described in other sections of this resource guide.

**Introduction to Hybrid Powertrains Web Seminar**
In this two-hour web seminar, energy storage systems, inverters, motor-generators, and DC-DC converters are explained, as well as design considerations for both light-duty and heavy-duty vehicle powertrains and developing trends such as plug-in, flywheel and hydraulic hybrids.
Read more about this course on page 126

**Principles of Electric Drives**
Industry professionals who are looking for a general understanding of the structure and components of vehicular electric drives will benefit from this course, which will cover theory, design, operation, and diagnostics of all major components used in electric drives (battery packs, inverters, motor-generators, DC-DC converters, and charging apparatus).
Read more about this course on page 127

**Basic Hybrid and Electric Vehicle Safety**
This 120-minute web seminar reviews safety concerns and precautions related to high-voltage circuits present in hybrid, plug-in hybrid, electric, and fuel cell hybrid vehicles.
Read more about this course on page 190

**Overview and Impact of the Automotive Functional Safety Standard ISO 26262**
This course provides background for reading and applying the standard and explains its scope, the major differences from the general safety standard IEC 61508, and how the scope changes with the introduction of new systems.
Read more about this course on page 192

**Safe Handling of High Voltage Battery Systems**
The battery system forms a key part of any of these vehicles and is probably the least understood. With practically no moving parts the battery systems show no visible or audible warning of any latent dangers. This seminar will introduce participants to the risks encountered in handling high voltage battery systems and their component parts.
Read more about this course on page 193
MANAGEMENT AND LEADERSHIP

Includes effective leadership, strategic thinking, team building, management, and effective decision making.

Effective Decision-Making: A Methodology Approach

1 Day  
I.D.# C1354

Effective decision making is critical to maximizing profit/minimizing expenses, return on capital spending, and operational efficiency. To understand the impact of decisions that affect the enterprise, professionals at every level must secure and integrate relevant cross-functional information. Register for this seminar and learn skills needed to base decision making on solid business knowledge and sound financial principles instead of on emotion or “your gut.” The instructor walks you through the tenets of structured decision-making and teaches a step-by-step approach to make practical, effective decisions.

Learning Objectives

By attending this seminar, you will be able to:

• Define the decision boundaries and expectations for decision outcomes  
• Select the optimal methodology for decision making  
• Select the best decision-making criteria in making project decisions and allocating capital budgets  
• Determine the lowest enterprise costs in raising capital through debt and equity offerings  
• Analyze make-buy, buy-lease, replacement and other alternative enterprise decisions based on the best financial strategies  
• Articulate the financial sensitivity of project decisions and the use of decision tools for integrating cross-functional business requirements  
• Develop an effective decision-making structure for your unique specific project criteria and your organization

Who Should Attend

This seminar will benefit individuals having responsibilities in engineering, business, finance, marketing, purchasing, manufacturing, research, and program management. In addition, local government leaders and individuals in non-profits may benefit from these decision-making case studies in determining business decisions including which projects and grants should be supported. A group from the same organization may find it advantageous to attend together.

Topical Outline

• Decision Boundaries and Expectations  
  • Region & Functions Impacted  
  • Time Frame of Decision  
  • Outcomes  
  • Plan B  
• Decision-Making Principles  
  • Evolution  
  • Terminology  
  • Types  
  • Stages  
• Financial Principles  
  • Time Value of Money, Interest & Inflation  
  • Worth (Present Value, Future Value, etc.)  
  • Financial Decision Methods (NPV, IRR, Payback Period, etc.)  
• Case Studies  
• Decision-Making Criteria  
  • Market Demographics  
  • Product or Service Position/Leadership, Parity  
  • Financials & Price/Margin/Cost Reduction  
  • Quality/Customer Satisfaction  
  • Change in Business Direction/Vision  
  • Personnel/Job Creation

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• Cost Impact & Enterprise Decisions
  • Cost of Capital: Equity & Debt, Revenue Sources
  • Cost of Ownership: Depreciation, Accelerated Cost Recovery
  • Influence of Tax Obligations
  • Case Studies
• Alternative Financial Decisions for the Enterprise (Principles & Case Studies)
  • Make/Buy
  • Buy/Lease
  • Replace/Repair
  • Investments of Unequal Life
• Sensitivity & Scenario Analysis & Decisions (Case Studies)
• Decision-Making Methodology
  • Matrix Priority Rating System
  • Case Study by Attendees

Learning Objectives
By attending this seminar, you will be able to:
• Define the importance of each of the nine Bodies of Project Management Knowledge and the essential components of APQP by Phase
• Properly evaluate Statement of Requirement, Statement of Work and Work Breakdown structures
• Apply the different timeline methodologies: Milestone, Gantt, Network (PERT) and Critical Path
• Recognize the minimum essential elements of a Robust Project Plan
• Utilize different types of meeting and conflict resolution strategies, formulate an effective meeting summary and action list, and conduct an actual Design Review
• Recognize the current U.S. and international legislation and directives which impact today’s technology development and manufacturing environment

Who Should Attend
New Project Managers, Lead or Design Release Engineers, Project Managers requiring refresher training or other individuals involved with projects will benefit by attending. The course is best suited for individuals in the mobility industry and specifically operating as Tier 1-3. Students should be familiar with how projects are currently managed in their company so they may ask questions relating to their specific problem areas.

Topical Outline
• The Project Management Process
  • Definition, outline and overview of the differences between 3rd and 4th editions
  • Project constraints
  • The nine bodies of Project Management Knowledge
  • Project Management and ISO
• Project Plan Life Cycle
  • Three types of life cycles: Product, Project, Project Management
  • Comparison of project management and the automotive APQP process
  • Major elements of each APQP phase
• Project Management Techniques
  • Principles of Integration Management
  • Defining, constructing, and recognizing the differences between Statement of Requirement, Statement of Work and Work Breakdown structures
  • Developing scope of work for conceptual-based (R&D) customers
  • Review of the various types of Work Breakdown Structures (WBS) and a guide to WBS development
  • Beyond lessons learned - Project Best Practices and the TGR/TGW database

Instructor: James Masiak
Fee $755 .7 CEUs

Engineering Project Management
2 Days
I.D.# 99003

Project Management and Advanced Product Quality Planning (APQP) are two critical techniques used in product development in the mobility industry today. This seminar will bring these techniques together in an easy to understand format that goes beyond the typical concept of constructing timelines and project planning, by exploring not only the AIAG APQP process, but also specific aspects of PM processes. Students will gain a solid foundation in the essential principles of Project Management and APQP.

Students will immediately apply learned skills by taking a sample project through all phases of the Project Plan using actual industry documents. Realistic issues, problems and time constraints are introduced throughout the exercise to stimulate actual project concerns. Each workshop exercise uses documents specific to the particular areas of study such as Statement of Requirements and Statement of Work, Timeline development and reacting to changing situations such as time crash. Discussion of the major milestones of typical OEM APQP processes, to include PPAP. The workshop is structured so that students must operate in teams and the time constraints allow students to see firsthand the effects of improper delegation of work assignments. Attendees will receive a copy of the book, PMBOK® - Project Management Body of Knowledge (4th edition) by the Project Management Institute (PMI).
MANAGEMENT AND LEADERSHIP

- Documentation requirements necessary to support the PM/APQP processes
- Resource Planning
  - Choosing an organizational structure to support effective Project Management
  - Roles and responsibility matrix (RASIC)
  - Creating a useful Staffing and Resource Plan
  - Special considerations for small projects
- Sequence Planning
  - Milestone Charts; Gantt Charts
  - Network Diagrams; PERT
  - Critical Path Method (CPM) and use of float/slack time
  - Techniques to address Fast Tracking and Crashing
- Project Costing and Tracking
  - Project cost analysis methods and estimating methods
  - Recognizing and dealing with Scope Creep
  - Control techniques -- Requirements for an effective Change Management System; Negotiating the difference between Phase and Design Reviews; Earned Value Analysis (EVA); Effective meeting techniques; Forming and leading project teams; Structure of effective Phase and Design Reviews; Recognizing and resolving internal and external conflict
- Project Risk Management
  - Components and construction of an effective Risk Management Plan
  - Risk qualification and quantification techniques -- Developing effective checklists; Expected Values Matrix; Probability and Impact Matrix; Product liability using the FMEA and HAZOP
- Procurement Management
  - Understanding partner supplier relationships
  - Suppliers rating techniques
  - Suppliers skill requirements

Instructor: Angelo E. Mago

Fee $1505 1.3 CEUs

Leading High Performance Teams

2 Days
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.

Topical Outline

- Designing High Performance Team
  - Characteristics of effective teams
  - Systems aspects of team design
  - Addressing systemic variables
  - Identifying key stakeholders
  - Establishing the team’s charter
- Leadership and Group Dynamics
  - Responsibilities of the team leader
  - Understanding human behavior in groups
  - Motivating team members
  - Establishing a productive team culture
  - Developing team support
  - Productive and destructive team roles
  - Effective communications
  - Influence of personality styles

SAE GENERAL MANAGEMENT AND LEADERSHIP CERTIFICATE PROGRAM

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

This program focuses on four core management and leadership competencies: management capability, team leadership, project management, and finance providing a basis for growth into a leadership or management role. View the list of required and elective courses and more information on enrolling in this SAE certificate program: training.sae.org/certificate/management_leadership

3 ways to get a no-obligation price quote to bring a course to your company • Call SAE Corporate Learning at 1-724-772-8529
• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
MANAGEMENT AND LEADERSHIP

• Launching the Team
  • Stages of team development
  • Pre-meeting considerations
  • Selecting the team
  • Common reasons meetings fail
  • Managing the first team interface
  • Establishing group norms
  • Structuring the agenda
• Making Sound Decisions
  • Situational analysis: problems, decisions and polarities
  • Common errors in decision making
  • Essential steps in the decision process
  • Quality and acceptance factors in decision making
  • When to use and avoid group consensus
  • Identifying the decision makers
  • Facilitating consensus decisions
• Flawless Facilitation
  • Recognizing and defusing common group problems
  • Managing conflict and providing feedback
  • Mind mapping, story boarding and other techniques
  • Making work assignments
  • Assessing group performance
  • Concluding the meeting

• 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.

Topical Outline
DAY ONE
• The Management Perspective - How Managers Earn Their Keep
  • The value proposition of management
  • The “Peter Principle” and how to avoid this trap
  • Understanding the most important errors that managers commonly make - and how to steer clear of major supervisory pitfalls
  • Why people usually struggle to cooperate, and how you can reduce this
• What You Need to Know about Today's Workforce
  • The evolution of leadership thought, and why recent events have significantly changed effective leadership methods
  • Understanding what leadership is really about
  • Why teamwork and cooperation are necessary in modern corporate structures
  • How you can generate consistent focus and daily commitment among technical and engineering professionals
  • Playing “The Tower Game” - applying focus and commitment
• The Psychology of Successful Modern Leadership
  • Process centered leadership: getting sustained results
  • Task and relationship balances
  • Why “Output Leadership” is ineffective and counter-productive
  • Different kinds of team models - and which is most effective

Managing Engineering & Technical Professionals

3 Days
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

Instructor: Joseph Doyle
Fee $1275 1.3 CEUs
• How to reduce the influence of “bad” politics in an organization through constructive decision making processes

DAY TWO
• The Psychology of Change
  • Why change is often stressful
  • Five stages of change
  • How to make change exciting and interesting
• Emotional Intelligence: Building an Effective Leadership Style
  • Why “emotional intelligence” is important - the research results
  • The five elements of emotional leadership
  • How to practice and develop greater emotional intelligence
  • Solving typical meeting problems with emotional intelligence
• Coaching in Supervision
  • Building trust
  • Coaching roles
  • Improving communication for constructive coaching
• Using Meeting Time Effectively
  • Five key issues for successful meetings
  • How teamwork breaks down in meetings, and how to correct this

DAY THREE
• Dealing with Practical Issues
  • Dealing with difficult people
  • Learning how to delegate effectively
• Basic Negotiation Principles
  • Soft & hard negotiating approaches
  • Win-win negotiation
  • Positions, interests, & goals
• How to Make Performance Reviews Constructive
  • Legal requirements
  • Style issues
  • 360 reviews

Instructor: Eric Timmis
Fee $1765 2.0 CEUs

Root Cause Problem Solving: Methods and Tools Web Seminar and Web Seminar RePlay
8 Hours
Web Seminar: I.D.# WB0931
Web Seminar RePlay: I.D.# PD330931ON

Tough times require searching for things that we can change and making them better. But so often problems are solved with ‘band-aids’ and not root cause solutions. This approach is getting too expensive and at best only helps companies tread water. To combat these issues and adopt a fresh approach, teams can use the methods and tools of Root Cause Problem Solving to first view problems as opportunities for improvement, identify root causes and implement solutions to prevent recurrence. Benefits include improved quality and customer satisfaction, reduced operation costs, and greater employee knowledge of work processes.

This proven 8-step approach to problem solving will help improve operational and financial performance by identifying causes and implementing solutions to significant or recurring problems. This approach to problem solving is used by many major automotive manufacturers.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Describe the 8-Step Problem Solving Methodology
• Define the difference between Symptom and Root Cause
• Use tools and techniques to solve problems
• Evaluate effectiveness of problems solving efforts
• Describe the role of problem solving in continuous improvement
• Write an action plan to apply problem solving to a specific concern

Who Should Attend
This course is applicable to those directly working in or responsible for performance improvement of any definable, repetitive process, e.g. manufacturing, design, logistics, purchasing, sales, or distribution, including:
• Manufacturing managers, supervisors and team leaders
• Manufacturing engineers
• Design engineers
• Quality engineers and technicians
• Technical managers
• Project team leaders
• Problem solving and quality improvement facilitators
• Anyone whose role includes problem solving; therefore all supervisors and lead personnel

Topical Outline
Session 1
• Overview
  • Following a process approach
  • What is a problem?
  • Inhibitors to effective problem solving
  • 8-step problem solving process overview
• Step 1: See the Problem as an Opportunity
  • Framing the problem solving effort
  • Identifying team member; Team roles
• Step 2: Describe the Problem
  • Symptoms vs. Causes
  • Methods for describing the problem
  • Using and charting data
  • Problem Is/Is-Not analysis
MANAGEMENT AND LEADERSHIP

Session 2
• Step 3: Implement Containment
  • Protect the Customer
  • Process Control Plan
• Step 4: Recognize Potential Root Causes
  • Identifying possible causes; Process Maps
  • Cause-Effect diagrams
  • 5-Why tool

Session 3
• Step 5: Design Solution
  • Solutions that don’t work
  • Process Controls and Error Proofing
  • Standardized Work
• Step 6: Implement Permanent Corrective Actions
  • Plan the work
  • Complete system changes
  • Verify effectiveness

Session 4
• Step 7: Prevent Recurrence
  • Was the problem eliminated?
  • Layered audits
  • Leverage learnings with FMEA
• Step 8: Recognize Efforts
  • Team debrief and lessons learned
  • Evaluate and celebrate success
• Summary
  • Sufficiency checklist for effective problem solving
  • Continuous Improvement

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.

Topical Outline
• Introduction to Strategic Leadership
  • What exactly do we mean by leadership?
  • Who is and is not a leader?
  • At what point do we become leaders?
  • Critical elements of leadership support
• Managing versus leading - is there really a difference?
• Critical factors in assessing leadership performance
• The relationship between leadership, strategy, human behavior, decision-making and organizational systems
• Understanding the Human Dimension
  • Similarities between animal behavior and human behavior
  • Influence of brain structure on human behavior
  • Rules of thumb for predicting human behavior in organizations
  • Recognizing the symptoms of pathological leadership
  • Managing and defusing dysfunctional behavior
• Assuming the Helm
  • Managing the transition to a new workgroup
  • Common and avoidable errors of leadership
• Developing and maintaining the support of your workgroup
• Simple, but effective steps to improve workgroup performance
• Shaping Corporate Culture

Strategic Leadership and Strategic Leadership Workshop
3 Days - I.D.# C0620
2 Days - I.D.# C1412

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.

Instructor: Murray Sittsamer
Fee $620 .8 CEUs
MANAGEMENT AND LEADERSHIP

- Understanding the critical components of corporate culture
- Forming productive organizational norms
- How leaders contribute to dysfunctional cultures
- Establishing a high performance work environment
- Creating Organizations that Work
  - Creating an organizational charter
  - Selecting an effective management team
  - Thinking systemically
  - Importance of managing image and expectations
  - Creating meaningful performance indicators
  - Eliminating turf battles and duplication
  - Limitations on the application of common systems
- Facilitating Strategic Decisions
  - Critical distinctions between problems, decisions and polarities
  - How to properly frame a decision
  - Selecting the decision makers
  - Common errors in decision making process
  - Essential elements of effective decision making process
  - Knowing when the decision has been made
- The Leader’s Role in Creating Effective Strategies
  - What exactly is a strategy?
  - Why business strategies fail
  - Internal and external considerations
  - What constitutes effective strategy?
  - Anticipating the impact of adaptive responses
  - Framing strategic initiatives
  - Barriers to strategy implementation
- Leading Strategic Change
  - Planning a change initiative
  - Critical variables in organizational change
  - The leader’s role in fostering change
  - Anticipating and dealing with resistance
  - Culture as a barrier to change
- Political Reality versus Dysfunctional Idealism
  - Gaining credibility in executive circles
  - Sources of leadership power
  - How power is gained and lost
  - The importance of building networks and relationships
  - How to avoid getting derailed
- Lessons of History for Strategic Leaders
- Developing a Leadership Profile
  - Charting your personal leadership profile
  - Identifying your leadership assets and liabilities
  - Creating a plan of action

Success Strategies for Women in Industry and Business

1 Day
I.D.# C1202

It is a well-known fact that the number of women in science, engineering and business fields is growing, yet men continue to outnumber women, especially at the upper levels of these professions. Many women appear to encounter a series of challenges at early or midcareer stages that contribute to them leaving their careers prematurely due to feelings of isolation, an unsupportive work environment, extreme work schedules, and unclear rules about advancement and success.

This program serves as a unique opportunity to obtain both formal and informal mentoring tips from a successful woman engineer who spent over 25 years in the petrochemical/specialty chemical industry. She has seen and has experienced significant changes in the number of professional women active in the technical/scientific field and is convinced that more positive change can happen in the future.

This seminar will provide detailed guidance, based on real life examples, on how female professionals can become proactive in creating career opportunities via self-assessment, self-motivation, an objective view of one’s own abilities, and continuous steps in self-improvement. The program will take participants beyond theory to case studies and real life examples exemplifying potential for immediate use.

Learning Objectives
By attending this seminar, you will be able to:
- Identify obstacles and common challenges that hold you back in your career
- Develop and utilize critical communication skills
- Develop focused and well defined criteria for professional progress
- Define your professional relationships with clear boundaries and respect
- Create a flexible career plan
- Handle criticism and difficult situations with composure

Who Should Attend
This seminar will benefit professional women who want to positively impact their careers. Recent engineering graduates, as well as experienced female engineers and/or scientists having responsibilities in research, design, product and process development, manufacturing, quality, information technology, sales/marketing, and management will learn skills to help them navigate these male-dominated fields. Additionally, individuals currently working in non-engineering disciplines, including general management, human resources, academia, business,

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<tr>
<th>Instructor:</th>
<th>Joseph Doyle</th>
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<tr>
<td>Fee (C0620) $1655</td>
<td>2.0 CEUs</td>
</tr>
<tr>
<td>Fee (C1412) $1320</td>
<td>1.3 CEUs</td>
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and law as well as current engineering students, will also benefit from this unique perspective.

**Topical Outline**
- Course Motivation: Why are you here?
- Historical Perspective - Women in Engineering and Scientific Professions
  - Dr. Ewa Bardasz - personal story
  - Survey data - status of women professionals: tenure, promotions, salary trends, recognitions, etc
- Case Study #1: What holds you back in your career?
- Common Challenges
- Case Study #2: Career Goals: Success Defining Questions
- Work Climate Changes
- Definition of Professional Success
  - Technical know-how
  - Leadership skills
- Refining Critical Verbal Communication Skills
  - Presentations/ public speaking
  - Negotiations/ conflict communications
  - Getting your points across
  - How to speak up without coming across as aggressive
  - How to find balance between “being to nice” and “coming on too strong”
  - How you can say “no” without feeling guilty
- Case Study #3: How can you successfully negotiate with a group of aggressive men?
- Refining Critical Written Communication Skills
  - Reports, technical papers
  - Email, social media
- Networking
- Behaviors and Relationships
  - Handling emotions at work
  - Mentors/Advisors - pros and cons
- Work-Life Balance
- Key Resources
  - Professional organizations
  - Community activities
- Reflections and Final Thoughts
- Take Away Message
- Case Study #4: What will I do next?

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<thead>
<tr>
<th>Instructor:</th>
<th>Ewa Bardasz</th>
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MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

Includes product development, compliance, risk management, problem solving, and quality.

Advanced Product Quality Planning (APQP) Workshop

4 Days
I.D.# C0111

This four-day workshop will provide you with fundamental knowledge and hands-on practice with the Advanced Product Quality Planning process and key tools. Topics addressed include the overview and application of the APQP process, Failure Mode and Effects Analysis, Control Plans, and Error Proofing. The program is designed for all levels of design and manufacturing personnel, as well as more experienced engineering and management personnel, especially for those involved in developing new products or processes.

Why All Four Topics Together? APQP, FMEAs, Control Plans, and Error Proofing are all interrelated and build on each other. Training that focuses only on one of these subjects at a time cannot show how these tools work together to minimize effort, improve quality, and complete programs more quickly with less headaches before, during, and after launch. Participants apply these key tools together to bring an actual product from concept to production during this comprehensive, start-to-finish workshop.

Learning Objectives

By attending this seminar, attendees will learn:
• APQP phases, milestones, and deliverables
• The relationship between APQP, PPAP, FMEAs, and Control Plans, and Error Proofing
• Step-by-step instructions for completing Design and Process FMEAs
• How to avoid some of the most common FMEA pitfalls
• How to use FMEAs and other inputs to complete Control Plans easily and quickly
• Error proofing and mistake proofing concepts, applications, and opportunities throughout the APQP process.

Who Should Attend

This course is designed for individuals with minimal experience with the APQP process and its related key tools. However, many experienced individuals attend the course to refresh their knowledge, gain advanced strategies, and practice development and application of these tools with an experienced facilitator. Program managers, design-responsible engineers or managers, potential APQP or FMEA team members such as operators and technicians, quality personnel, and other product design and manufacturing personnel who are interested in continuous improvement strategies will all benefit.

Topical Outline

DAY 1
• Advanced Product Quality Planning
• Product Design and Development
• Process Design and Development
• Product and Process Validation
• Feedback, Assessment and Corrective Action

DAY TWO
• Failure Mode and Effects Analysis
• Design FMEA Development
• Process FMEA Development
• FMEA Application Workshop

DAY THREE
• FMEA and Control Plans
• FMEA Summary and Advanced Strategies
• Control Plans
• Process Flow and Characteristics
• Standardization and Continuous Improvement
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

DAY FOUR
• Error Proofing and Workshop Summary
• The Key Elements of Error Proofing
• Error Proofing Case Studies
• Error Proofing, QS-9000, and the APQP process
• Error Proofing Case Study Workshop
• Error Proofing Summary and Advanced Strategies
• Cost/Benefits Analysis Methods
• Potential Problems, Pitfalls, and Lessons Learned
• Additional Resources

Who Should Attend
This seminar is designed for managers with implementation authority for product safety and compliance; product development engineers, designers and managers; new business development managers; risk managers and compliance or certification managers. Companies considering expanding or modifying their product line, or attempting to enter new export markets, will especially benefit. Suppliers who are involved in product development and compliance, regulatory agency representatives, industry safety organization representatives, and corporate compliance lawyers will also benefit.

Topical Outline
DAY ONE
• Introduction to Compliance
  • What do we mean by compliance
  • The 3 basic forms of compliance
  • Why we need to show compliance: Legal requirements in different countries; Commercial advantages; Product liability risks
  • What is a formal compliance program
• Creating a compliance checklist - getting started
  • An introduction to the compliance process
  • Defining your markets in terms of compliance requirements
  • Finding applicable regulations, standards, and guidelines
  • Documenting best practices in the compliance checklist
DAY TWO
• Completing the compliance checklist
  • Extracting relevant requirements from the regulations, standards and guidelines
  • Selecting methods of compliance
  • Sorting and presenting the blank checklist
• Applying the checklist to a development project
  • Introducing the checklist within your organization: Integrating the checklist process into existing policies and procedures; Identifying key players, and getting them on your side
  • When and how to start the product specific checklist
  • Sidebar: discoverable documents and document retention
• Managing the compliance program over a product’s life
  • Storing and sharing the final checklist
  • Using the checklist as the product grows and develops
  • How the checklist gives your product a unique identity: Learning from the checklist for your next project; the checklist as “corporate memory”; identifying and retaining best practices beyond minimum compliance requirements
  • The standards development process

Instructor: Daniel P. Bauer, Jr.
Fee $1655 2.6 CEUs

Creating and Managing a Product Compliance Program

2 Days
I.D.# C1213

Around the world, and more often than not, government bodies require formal certification of products. As product developers expand into new markets, they will be confronted with new standards, regulations, and customer expectations that may require new compliance processes. A properly run compliance program improves your product’s quality and safety, broadens your product’s market, ensures compliance with regulations and laws, and helps provide protection from future product liability issues.

This two-day seminar presents a process development methodology that can be used repeatedly as new compliance requirements emerge. You will learn best practices in creating a compliance program for your products and markets, and how to use this program at all stages of product development and production. Sample spreadsheets will be used to demonstrate tailoring the program to your product, your markets, and your organization. A properly managed compliance program simplifies the certification or approval of your product, and ensures that you regularly apply and document good engineering practices for product safety and reliability.

Learning Objectives
By attending this training program you will be able to:
• Summarize how a formal compliance program adds value to your goods and services
• Develop a compliance checklist
• Identify effective strategies for researching compliance requirements
• Describe how to manage the ongoing compliance process
• Explain the importance of documenting compliance and retaining records

Instructor: R.W. (Bill) Walker
Fee $1275 1.3 CEUs

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I.D.# C1213

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Fee $1655 2.6 CEUs

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Instructor: Daniel P. Bauer, Jr.
Fee $1655 2.6 CEUs
Fault Tree/Success Tree Analysis

1 Day
I.D.# 92028
Sharpen your skills with this no-nonsense program that will show you practical ways to implement popular tools in your product/process design, manufacturing, reliability assurance and safety operations. Fault Tree/Success Tree analysis are proven devices for improving the design of a product or process by revealing logical failure paths and appropriate actions for implementing design changes or controls.

Learning Objectives
By attending this seminar, you will be able to:
- Define Fault Tree and Success Tree Analysis
- Identify the terminology and methodology used in Fault Tree/Success Tree Analysis
- Compare the benefits of Fault Tree/Success Tree Analysis to the product/process design and development process
- Appraise Fault Tree/Success Tree Analysis in relation to other tools
- Demonstrate Qualitative and Quantitative Analysis using the Fault Tree/Success Tree approach

Who Should Attend
You will profit from this detailed seminar if you...
- Are a product/process design or development engineer
- Are involved in manufacturing/process/industrial engineering
- Are a quality/reliability engineer
- Have product/process assurance responsibility
- Are a safety or service engineer
- Manage any of the above
- You and your company want to observe new automotive supplier quality requirements

Topical Outline
- Exposure to Fault Tree Analysis - Basic Concepts
- Uncovering Basic Elements of a Fault Tree
- Focusing on Fault Tree Construction
- Tackle Boolean Algebra and its Application to Fault Tree Analysis
- Zero in on Success Tree/RFT Concepts
- Reveal the Relationship between Fault Tree/Success Tree Analysis
- Mastering Block Diagrams
- Reliability Prediction Using Fault Tree/Success Tree Analysis

Instructor: E. Harold Vannoy
Fee $725 .7 CEUs

Fundamentals of Systems Acquisition Management

26 Hours
I.D.# PD43DAU01
This online course provides a broad overview of the DoD systems acquisition process, covering all phases of acquisition. The content of this course is based on and is presented from the DoD perspective and serves as the foundation for understanding the regulations and language used in the federal acquisition system. This course introduces the Joint Capabilities Integration and Development System; the planning, programming, budgeting, and execution process; DoD 5000-series policy documents; and current issues in systems acquisition management. Designed for individuals who have little or no experience in DoD acquisition management, this course familiarizes the participant with the terminology and processes used by government agencies and contracting organizations.

Major topics include:
ACQ 101 consists of 24 lessons that are divided into three sections:
1. Acquisition Policy and Planning
   - Lesson 1 - Defense Acquisition Workforce Improvement Act (DAWIA)
   - Lesson 2 - Systems Acquisition Management: An Introduction
   - Lesson 3 - Systems Acquisition Management: Introduction to the Life Cycle
   - Lesson 4 - Systems Acquisition Management: Organizations and Acquisition Categories
   - Lesson 5 - Team Building
   - Lesson 6 - The Joint Capabilities Integration and Development System (JCIDS)
   - Lesson 7 - Work Breakdown Structure
2. Financial and Contract Management
   - Lesson 8 - Financial Management: Cost Estimation
   - Lesson 9 - Financial Management: Resource Allocation Process
   - Lesson 10 - Financial Management: Program/Budget Execution
   - Lesson 11 - Contract Management: Planning for Solicitation
   - Lesson 12 - Contract Management: Solicitation, Evaluation, and Award
   - Lesson 13 - Contract Management: Post-Award
   - Lesson 14 - Earned Value Management
3. Technical Management
   - Lesson 15 - The Systems Engineering Process Environment
   - Lesson 16 - The Systems Engineering Process
   - Lesson 17 - Science and Technology in the Acquisition Process
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

• Lesson 18 - Test and Evaluation Overview
• Lesson 19 - Acquisition Logistics: Fundamentals
• Lesson 20 - Acquisition Logistics: Supportability Planning
• Lesson 21 - Software Acquisition: Fundamentals
• Lesson 22 - Software Acquisition: Development and Management
• Lesson 23 - Production, Quality, and Manufacturing Management
• Lesson 24 - Facilities Engineering

Is this Defense Acquisition University Course for You?
SAE is pleased to offer this course to government contractors and other individuals requiring an understanding of the regulations and language used in the federal acquisition process. Additionally, individuals interested in pursuing acquisition careers with the federal government will benefit from this certified DAU Equivalency course. Successful completion also meets the ACQ101 course requirement for DAWIA Level I Certification.

What You Will Receive
• 365 days of access (from date of purchase) to the 26 hour course
• Online coursework
• downloadable resource documents for each lesson
• Periodic knowledge checks
• Online testing (immediate results and automatically submitted to SAE)
• 2.6 CEUs*/Certificate of Achievement with credit granted for DAU Equivalency (with successful completion)

Author: Defense Acquisition University
Fee $1,195 2.6 CEUs

Global 8D - Ford Online Course
12 Hours I.D.# PD111012ON
Global 8D (G8D) is a disciplined process developed by Ford Motor Company to help product development and manufacturing engineers identify and solve problems. Solving problems results in efficient, as well as effective, resolution to ‘root causes’ of customer satisfaction issues, and helps reduce warranty costs. With this 12-hour online course, you will learn the methods and tools used to complete each step in the Ford Global 8D find-and-fix problem-solving process, including steps to define the problem, verify the root cause and escape point, and prevent occurrence.

Major topics include:
• Global 8D Overview
• Prepare for Global 8D and Establish the Team
• Describe the Problem and Find the Root Cause

Choose and Implement a Permanent Corrective Action (PCA)
Complete the Global 8D

Is this SAE/- Ford Online Course for you?
This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive
• Four months of online access to the 12-hour course
• Proof of Participation
Fee $395

Introduction to Advanced Product Quality Planning (APQP) Fast Track
1 Hour I.D.# PD230908ON
To become a preferred supplier in the automotive industry, organizations must demonstrate high-level engineering and organizational capabilities that will meet customers’ needs today and tomorrow. Because the outcome of a product development project may determine whether or not an organization procures a purchase order or contract from a global automotive customer, the Introduction to Advanced Product Quality Planning Fast Track will address an overview of the best practices / methodologies for planning and managing the successful launch of a new product.

Major topics include:
• What is APQP?
• What is the purpose of APQP?
• Understanding how APQP integrates into the automotive supply chain
• APQP - A master plan for new product development
• Summary of APQP benefits

Is this Fast Track for You?
Participants in the one hour Introduction to Advanced Product Quality Planning (APQP) Fast Track will gain a ‘common-sense’ perspective for successful new product launches and what needs to be done to comply with automotive customer specific requirements. You will also understand how to apply the concepts of “front-end” planning (via the APQP process) that will result in continual improvement of products and services for both the customer and the supplying organization. This course is relevant to individuals with limited or general knowledge of the APQP process and some experience with introducing new products or new manufacturing processes.
Managing Programs and Associated Risks

2 Days
I.D.# C0409

This course presents a proven eight-step method for program planning and control, including: definition of customers’ requirements, roles of the program team, determination and flowcharting of program tasks, scheduling and costing, quality aspects of critical tasks, and risk management. Easy to grasp, each of the eight steps evolve from common-sense questions that should be answered for any program, regardless of size or complexity.

With shortened development cycles and greater reliance on information in programs, this course emphasizes the value of communication within a program team, between the team and functional areas, and between the team and the program customer. Since the appropriateness of communication vehicles vary depending on purpose and audience, alternative modes of communication and change control are discussed.

Learning Objectives

By attending this seminar, you will be able to:
• Explain the eight-step method for program planning and control
• Implement the eight-step method to improve program outcomes as measured by cost, schedule and quality
• Make plans and progress visible to team members and to the program customer

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.

Topical Outline

• Program and risk management overview
  • Process approach to planning programs
  • Competition drives us to perform better
  • Why programs sometimes fail
  • Reference materials and website
• Defining program outcomes and measurables
  • Building quality and performance targets into program planning
  • Financial impact of poor planning
  • Roles and responsibilities of project team members
  • Design reviews
  • Product performance measurement
  • Program/project metrics
• Team formation and task planning

Introduction to Weibull Engineering Fast Track

80 Minutes
I.D.# PD230946ON

The Weibull engineering technique is the starting point for solving most issues related to product reliability, maintainability, supportability, quality, safety, test planning, and cost control. Weibull Analysis is popular worldwide as the best method for predicting modeling variability and failure of designs, products, and systems. In this 80-minute, introductory short course, instructor Wes Fulton will provide a solid overview of Weibull Engineering capabilities. This Fast Track should be considered a prerequisite for participation in a Weibull project or for attending additional SAE training that covers advanced Weibull applications.

Major topics include:
• Introduction and Background
• Basic Weibull Plotting and Interpretation
• Case Studies of Successful Weibull Applications
• Overview of Weibull Extensions
• Course Summary

Is this Fast Track for You?

The Introduction to Weibull Engineering Fast Track is designed for the engineer - from automotive, aerospace, electrical, biomedical, and nuclear. This course does not require any pre-requisite, as the content will unfold from the basics, up to the more advanced features of this valuable analysis tool. The knowledge gained in this course can serve as a prerequisite to more advanced Weibull projects.

What You Will Receive

• Three months of online access to the 80 minute presentation
• Integrated knowledge checks to reinforce key concepts
• Proof of Participation

Instructor: Wes Fulton
Fee $152

What You Will Receive

• Three months of online access to the one hour presentation
• Integrated knowledge checks to reinforce key concepts
• Proof of Participation

Instructor: Larry Bissell
Fee $110
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

• Team development
• Roles and responsibilities
• Matrix management
• Meeting management

• Scheduling work
  • Critical Path calculation
  • Fast tracking
  • Developing a baseline schedule
  • Gantt chart creation
  • Software tools for scheduling
  • Software tools for program management

• Resource planning
  • Resource planning (quantity, skills, resource conflicts, anticipating needs)
  • Adding contingencies
  • Constraint management

• Risk Management
  • Proactive assessment and mitigation of risks
  • Types of risk
  • Failure mode and effects analysis applied to programs/projects

• Optimizing work performance
  • Spheres of influence and control
  • Cause-effect diagrams
  • Assessing critical information flows
  • Managing human performance
  • Responsibility matrix (RASIC)

• Project initiation
  • Establishing a war room
  • Authorization to begin
  • Meeting management
  • Tracking program performance

Instructor: Murray Sittsamer
Fee $1315 1.3 CEUs

Military Tactical Vehicle Product Development - Concept to Production

2 Days
I.D. # C1248

Understanding the U.S. Department of Defense (DoD) requirements, processes, and product development lifecycle allows for more effective new product engineering and development within the DoD marketplace. In addition, understanding how industry can apply currently available commercial vehicle technologies as a platform to meet current and future DoD needs may become an important factor in reducing costs and conforming to DoD budget constraints.

The overall objective of this two day seminar is to establish a working knowledge of the military tactical vehicle product development process. The instructor will provide attendees an in-depth explanation of the DoD product development lifecycle. This will include the product specifications during the infancy stage of development on the government side and continue through the various technical development stages required for the full production launch of various military vehicle platforms, including wheeled and tracked vehicles. This course will give those who are entering the military tactical vehicle market, or those who want to effectively move commercial products into the DoD market the foundation to do so.

Learning Objectives
By attending this seminar, you will be able to:
• Identify the requirements and philosophies of DoD Product Development and Key Metrics for success
• Recognize the roles of contracting, the program office, testing requirements, and the overall acceptance process of militarized products by the DoD
• Evaluate and support product specifications to key metrics (KPP’s) that allow you to successfully meet your end customer’s expectations
• Identify and explain, with a clear understanding, the product development life cycle and the key gates a particular product is required to pass through to be successfully adopted by the DoD
• Identify and associate the similarities and differences between tracked and wheeled vehicles and component level product development and the various paths that can be taken to successfully develop militarized products

Who Should Attend
Program managers and engineers working within or supporting the tactical vehicle market as well as those who are looking to develop a militarized component.

SAE PROFESSIONAL AND LEGAL ISSUES CERTIFICATE PROGRAM

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

This program focuses on legal and risk management issues critical for you to master to facilitate the successful design and deployment of products from a safety and reliability perspective. View the list of required and elective courses and more information on enrolling in this SAE certificate program--training.sae.org/certificate/legalissues
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

Topical Outline

DAY ONE
• Product Development Lifecycles
  • Program of Record - Full Vehicle Platform
  • Component Level Refinement / Sustainment / Depot / Recapitalization
  • Small Business, Large Business, Small Business Innovation Research (SBIR)
• Product Specifications
  • Automotive Tank Purchase Description (APTD)
  • Capability Production Document (CPD)
  • Operational Requirements Document (ORD)
  • Contractor Performance and Reporting System (CPARS)
  • Other vehicle platform specifications
• Military Standards (MIL-STD)
  • Technology Readiness Level (TRL)
  • Technical Operating Procedures (TOP)
  • Performance vs. Development
• Acceptance
  • Input from customer
  • Testing: Laboratory
  • Testing: Finite Element Analysis (FEA)
  • Testing: Aberdeen Test Center (ATC)
  • Testing: Yuma Proving Grounds (YPG)
  • Other testing facilities

DAY TWO
• Contracting
  • Proposals
  • Contract Data Requirements List (CDRL), process, and mechanisms
• Challenges - Trends
  • Time of development
  • Transition from war support to sustainment and recapitalization
• How to successfully tie all elements of contracting, program office and acceptance testing into product development
  • Large programs (vehicle development)
  • Component level

Instructor: Glen Simula  
Fee $1265  1.3 CEUs

Patent Law for Engineers

1 Day  
I.D.# 88007

This information-packed seminar focuses on the intricacies of patents, patent infringement litigation and patent licensing. Attendees will explore the important subjects of obtaining U.S. and foreign patents, maintaining U.S. and foreign patent rights, enforcing patent rights, defending against patent rights asserted by competitors, and licensing patent rights for revenue. After this seminar, you will effectively understand patents and ways to protect your company’s valuable inventions. Your new knowledge will help your company maintain and enhance its position in the marketplace.

Learning Objectives

By attending this seminar, you will be able to:
• Obtain an overview of U.S. patent litigation
• Understand the basic legal principles for liability and damages in patent cases
• Gain insights into how patent disputes are resolved
• Predict the fees and expenses associated with bringing and/or defending a patent case in the U.S.
• Anticipate the scope of discovery in, and/or business disruption arising from, a U.S. patent case
• Peek into the future of potential patent law reform

Who Should Attend

Participants should have a mid- to upper-level managerial role. Research and development, in-house legal staff members such as in-house lawyers, patent agents, or patent liaisons will especially benefit.

Topical Outline

• Overview of Patent Litigation
  • Issues the Patent-Owner Has to Prove
  • Issues the Accused Infringer Has to Prove
• Who Decides Liability and Damages
  • Jury
  • Judge
  • Mediator/Arbitrator
• How Long Does it Take From Filing to Trial
  • District Courts
  • ITC
• How Much Does It Cost
  • Fees and expenses
  • Contingency Fees
  • Recovery of fees and expenses
• What is the Scope of Discovery
  • Documents, including e-documents
  • Depositions

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• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
• Third parties (e.g. customers, suppliers)
• Confidentiality of discovery materials
• What Changes are on the Horizon
  • Supreme Court
  • Patent law reform

ANTICIPATE THE SCOPE OF DISCOVERY IN, AND/OR BUSINESS DISRUPTION ARISING FROM, A U.S. PATENT CASE
• Peek into the future of potential patent law reform

Who Should Attend
This course is geared toward executives, in-house counsel, in-house patent agents, and senior managers across industries, such as automotive and aerospace. Participants may be both U.S. and non-U.S. -- anyone who needs help in understanding what to expect and what the realities are should they become involved in U.S. patent litigation.

Topical Outline
Session 1
• Overview of Patent Litigation
  • Issues the patent-owner has to prove
  • Issue the accused infringer has to prove
• What is the Scope of Discovery?
  • Documents, including e-documents
  • Depositions
  • Third parties (e.g. customers, suppliers)
  • Confidentiality of discovery materials
• Who Decides Liability and Damages?
  • Jury; Judge; Mediator/Arbitrator

Session 2
• How Long Does it Take from Filing to Trial?
  • District Courts
  • ITC
• How Much Does it Cost?
  • Fees and expenses
  • Contingency fees
  • Recovery of fees and expenses
• What Changes are on the Horizon?
  • Supreme Court
  • Patent law reform

Learning Objectives
By connecting with this web seminar, you will be able to:
• Obtain an overview of U.S. patent litigation
• Explain the basic legal principles for liability and damages in patent cases
• Gain insights into how patent disputes are resolved
• Predict the fees and expenses associated with bringing and/or defending a patent case in the U.S.
Principles of Cost and Finance for Engineers

3 Days
I.D.# C0828

In today's corporate environment of shrinking budgets, required structural cost reductions, sharing of global designs/services, and pricing pressures, it is critical that engineers possess a working knowledge of engineering economics principles. To fully understand the economic viability of engineering decisions, engineers need to find the appropriate balance between design alternatives, resulting costs, and impact on their enterprise. This seminar introduces participants to the cost, finance and economic concepts and their applications to products and services. This three-day course provides you with practical information normally obtained through university level economics and business management courses and will help you to maximize efficiencies from both an engineering and business perspective.

Note: Attendees are requested to bring with them a business or scientific calculator capable of doing exponential calculations.

Learning Objectives

By attending this seminar, you will be able to:

• Understand the hierarchy of economics, finance and cost in making financial decisions
• Review financial statements and ratios in assessing the financial state of a business
• Select the best decision-making criteria in making project decisions and allocating capital
• Implement a benchmarking plan to establish a competitive market position
• Determine the enterprise costs of raising capital through debt and equity offerings
• Analyze make-buy and buy-lease options and other alternative decisions based on the best financial strategies
• Understand the financial sensitivity of project decisions and the use of decision tools for integrating business requirements
• Determine and optimize all costs in the production process
• Select the optimum cost accounting strategy and inventory plan
• Identify the appropriate cost estimation methodology for metallic, electronic & plastic components
• Select cost control alternatives from marketing, engineering, commercial & geographic options

Who Should Attend

This seminar will benefit engineers having responsibilities in manufacturing, maintenance, research, design, product and process development, program and project management, troubleshooting, and materials management. Additionally, individuals in non-engineering disciplines, including marketing and general management, will benefit from an introduction to the engineering perspective.

Topical Outline

DAY ONE - Principles of Economics & Finance

• Process & Responsibility for Determining Cost
• Economics, Finance & Cost Principles
  • Macroeconomics and Growth
  • Microeconomics, Supply & Demand
  • International Economics & Comparative Advantage
  • Finance & Accounting: Corporate
• Finance
  • Financial Statements & GAAP
  • Financial Analysis & Ratios, Case Analysis
  • Capital Sources & Allocation
• Time Value of Money and Decision Making
  • Interest: simple and compounded
  • Inflation
  • Worth: present and future values
• Decision Making
  • Net Present Value, Payback Period
  • AAR, Internal Rate of Return, Profitability Index
  • Case Analysis
• Benchmarking Module

DAY TWO - Cost Impact & Enterprise Decisions

• Cost Impact on the Enterprise
  • Cost of capital, cost of equity and debt, WACC, Case Analysis
  • Cost of Ownership, Depreciation; Accelerated cost recovery; Depletion
  • The influence on tax obligations
• Alternative Financial Decisions Using Case Analysis
  • Make-Buy; Buy-Lease
  • Repair-Replace
  • Investments of Unequal Life
• Sensitivity & Scenario Analysis
• Matrix Priority Rating Systems

DAY THREE - Cost Management

• Production Cost Relationships
  • Break-even Point
  • Marginal Costing
• Elements of the Production Process
  • Pricing influences -- Quality; Competition
  • Elasticity of Demand
• Cost Principles & Definition
  • Accounting, Opportunity, Estimating
  • Fixed, Variable, Cost Function, Transfer Pricing
  • Economies of Scale
• Managerial & Cost Accounting
  • Cost Volume Profit Analyses
  • Standard Costing
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

- Throughput Costing & Case Analysis
- Activity-based
- Inventory Management
  - Types
  - Accounting
- Cost Estimating Methodology
  - Activity-based costing
  - Cost analysis process examples (metallic, electronic, plastic)
- Cost Control Alternatives
  - Marketing & content evaluation
  - Engineering & redesign (DFSS, DFMA, VE, Benchmarking)
  - Commercial Decisions (Purchasing, Economies of Scale)

Regions of manufacture & transportation

Instructor: James Masiak
Fee $1645 2.0 CEUs

Product Liability and The Engineer

1.5 Days  
I.D. # 82001

In the past few decades, product liability law has dramatically changed the manufacturer’s outlook in the design and manufacture of product. The concept of safety and reliability has been altered from a purely engineering/manufacturing concept to a legal/manufacturing approach. This new approach requires an understanding of legal concepts as related to the manufacturing and design process. The engineer’s role has shifted to include a safety audit analysis to minimize the existence of a product defect and/or to defend the product in a way that is responsive to the legal concerns. An overnight assignment will be made by the instructor. It will consist of problems drawn from actual cases and a group project that examines the design, instructions, and warnings of a product.

Learning Objectives
By attending this seminar, you will be able to:
• Relate legal concepts as they apply to the manufacturing/design process
• Use safety audit analysis techniques to minimize or eliminate product defects during design, thus reducing product liability
• Discuss defense of product from a legal perspective
• Recognize the importance of potential liability as it relates to the manufacturer

Who Should Attend
Persons responsible for product design, including managers and designers; corporate risk managers; persons responsible for developing and approving product instructions and warnings; marketing personnel; production and quality assurance managers and personnel; personnel responsible for product safety and those persons, including lawyers, who oversee and manage product liability issues.

Topical Outline
• Legal Concepts
  - Negligence: elements, defenses
  - Strict liability: section 402A (elements, defenses)
  - Warranties: express, implied
• Analysis of Defect
  - Meaning of unreasonable danger
  - Production defect
  - Design defect
  - Defect by words
• Designing for Reasonable Safety
  - Products’ use, users & environment
  - Product safety audit
• The Role of Standards in Design
• Warnings
  - Guidelines for design & warnings
  - Functions & use
• Problem Analysis by Participants
• Review of a Product Design by Participants

Instructor: Charles F. Seyboldt
Fee $1275 1.0 CEUs

Quality Function Deployment

2 Days  
I.D. # 92029

Quality Function Deployment (QFD) is an excellent technique for determining and understanding customer requirements and then translating these requirements into your company’s internal technical language for use in product design through final assembly. QFD is a method for converting customer requirements into company requirements. The first day of this two-day program provides practical strategies and benefits of the successful QFD technique. On the second day, you will receive additional details to enhance the QFD technique. You will also strengthen your QFD skills during monitored practice sessions and thought-provoking question and answer periods.

Learning Objectives
By attending this seminar, you will be able to:
• Define Quality Function Deployment (QFD)
• Identify the terminology and methodology used in QFD
• Recognize the workable benefits of QFD to the product/process design and development process
• Review methods for determining and monitoring the “Voice of the Customer”
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Managing Product Development/Quality Assurance

• Describe two accepted approaches to QFD
• List the requirements for QFD’s success

Who Should Attend

You should attend if you:
• Are a product/process design or development engineer
• Are a sales/marketing engineer
• Are a quality/reliability engineer
• Are an engineer involved in product/process assurance
• Manage any of the above
• And your company wants to conform to the new automotive supplier quality requirements

Topical Outline

• Capturing the Concept of Quality
  • Targeting the Kano model
  • Branching out with the quality success tree
• How to Determine Customer Requirements (“Voice of the Customer”)
• Establishing Designing Requirements
• Constructing the Product Planning Relationship Matrix
• Making Cascading Matrices Work for You
  • Design alternative selection
  • Determine subassembly and part characteristics
  • Ascertain manufacturing processes
  • Targeting quality controls
• Comparing the Relationship of QFD and Other Product and Process Design Tools

Instructor: E. Harold Vannoy
Fee $1225 1.3 CEUs

The Role of the Expert Witness in Product Liability Litigation

1.5 Days
I.D.# 92054

According to the Federal Rules of Evidence, an expert witness is anyone who can assist the trier of fact (the jury) in understanding any issue in dispute at trial. The witness’ ability to give this assistance can be derived from any specialized training, education, background, or experience. To be effective in providing this assistance, however, requires that the expert witness understand the true role that he or she is to play both before and at the trial.

This seminar will address the critical issues that every person who may be, has been, or is, an expert witness must understand to assist both the attorney and the product manufacturer, regardless of which side the expert serves.

Learning Objectives

By attending this seminar, you will be able to:
• Employ the risk/utility balancing process necessary for effectively addressing the issue of design defect
• Recognize the critical elements that govern the interaction between human behavior and product behavior
• Apply the technical/legal elements that will enhance your effectiveness as an expert witness

Who Should Attend

This seminar is intended for anyone who is or may become an expert witness in product liability litigation. In-house experts typically have engineering, engineering management or field technician responsibilities. In addition, insurers, risk managers, corporate product safety personnel, attorneys and those who manage product liability litigation will benefit from insight into selecting and using expert services and witnesses more effectively and efficiently.

Topical Outline

(Day two ends at 1:00 p.m.)
• The Legal Framework of Negligence and Strict Liability
• The Relationship Between the Attorney and the Potential Expert Witness
• Investigation of an Accident Years After an Occurrence
• Developing the Background Necessary to Understand the Product and its Environment
• Understanding How to Allege or Refute the Existence of a Product Defect
• Analyzing the Role of Human Behavior and its Relationship to the Cause of an Accident
• Guidelines for Effective Presentation Before Trial and on the Witness Stand
Managing Product Development/Quality Assurance

- The seminar will also include overnight problem assignments and a demonstration of direct and cross-examination of an expert witness.

**Instructor:**Charles F. Seyboldt
**Fee:** $1275 1.0 CEUs

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**Weibull-Log Normal Analysis Workshop**

3 Days  
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, originally developed by Dr. Bob Abernethy, 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. Classwork 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 must bring a laptop to this course.


Optional Weibull Introduction—to accelerate your learning in this Workshop, you may want to complete the SAE Fast Track, *Introduction to Weibull Engineering* (I.D.# PD230946ON, page 165). This highly recommended overview of Weibull engineering can improve your retention prior to taking the workshop or provide a great review afterwards.

**Learning Objectives**

- 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**

An engineering undergraduate degree in any discipline would be beneficial. Engineers responsible for reliability, safety, supportability, maintainability, materials, warranties, life cycle cost, design, structures, instrumentation and logistics will find these Weibull techniques extremely useful.

**Topical Outline**

**DAY ONE - Undergraduate Weibull Analysis**
- Background, Development & Introduction - 23-Minute Video Short Course
- How to do Weibull Analysis
- Interpretation of Good Weibulls - 2 & 3 Parameter
- Are two Weibull datasets significantly different?
- Interpretation of Bad Weibulls
- Risk and Failure Forecasting Case Studies
- Weibull Experiments (Wire Rupture, Torsion, LCF, Accelerated Testing), Classwork Problems and Solutions
- Log Normal Analysis
- Optimal Replacement Intervals, Block Replacement

**DAY TWO - Postgraduate Weibull Analysis**
- Maximum Likelihood Weibull Theory and Application
- Weibayes Analysis
- Dauser Shift, Warranty Analysis
- Rank Regression vs. Maximum Likelihood
- Extremely Small Samples Analysis
- One Failure Weibull Case Study
- An Introduction to SuperSMITH® Software, Features, Input, Analysis, Output
- Summary of Weibull Methods
- Class Work Problems
- Experimental Wire Data Distribution Analysis
- Playtime With SuperSMITH® Tutorial

**DAY THREE - Confidence Intervals and System Models**
- Confidence Intervals, “The Good, The Bad and The Complicated”
- Comparing Designs
- The Binomial & Poisson
- Crow-AMSAA Reliability Growth Modeling - Useful Technology for Tracking Development Testing and Any Significant Event to be Managed
- The Exponential Related to the Poisson and the Weibull
- Kaplan-Meier Survival Analysis
- Crow-AMSAA Employed for Analyzing Renewal-Repairable Systems
- System Models
- Classwork
- Complete Playtime With SuperSMITH®
- Ph.D. Oral Examination

**Instructor:**Wes Fulton
**Fee:** $2145 2.0 CEUs
Good Laboratory Practices (GLP) Training – CALISO Online Course

8 Hours
I.D.# GLP

GLP refers to a Quality Systems of management controls for laboratories and research organizations to ensure the consistency and reliability and reproducibility of results. The original regulatory enforcement was first published by FDA and then a few years later by EPA. It is also outlined in the Organization for Economic Co-operation and Development (OECD) Principles of GLP in 1992 and has since been added to many national regulations. Your company, and all who partake in the daily activities of running a laboratory or a research and testing center, will benefit from this course. This 8-hour GLP (0.8 CEU) overview is particularly adapted for training all levels of an organization on the requirements of this standard.

Major topics include:
• Scope
• Definitions
• Inspection of a testing facility
• Personnel
• Testing facility management
• Quality assurance unit
• General
• Animal care facilities

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently get a comprehensive training of GOOD LABORATORY PRACTICES (GLP)
• Want to improve your CV and career opportunities with qualifications in quality assurance

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $185.95 0.8 CEU

ISO 9001 Overview – CALISO Online Course

4 Hours
I.D.# ISO9001OVERVIEW

ISO 9001 is a quality management standard developed by the International Organization for Standardization (ISO). The ISO 9001 standard is generic and can be used for any organization, whether it provides physical products or services. The requirements must be carefully interpreted to make sense within a particular organization. Developing automotive products is not like producing food products or offering consulting services; yet the ISO 9001 standard, because it is business and management oriented, can be applied to any activity. It is the most widely used quality management standard in the world. This four-hour ISO 9001 overview is particularly adapted for training top management on the high level requirements.

Major topics include:
• General Requirements of ISO 9001
• Management Responsibility
• Resource Management
• Product Realization (summary)
• Measurement, Analysis and Improvement

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently get a comprehensive overview of ISO 9001:2008
• Want to improve your CV and career opportunities with qualifications in ISO 9001
• Want to upgrade your expertise from auditing ISO 9001:2000 to ISO 9001:2008
• Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $159.95 0.4 CEUs
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

ISO 9001:2008 Training – CALISO Online Course

8 Hours
I.D.# ISO9001TRAINING

ISO 9001 is a quality management standard developed by the International Organization for Standardization (ISO). Your company and all who partake in the daily activities of running the business will benefit from taking ISO 9001 training. This eight-hour ISO 9001 (.8 CEU) overview is particularly adapted for training all levels of an organization on the requirements of this standard.

Major topics include:
• General Requirements of ISO 9001
• ISO 9001 Vocabulary
• Management Responsibility
• Resource Management
• Product Realization
• Measurement, Analysis and Improvement

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently get a comprehensive training of ISO 9001:2008
• Want to improve your CV and career opportunities with qualifications in quality assurance
• Want to upgrade your expertise from ISO 9001:2000 to ISO 9001:2008

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $229.95 0.8 CEUs

ISO 9001:2008 Auditor Training – CALISO Online Course

8 Hours
I.D.# ISO9001AUDITOR

ISO 9001 is a quality management standard developed by the International Organization for Standardization (ISO). Your company and all who partake in the daily activities of running the business will benefit from taking ISO 9001 training. The eight-hour (.8 CEU) ISO 9001 Auditor course provides training on the standard itself and on how to lead or conduct internal audits and supplier audits using ISO 19011, the guideline standard on how to audit management systems.

Major topics include:
• General Requirements of ISO 19011
• Auditing techniques
• QMS Auditing Case Studies

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently learn how to lead an ISO 9001:2008 audit
• Want to quickly and efficiently be trained on ISO 9001 (the standard), and ISO 9000 (the vocabulary for the standard)
• Want to be a lead auditor to conduct internal audits and supplier audits for your company
• Want to improve your CV and career opportunities with qualifications in quality assurance and leading 1st part audits
• Want to upgrade your expertise from auditing ISO 9001:2000 to ISO 9001:2008
• Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $229.95 0.8 CEUs
ISO 9001:2008 Lead Auditor – CALISO Online Course

22 Hours
I.D.# ISO9001LEADAUDITOR

As described in the previous ISO 9001 Overview description, ISO 9001 is a quality management standard developed by the International Organization for Standardization (ISO). Your company and all who partake in planning, leading and conducting the audit activities of running the business will benefit from taking ISO 14001 Auditor training. The 22-hour (2.2 CEU) ISO 9001 Auditor course provides training on the standard itself and on how to lead or conduct internal audits and supplier audits using ISO 19011, the guideline standard on how to audit management systems.

Major topics include:
• General Requirements of ISO 9001
• Management Responsibility
• Resource Management
• Product Realization
• Measurement, Analysis and Improvement
• General Requirements of ISO 19011
• Auditing techniques
• QMS Auditing Case Studies

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently learn how to conduct an ISO 9001:2008 audit
• Want to quickly and efficiently be trained on ISO 9001 (the standard), and ISO 9000 (the vocabulary for the standard)
• Want to conduct internal audits and supplier audits for your company
• Want to improve your CV and career opportunities with qualifications in quality assurance and leading 1st part audits
• Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $355.95 2.2 CEUs

ISO 9001 Business Strategy – CALISO Online Course

I.D.#BSI

This is the ideal course for the CEO, Executive, other senior management team member, or corporate development department (strategy) staff who must design the vision for the company and chart the course and strategy for the management team to follow. This course was designed by expert partner-level management consultants with an average 15-years of experience with the top tier global strategic management consulting firms as consultants to Fortune 500 companies and financial institutions.

Major topics include:
• Vision, what does it do and how important is it?
• Selecting market segments where the company will compete
• Understanding market segments and capturing with tactical strategy and brand
• Figuring out the capabilities the company needs to have to win
• Enabling the needed set of capabilities at your company
• Performance metrics and aligning the firm to successfully execute the strategy

This SAE/CALISO course is for you if you:
• Are an employee or manager and want to quickly and efficiently become familiar with business strategy for implementation
• Want to understand Business Strategy in order to knowledgeably assess and contract Business Strategy services from a management consulting firm
• Want to improve your CV and career opportunities with Business Strategy knowledge and qualifications
• Are interested in learning world-class best practice methodology which will help increase your value to your company and help you think strategically
• Need to develop a competitive strategy for your company
• If the vision and strategy for your company is unclear or possibly in need of further enhancement
• Are uncertain that you have the correct organization design, processes, technology, and performance metrics needed to successfully execute the company’s business strategy
• Are restructuring or implementing quality programs but, so far, have not seen desired results
• Noticed that legacy processes, policies, and organization structures at your company don’t change although they seem inadequate, out of date, or inconsistent with the business strategy

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going
quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $219.95 1.2 CEUs

ISO 14001:2004 Training – CALISO Online Course

8 Hours
I.D.#ISO14001

ISO 14001 is an environmental management standard (EMS) developed by the International Organization for Standardization (ISO). The ISO 14001 standard is generic and can be used for any organization, whether it provides physical products or services. The requirements must be carefully interpreted to make sense within a particular organization. Developing automotive products and the environmental impact of this activity is not like producing food products or offering consulting services; yet the ISO 14001 standard, because it is business and management oriented can be applied to any activity. It is the most widely used EMS standard in the world.

Your company and all who partake in the daily activities of running the business will benefit from taking ISO 14001 training. This eight-hour ISO 14001 (.8 CEU) overview is particularly adapted for all members of the organization.

Major topics include:
- General Requirements of ISO 14001
- ISO 14001 Vocabulary
- Environmental Policy
- Planning
- Implementation and Operation
- Checking
- Management Review

This SAE/CALISO course is for you if you:
- Want to quickly and efficiently get a comprehensive training of ISO 14001:2004
- Want to improve your CV and career opportunities with qualifications in EMS
- Do NOT have time to allocate two full days to take an environmental management class
- Want to train more of your staff on auditing economically and without having to immobilize them in a class for a full day

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $219.95 0.8 CEUs

ISO 14001:2004 Auditor Training – CALISO Online Course

8 Hours
I.D.#ISO14001AUDITOR

ISO 14001 is an environmental management standard (EMS) developed by the International Organization for Standardization (ISO). The ISO 14001 standard is generic and can be used for any organization, whether it provides physical products or services. The requirements must be carefully interpreted to make sense within a particular organization. Developing automotive products and the environmental impact of this activity is not like producing food products or offering consulting services; yet the ISO 14001 standard, because it is business and management oriented can be applied to any activity. It is the most widely used EMS standard in the world. Your company and all who partake in the daily activities of running the business will benefit from taking ISO 14001 training. This eight-hour (.8 CEU) ISO 14001 Auditor course provides training on the standards and how to conduct internal audits and supplier audits using ISO 19011, the guideline standard on how to audit management systems.

Major topics include:
- General Requirements of ISO 19011
- Auditing Techniques
- EMS Auditing Case Studies

This SAE/CALISO course is for you if you:
- Want to quickly and efficiently learn how to lead an ISO 14001:2004 audit
- Want to quickly and efficiently be trained on ISO 14001 (the standard) and ISO 14000 (the vocabulary for the standard)
- Want to be a lead auditor to conduct internal audits and supplier audits for your company
- Want to improve your CV and career opportunities with qualifications in EMS and leading first part and second party audits
- Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002
- Do NOT have time to allocate two full days to take an ISO 14001 auditor class
- Want to train more of your staff on auditing economically and without having to immobilize them in a class for a full day
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $229.95 0.8 CEUs

ISO 14001:2004 Lead Auditor – CALISO Online Course

22 Hours
I.D.#ISO14001LEADAUDITOR

As described in the previous ISO 14001 course description, ISO 14001 is an environmental management standard (EMS) developed by the International Organization for Standardization (ISO). Your company and all who partake in planning, leading and conducting the EMS audit activities of your business and managing its environmental program will benefit from taking ISO 14001 training. The 22-hour (2.2 CEU) ISO 14001 Lead Auditor course is the most comprehensive training on the subject. It provides training on the standard itself but also on how to lead or conduct internal audits and supplier audits using ISO 19011, the guideline standard on how to audit management systems.

Major topics include:
• General Requirements of ISO 14001
• ISO 14001 Vocabulary
• Environmental Policy
• Planning
• Implementation and Operation
• Checking
• Management Review
• General Requirements of ISO 19011
• Auditing Techniques
• EMS Auditing Case Studies

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently learn how to lead an ISO 14001:2004 audit
• Want to quickly and efficiently be trained on ISO 14001 (the standard), and ISO 14000 (the vocabulary for the standard)
• Want to be a lead auditor to conduct internal audits and supplier audits for your company
• Want to improve your CV and career opportunities with qualifications in EMS and leading first part and second party audits
• Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002

Fee: $319.95 2.2 CEUs

ISO/TS 16949:2009 Training – CALISO Online Course

8 Hours
I.D.# ISO16949

The ISO/TS16949 is an ISO technical specification for the automotive industry aiming to the development of a quality management system that provides for continual improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain. The requirements must be carefully interpreted to make sense within a particular organization.

Your company and all who partake in the daily activities of running the business will benefit from taking ISO/TS 16949 training. This eight-hour ISO/TS 16949 (.8 CEU) overview is particularly adapted for training all levels of an organization on the requirements of this standard.

Major topics include:
• General Requirements of ISO 16949
• ISO 16949 Vocabulary
• Management Responsibility
• Resource Management
• Product Realization
• Measurement, Analysis and Improvement

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently get a comprehensive training of ISO 16949:2009
• Want to improve your CV and career opportunities with qualifications in quality assurance
• Want to upgrade your expertise from QS 9000 to ISO 16949:2009

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $229.95 0.8 CEUs
ISO/TS 16949:2009 Auditor Training – CALISO Online Course

8 Hours
I.D.# ISO16949AUDITOR

The ISO/TS16949 is an ISO technical specification for the automotive industry aiming to the development of a quality management system that provides for continual improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain. The requirements must be carefully interpreted to make sense within a particular organization. Your company and all who partake in the QMS and supplier audit activities will benefit from taking ISO/TS 16949 training. The eight-hour (.8 CEU) ISO/TS 16949 Auditor course is the most comprehensive training on the subject. It provides training on the standard itself but also on how to lead or conduct internal audits and supplier audits using ISO 19011, the guideline standard on how to audit management systems.

Major topics include:
- General Requirements of ISO 19011
- Auditing techniques
- QMS Automotive Auditing Case Studies

This SAE/CALISO course is for you if you:
- Want to quickly and efficiently learn how to lead an ISO/TS 16949:2009 audit
- Want to quickly and efficiently be trained on ISO/TS 16949 (the standard), and ISO 9000 (the vocabulary for the standard)
- Want to be a lead auditor to conduct internal audits and supplier audits for your company
- Want to improve your CV and career opportunities with qualifications in quality assurance and leading 1st part audits
- Want to upgrade your expertise from auditing QS 9000 to ISO/TS 16949:2009
- Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $239.95 0.8 CEU

ISO/TS 16949:2009 Lead Auditor Training – CALISO Online Course

22 Hours
I.D.# TS16949LEADAUDITOR

The ISO/TS16949 is an ISO technical specification which forms the requirements or application of ISO 9001 for automotive production and relevant service part organizations. It is essentially ISO 9001 with additional automotive specific requirements and is require by most major automotive manufacturers. Once your company implements processes and procedures that comply with the requirements listed in ISO/TS 16949, you can be audited by a third party organization called a Registrar, which will certify your organization to this standard.

This lead auditor course provides management representatives, QA managers or supervisors and others not only the information needed to conduct an audit for ISO/TS 16949, but also to organize, implement and lead it. All audit teams need a leader, and the body of knowledge of this course covers all of the lead auditing aspects.

Major topics include:
- Statistical Process Control (SPC)
- APQP/CP: Advanced Product Quality Planning and Control Plans
- PPAP: Product Part Approval Process
- FMEA: Failure Mode and Effects Analysis
- MSA: Measurement Systems Analysis

This SAE/CALISO course is for you if you:
- Want to quickly and efficiently learn how to lead an ISO/TS 16949:2009 audit
- Want to quickly and efficiently be trained on the TS 16949 specification
- Want to be a lead auditor to conduct internal audits and supplier audits for your company
- Want to improve your CV and career opportunities with qualifications in quality assurance and leading 1st part audits
- Want to upgrade your expertise from auditing with ISO 19011:2002 to ISO 19011:2011

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $369.95 2.2 CEUs
ISO 19011:2011 Auditor Training – CALISCO Online Course

4 Hours
I.D.#ISO19

ISO 19011 is a guideline developed by the International Organization for Standardization (ISO). The ISO 19011 standard is generic and can be used for auditing any type of management standard: quality, environmental, health and safety and others. Your company and all who partake in the daily activities of running the business will benefit from taking ISO 19011 training for its auditing activities. The four-hour (.4 CEU) ISO 19011 course is the most comprehensive training on the subject. It provides training on the standard itself but also on how to lead or conduct internal audits and supplier audits using ISO 19011, the guideline standard on how to audit management systems.

Major topics include:
- General Requirements of ISO 19011
- Auditing techniques
- Auditing Case Studies

This SAE/CALISO course is for you if you:
- Want to quickly and efficiently learn how to audit management systems
- Want to be a lead auditor to conduct internal audits and supplier audits for your company
- Want to improve your CV and career opportunities with qualifications in quality assurance and leading 1st part audits
- Want to upgrade your expertise from auditing with ISO 10011-1 to ISO 19011:2002

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $169.95 .4 CEUs

Sarbanes-Oxley (SOX) Training – CALISCO Online Course

4 Hours
I.D.#SOX

This is the ideal course for employees or managers who want to get a comprehensive training on Sarbanes-Oxley (SOX) compliance requirements, practical applications, and how ISO 9001 business management methodologies can be used, applied and combined to implement Sarbanes-Oxley. This is the ideal course for individuals who you want improve their résumé and career opportunities in SOX, by adding this course to the education or training section of your CV.

Major topics include:
- Sarbanes-Oxley, what is it?
- Sarbanes-Oxley (SOX) Certification Requirements
- Sarbanes-Oxley Section 302 - a big concern; Section 906 - the biggest concern
- What’s a CEO to do? How to most easily implement SOX without the CEO having to do everything?
- Minimal levels of SOX compliance, Risk Analysis
- How to avoid defrauding of the auditors by the business
- Whistle blower program
- What to do if something is already wrong (non-compliance)?
- Top steps to Sarbanes-Oxley compliance

This SAE/CALISO course is for you if you:
- Want to quickly and efficiently become familiar with Sarbanes-Oxley to understand, implement Sarbanes-Oxley compliance as an employee or a manager
- Want to understand Sarbanes-Oxley compliance in order to knowledgably assess and contract Sarbanes-Oxley services
- Want to improve your CV and career opportunities with Sarbanes-Oxley knowledge and qualifications
- Want to protect your company from financial fraud and related legal, criminal and financial liability

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $269.95 .4 CEUs
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

Six Sigma Overview – CALISO Online Course

8 Hours  I.D.#SIGMA
Six-Sigma is a systematic way to improve a product, process and/or service. This is the ideal course for employees or managers who want to get a basic training on Six-Sigma concepts, methodology and techniques.

Six-Sigma methodology can be used for any size organization, whether it provides physical products (i.e. hardware or software) or services. Developing and maintaining profitable products and services require continuous improvement in numerous key areas such as quality, performance and efficiency. Six-Sigma techniques can help any company achieve these goals.

This is the ideal course for individuals who you want improve their résumé and career opportunities in Six-Sigma, by adding this industry-wide recognized course to the education or training section of your CV.

The course covers Six-Sigma process improvement techniques; it is a stepping stone for Six Sigma Green and Black-belt certifications.

Major topics include:
• Six-Sigma, what is it?
• Six-Sigma, why use it?
• International quality standards and Six-Sigma
• Six-Sigma Core Concepts, How to use Six-Sigma
• Six-Sigma application example and Case Study “JFS”
• Another Case Study “BBB”
• Top steps to Six-Sigma
• Sigma Table, Spread Sheet Tips

This SAE/CALISO course is for you if you:
• Want to quickly and efficiently become familiar with Six-Sigma to understand and launch Six-Sigma projects as an employee or a manager
• Want to improve your CV and career opportunities with Six-Sigma knowledge and qualifications
• Want to systematically improve the profitability and customer satisfaction of your product or service by improving numerous key areas such as quality, performance and efficiency

This is an internet-delivered course featuring graphical presentation screens with text-based instruction, videos, and on-going quizzes to reinforce learning and retention and gauge your understanding of a topic before you move forward. An online training certificate will be issued upon successful completion of the course and obtaining 70% or above on the final average of the ongoing quizzes.

Fee: $159.95  .8 CEUs

CATALOG KEY
You will see the following icons alongside the course descriptions. These icons indicate:
• delivery formats available for the course
• the course is part of an SAE certificate
• that it is an ACTAR approved course

Many courses are available in multiple formats. See page X to get more information on the learning formats offered by SAE. In addition to finding courses that fit your technology need, look for courses with icons that fit the way you want to learn.

Classroom – indicates the course is an instructor-led seminar or workshop offered in a classroom setting

Live, online – indicates the course is an instructor-led web seminar offered live and online via telephone and internet connection

Online, on demand – indicates the course is available online anytime the participant would like to access the course through the internet

Certificate – indicates the course is part of an SAE International curriculum-based, multi-course certificate. See a list of the multi-course certificates on page XII

ACTAR logo – indicates the course is an ACTAR approved course. For more information on ACTAR and ACTAR accredited courses, see page IX
MANAGING PRODUCT DEVELOPMENT/QUALITY ASSURANCE

RELATED TRAINING SOLUTIONS
Some of our courses apply to more than one technology category. Consider these related courses described in other sections of this resource guide.

**Accelerated Concept to Product (ACP) Process for Design Optimization**
Accelerated Concept to Product (ACP) Process is a performance-driven, holistic, product design development method intended to create a balance between structure and strength, synchronizing the individual facets of the product development process.

Read more about this course on page 155

**Accelerated Concept to Product (ACP) Process using a 3G Design Approach**
This three-session web seminar will offer information on how to design a concept model from a clean sheet using a holistic 3G design approach (ACP-3G), where material types and its properties (Grades and Gauges), Geometry (shape), and manufacturing process can work together for the optimum weight and performance.

Read more about this course on page 156

**Accelerated Test Methods for Ground and Aerospace Vehicle Development**
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).

Read more about this course on page 157

**Robust Design**
Robustness refers to creating designs that are insensitive to variability in the inputs. This course presents mathematical formulas based on derivatives to determine system variation based on input variation and knowledge of the engineering function. If the function is unknown, experimental techniques are presented to efficiently estimate a function.

Read more about this course on page 180
MANUFACTURING

Automotive Plastics: Principles of Materials & Process Selection

2 Days
I.D.# C0135

Plastic - any class of synthetically-produced organic compounds capable of being molded and hardened into a specific shape or form. This course is designed to offer a basic understanding of plastics and plastic processing. Using plastics can be simple, but there is much more behind producing high performance plastic parts. This seminar will walk you through the molding process, provide a comprehensive look at the variables in the manufacturing mix, and review characteristics of typical automotive plastics such as PP, PVC, ABS, and more. This seminar will also cover troubleshooting molding mistakes and alternative processes, and review the selection of an application’s appropriate plastic material. Material presented is both an excellent foundation for further development and an extensive update for those already working in the field.

Learning Objectives
At the completion of this seminar, attendees will be able to:

- Demonstrate an understanding of typical automotive plastics and primary and application-specific plastics processing methods
- Recognize key plastics terminology and parameters related to plastics
- Explain alternative molding processes
- Prevent or reduce molding mistakes
- Understand the molding cycle
- Troubleshoot the processing operation

Who Should Attend
This seminar is designed for those who are new to automotive plastics, as well as those who have some experience. The program will benefit product designers, process engineers, purchasing agents, project engineers, manufacturing engineers, material engineers, and sales and marketing professionals.

Topical Outline
DAY ONE
- Introduction to Injection Molding
  - Process description
  - Product description
  - Business overview
- The Injection Molding Machine
  - Clamp systems
  - Plastication unit
  - Screw
  - Controls
- The Molding Cycle
  - Pressure in process
  - Velocity generation, including mold filling, mold packing, cooling, ejection, material melting and material handling.
DAY TWO
- Typical Injection Molding Mistakes

MATERIALS AND MANUFACTURING

Includes manufacturing, parts and components, and assembly; as well as materials including plastics, alloys, and metals.
MATERIALS AND MANUFACTURING

- Melt temperature
- Material drying
- Contamination
- Over packing
- Incomplete fill
- Oversized machines
- Undersized machines
- Temperature control
- Mold(s)
- Function
  - Forming
  - Cooling
- Basic Design Requirements
  - Clamp slots
  - Ejection “hole”
  - Support
  - “Seal-off”

Learning Objectives
By attending this seminar, you will be able to:
- Describe the basic electrochemical concepts of various corrosion processes
- Articulate and utilize corrosion prevention strategies and estimate corrosion behavior of materials and components
- Describe the role of ion-diffusion, crystal structure, and grain size on corrosion of metals and alloys
- Design and engineer corrosion resistive components for different industries
- Define methods of corrosion protection and interpret corrosivity maps
- Perform standard corrosion tests, in-depth analyses of test results
- Define anodic/cathodic protections and coatings specifications for various components
- Formulate corrosion prevention coatings materials for metallic and non-metallic structures

Who Should Attend
This course is designed for engineers working in automotive, commercial vehicle, off-road, aerospace, marine, rail, energy sectors, electronics and related industries who are interested in corrosion and corrosion prevention. Engineers working for chemical companies on the production of corrosion resistive materials and chemicals and scientists working for government and national laboratories working in the area of conservation, national infrastructures, and advanced energy technologies, as well as academicians will benefit from this course.

Topical Outline
DAY ONE
- Fundamentals of Corrosion and Corrosion Prevention
  - Overview of corrosion problems and their economic impacts
  - Basic electrochemical principles of corrosion and corrosion prevention
  - Types of corrosion and role of electromotive force, ion diffusion, crystal structure, and grain size
  - Corrosion of composite materials and impact of combined cyclic loading and corrosion
  - Standard corrosion tests, and recent software and hardware for corrosion testing
- Mechanisms and Prevention of Corrosion
  - Automotive components
  - Aerospace components
  - Marine and underwater infrastructures
  - Electronics and energy related systems
- Corrosion Engineering and Coating Technologies
  - Design principles to minimize corrosion
  - Passive and active coating technologies

Corrosion Engineering and Prevention
2 Days
I.D.# C1217

The transportation industry, including motor vehicles, aircraft, rail, marine, commercial, off-road and defense vehicles, as well as infrastructures, energy sectors, raw materials, manufacturing, health and food industries all experience significant issues with corrosion resulting in billions of dollars of loss each year. Corrosion education and prevention is essential to improve and increase the service life of parts and components - possibly impacting the economy of various industries and nations.

The focus of this course is on the fundamentals of corrosion engineering and corrosion prevention of metallic and alloy structures as well as on non-metallic composites and hybrid materials. Recent challenges and opportunities in corrosion of advanced composites used in the automotive, aerospace, and marine industries as well as for underground structures for oil, gas, geothermal and tidal wave technologies will also be included. Different types of corrosion, methods of corrosion protection and prevention, optimum engineering design of corrosion resistance parts and components, standard corrosion tests, responsibilities of corrosion engineers, and a process for setting-up an advanced corrosion laboratory will be discussed. This course also covers most traditional and non-traditional tests for corrosion studies, including real-time characterization techniques and analysis of corrosion phenomenon and corrosion monitoring principles.

Instructor: Robert G. Speirs
Fee $1265 1.3 CEUs
MATERIALS AND MANUFACTURING

DAY TWO

- Surface Coating Technologies for Corrosion Prevention
  - In-situ surface coating and coating optimization
  - Anodic and cathodic protections and engineering principles
  - Application of metal oxides, carbides, nitrides and composite coating
- Supply and Manufacturing of Corrosion Prevention Materials
  - Inorganic base coating materials and their applications
  - Organic based coating materials and mode of operation
  - Composite coatings and their applications in auto and aerospace industries
- Corrosion and Corrosion Prevention of EVs and HEVs with Batteries, Supercapacitors and Fuel Cells
  - Corrosion prevention and role of high voltage, electromagnetic sources
  - Corrosion in fuel cells and component design to optimize corrosion
  - Corrosion in renewable alternative energy sectors

Who Should Attend
This course is designed for Automotive Body Engineers, Die Engineers, Designers, Manufacturing Plant Personnel, New Hires in the Steel Industry, Supervisors, Planners, and others who would like to decrease vehicle weight through the use of AHSS.

Topical Outline
DAY 1

- Background/Overview of AHSS
  - Definition
  - Types of AHSS
  - Typical chemistry and properties
  - Comparison to High Strength Low Alloy (HSLA) Steels
  - Thermo-mechanical processing
  - Coatings
  - Material call-outs
  - Availability of grades/gauges/coatings/coil widths
  - Coil tolerances
- Product Applications and Design Considerations
  - Typical automotive body and chassis applications
  - Crash performance advantages
  - Design for manufacturability
Day Two

- Stamping
  - Formability
  - Springback
  - Effect of material variation
  - Press tonnage
  - Edge fracture
  - Lubrication
- Stamping Tooling
  - Die design standards
  - Die materials and surface treatments
  - Die maintenance
- Die Try-Out
  - Proof tooling
  - Trouble shooting
  - Lessons learned
- Roll Forming
- Assembly
  - Joining/welding
  - Other assembly considerations
- Case Studies

Instructor: Gholam-Abbas Nazri
Fee $1235 1.3 CEUs

Introduction to Advanced High Strength Steel Applications and Manufacturing

2 Days
I.D.# C1416

Advanced High Strength Steels (AHSS) are now commonly used in automotive body structural applications. The high strength of this grade classification is attractive to help reduce mass in the automotive body through reduction in thickness. Strength also supports improvements in safety requirements so that mass increases are minimized. In some specific grades of AHSS, energy absorption is possible in addition to the high strength. This course will review the definition and properties of AHSS and cover several common applications in automotive body structures. In addition, key manufacturing areas including stamping and welding will be addressed to demonstrate the increased challenges as compared to lower strength steel grades. Troubleshooting of typical engineering and production problems will round out the seminar leaving attendees with tools to help design more robust engineering solutions to AHSS applications.

Learning Objectives
By attending this seminar, you will be able to:
- Define AHSS grades and describe general properties of AHSS
- Identify potential applications for AHSS
- Describe key manufacturing processing issues
- Assimilate tools for trouble shooting part issues

Instructor: Jody N. Hall
Fee $1275 1.3 CEUs
Introduction to Welded Joints

2 Days
I.D.# C1343

Welding is one of the most important and widely used of the joining processes, providing distinct advantages in mechanical performance, ease of implementation, cost and adaptability. This seminar will provide engineers with applicable knowledge related to metallurgy, stress analysis and welding processes which will enable them to consider design, analysis, implementation and inspection of welds for their respective products. The course will cover the fusion operation of welding involving casting, heat treatment and metallurgical processes as well as additional complexities such as residual stress and distortion, introduction of various defects and sensitivity of materials, considerations related to static strength, fatigue behavior and resistance to corrosion. The primary focus of the seminar will be arc welds, but there will also be discussion of other welding processes important to the mobility industry including resistance spot, laser and friction stir. The seminar will make extensive use of case studies and will discuss appropriate codes and standards.

Learning Objectives
By attending this seminar, you will be able to:
- Identify the various welding processes and describe potential applications
- List the key factors that impact the performance of welds
- Explain why the various factors impact performance of welds
- Describe for a given weld (process, geometry, material) which of the key factors are critical
- Define the procedure and simplifying assumptions used to analyze a weld for static strength
- List the various non-destructive evaluation methods and select the appropriate method for a given application
- Evaluate a weld and identify the factors impacting fatigue performance
- Describe the various methods used to analyze a weld for fatigue performance

Who Should Attend
This seminar is intended for any engineer dealing with one or more of the many aspects of welds: design, analysis, specification, manufacturing, quality assurance, training, repair and maintenance.

Topical Outline
DAY ONE
- Arc Welding Processes
  - TIG, GMAW, SAW, etc.
  - Strengths, weaknesses, typical applications
- Overview of Key Considerations
  - Description of the casting process
  - Weld as a thermal gradient
  - Weld can change microstructure
  - Weld can introduce defects
- Engineering Properties of Welds
  - Strength and ductility
  - Hardness
  - Toughness
- Welded Connection
  - Types of joints
  - Considerations: weldability, strength and inspection
- Material Considerations
  - Mild steel
  - Medium and high strength steel
  - Stainless steel
  - Aluminum
- Residual Stress and Distortion
  - Sources of residual stress
  - How to minimize distortion
- Source of Defects and Cracking
  - Porosity and inclusions
  - Undercut, lack of fusion and lack of penetration
  - Hot and cold cracking
  - Hydrogen damage
  - Methods to limit defects

DAY TWO
- Failure Modes, Static, Fatigue and Fracture Considerations
  - Design for Static Strength
  - Basic principles
  - Codes and Standards
  - Loading of the joint
  - Determining weld size
- Fracture Mechanics
  - Causes of brittle behavior
  - Behavior of sharp notches
  - Overview of Fracture Mechanics
  - Analysis of welds
- Non-Destructive Inspection
  - Methods, application and limitations
- Fatigue Considerations
  - Overview of fatigue mechanism
  - Improving fatigue behavior of welds
  - Analysis methods: global and local approaches
- Other Welding Processes
  - Resistance spot, laser and friction stir
  - Description of method, limitations and applications

Instructor: Jess J. Comer
Fee $1265 1.3 CEUs
Metal Forming

2 Days
I.D.# 85012

This seminar covers metal forming and related manufacturing processes, emphasizing practical applications. From forged or P/M connecting rods to tailor-welded blank forming, metal parts are integral to the automotive industry. As a high value adding category of manufacturing, metal forming is increasingly important to the core competency of automobile manufacturers and suppliers. A thorough survey of metal forming processes and metal forming mechanics will be performed, including bulk deformation, sheet-metal, and powder metallurgy operations. Design considerations are fully integrated into the course and are presented with every process. A large number of real-world case studies are presented to the attendees to emphasize course content. Attendees will receive a copy of the book Manufacturing Engineering Technology, co-written by instructor Steven R. Schmid.

Learning Objectives
By attending this seminar, you will be able to:
• Identify the unique characteristics of metals that lead to plastic deformation as a processing strategy
• Explain the processes involved in metal forming mechanics, materials, and tribology
• Analyze the interrelationships between various factors that influence the quality of manufactured products
• Describe sheet metal characteristics and forming
• Describe the wide variety of processes used to shape and deform metals, including forging, rolling and extrusion; sheet metal forming, shearing and stamping; powder metallurgy processes and assorted other processes

Who Should Attend
This course is designed for engineers who are involved in metal forming and other related manufacturing processes.

Topical Outline
DAY ONE
• Overview of Solid Mechanics and Materials Science Topics of Importance to Metal Forming
• Tribology of Metal Forming: Friction, Lubrication and Wear
• Bulk Deformation Processes
  • Forging: open die and closed-die (impression) forging; machinery description and capabilities; forging process layout and die design; heading, coining, piercing and upsetting operations; swaging
  • Rolling: flat rolling process, including Orowan model; control of product quality including surface finish and gage control; rolling equipment and capabilities; shape rolling; ring rolling
• Extrusion and drawing: direct, indirect and hydrostatic extrusion; cold and hot extrusion; die design; defects in extrusion; drawing equipment and mechanics; limiting drawing ratio

DAY TWO
• Sheet Metal Forming Processes
  • Sheet metal shearing: mechanics of shearing, burr formation, blanking operations, fine blanking
  • Sheet metal bending: types of bending operations and equipment; springback calculation and control; tube bending
  • Sheet forming operations: deep drawing and ironing; stretch forming; bulging, rubber forming and hydroforming; roll forming of sheet; spinning; incremental forming; explosive, peen and other specialty forming processes; stamping operations and die design
  • Sheet metal formability: limiting drawing ratio for deep drawing; sheet metal formability; forming-limit diagrams
• Powder Metallurgy Processes
  • Compaction through pressing, cold and hot isostatic pressing and metal injection molding; sintering mechanics and processes; coining and finishing

Instructor: Steven R. Schmid
Fee $1365 1.3 CEUs

Sheet Metal Stamping: Robust Formability

2 Days
I.D.# C0713

Preventing future problems and troubleshooting existing problems in today's stamping plants requires greater stamping process knowledge. The link between inputs and outputs isn't as clear as many think, increasing the need for detailed understanding of the variables involved. This course discusses the key inputs and outputs associated with sheet metal stamping, including important elements for controlling the process and making it more robust. The course reviews sheet metal characteristics and their application, especially from a formability standpoint, using many automotive-related examples. Common issues such as springback, dent resistance, and process differences among mild steel, high strength steel, bake hardenable steel, and aluminum are discussed. Stamping die types and functions, in particular the types of dies used in draw forming, are explained. Mechanical presses and lubrication are briefly discussed as other variables in the process. Other processes, including tube and sheet hydroforming, and progressive dies are covered in less detail.
MATERIALS AND MANUFACTURING

Learning Objectives
By attending this seminar, you will be able to:
• Describe steps and elements of the stamping process
• Identify common grades of sheet metal and their applications
• Specify key mechanical properties and their relationship to product quality
• Identify important inputs and outputs of the stamping process
• Describe important aspects of process control
• Read and interpret sheet metal strain analysis and forming limit diagrams

Who Should Attend
Anyone who wants to know more about sheet metal stamping, from new hires in the industry, to product design engineers who design sheet metal parts, to manufacturing engineers, supervisors, and others working at a stamping plant, will benefit from this seminar. Those with plant floor experience who are lacking a solid understanding of the how’s and why’s will also benefit.

Topical Outline
DAY ONE
• The Stamping Process
  • Inputs vs. outputs
  • Steps: from coil to assembly
  • Process control and quality
• Stamping Dies
  • Draw forming process -- Die types and functions; Die materials; Die design and construction
  • Other types of forming (tube and sheet hydroforming, progressive dies, etc)
• Stamping Presses
DAY TWO
• Sheet Steel
  • Mechanical properties
  • Grade designations
• Sheet Aluminum
  • Mechanical properties
  • Grade designations
• Sheet Metal Formability
  • Forming limit diagram
  • Circle grid and thinning strain analyses
  • Applications

Instructor: Edmund Herman and Jody N. Hall
Fee $1275 1.3 CEUs

Threaded Fasteners and the Bolted Joint

2 Days
I.D.# 95030

This seminar introduces participants to all aspects of threaded fasteners including nomenclature, geometric considerations, metallurgy, material properties, applied stresses, and considerations for fatigue, corrosion, brittle fracture and temperature. Methods are developed for the analysis and design of bolted joints under axial and shear loads. Other topics include assembly practice and methods to control preload.

Learning Objectives
By attending this seminar, you will be able to:
• List the characteristics of threaded fasteners - their geometry, materials and standards
• Describe how fasteners fail and failure prevention methods
• Identify the methods and key variables involved in the analysis and design of a bolted joint
• Define assembly practice and methods to control preload

Who Should Attend
This seminar is intended for design, analysis, test or production engineers who deal with threaded fasteners. Although the seminar content was developed for engineers, the material would also be useful to others who deal with threaded fasteners including designers, technicians, production and maintenance supervisors and managers.

Topical Outline
PART 1 - Geometry, Materials and Standards
• Introduction
  • Bolts, rivets and pins
  • Are you breaking fasteners?
  • Do you have a happy joint?
• Geometry
  • Threaded fastener -- Head, threads
  • Nuts
  • Washers and other elements
• Materials and Manufacturing
  • Material Properties & Fastener Testing
  • Fastener Grades and Classes
  • Nut Grades and Classes
  • Selection Nut & Fastener
  • Forming Method
  • Coatings and Finishes
  • Other Fastener Material
PART 2 - Behavior of the Bolted Joint
• Joint Diagram
  • Introduction
  • Behavior - Axial Loading
  • Preload and Clamp Load
• Joint Constant
• Separation
• Joint Diagram
  • Hard vs. Soft Joint
  • Application of Joint Diagram
  • Application of external load
  • Determination of separation load
  • Axial and shear loading
  • Non-linear member behavior
  • Non-linear fastener behavior
  • Loss of preload due to embedment
  • Joint Analysis
• Joint Preload
  • Overall Strategy
  • Considerations in Selection of Preload
  • Selection of Preload

PART 3 - Loads and Environment
• Fatigue and Fracture
  • Ductile vs. Brittle Fracture
  • Fatigue
  • Methods to Improve Fatigue Performance
  • Relative Importance of Sources
  • Hydrogen Embrittlement
  • Stress Corrosion Cracking
• Loading of the Fastener
  • Applications of Fasteners
  • Loading of the Joint - Axial, shear, torsion, thermal
  • Loading of the Member -- Contact stress; creep and stress relaxation; thread loading
• Corrosion
  • General Corrosion
  • Performance of Coatings
  • Galvanic Corrosion
  • Crevice Corrosion

PART 4 - Preload and Assembly
• Loss of Preload
  • Basic Behavior
  • Sources of Loss of Preload -- Self loosening; preload relaxation; differential thermal contraction
  • Methods to Prevent Loss of Preload -- Self loosening; preload relaxation
• Methods to Control Preload
  • Tools
  • Potential Assembly Problems
  • Control of Preload
  • Torque Control

• Stretch Control; Tension Control
• Turn Control
• Torque-Turn Control
• Yield Control

Instructor: Jess J. Comer
Fee $1415  1.3 CEUs

Automotive Glazing Materials
2 Days
I.D.# 99002

Automotive glazing materials affect the total automotive system. This seminar presents an overview of different automotive glazing materials and covers a wide range of topics including history, manufacturing, testing, and safety. The chemical, physical, and design issues related to various glazing materials (annealed, laminated, tempered, glass-plastic, and plastic) are covered in depth.

Attendees will receive a copy of SAE Standard J673 Automotive Safety Glasses as part of the course material.

Learning Objectives
By attending this seminar, you will be able to:
• Describe the evolution of glazing materials in the automotive industry
• Contrast the safety characteristics of various products and how they perform in normal usage and in accidents
• Explain how safety glazing materials are regulated and certified
• Describe the production processes used to make laminated and tempered glass
• Avoid problems by optimizing the performance and failure modes of the different glazing materials
• Describe the physical and chemical characteristics of the different products
• Summarize glass manufacturing procedures, processing, handling, installation, and usage to disposal
• List the important characteristics of tempered, laminated glass, and plastic glazing
• Articulate how glazing materials affect the total automotive system
MATERIALS AND MANUFACTURING

- Explain when and why specialty products are used and how they are manufactured
- Discuss future trends and technical innovations

Who Should Attend
This seminar is designed for transportation, safety and glass engineers and others who work on or with automotive or similar glazing products. Individuals who need either general information on glazing or details on specific glazing topics, such as legal, safety, marketing, performance and manufacturing issues will benefit from this seminar.

Topical Outline
- Introduction
  - Laminated glass; Tempered glass
  - History of automotive glass
  - Automotive safety glass regulations
- Glass
  - Chemistry
  - Surface properties
  - Ceramic paint and silver
  - Stress; Breakage
  - Physical properties
  - Manufacturing process
- Glass Processing
  - Inspection
  - Cutting; Break-out
  - Grinding and seaming
  - Washing
  - Printing
  - Bending
- Laminated Glass - The Windshield
  - History
  - Production process: glass bending; windshield interlayer; and windshield production
  - Safety
  - Testing and weathering
  - Windshield issues
  - Encapsulation and adhesion
  - Packaging and shipping
  - Installation
  - Replacement, repair, disposal and warranties
  - Design considerations
  - Specialty windshields: heated, HUD, and solar control
- Tempered Glass
  - Production process
  - Testing and evaluation
  - Safety: legal requirements; testing; and performance
  - Design considerations
  - Encapsulation and adhesion
  - Installation: movable and stationary
- Warranty
- Tempered vs. Laminated Glass
- History
- Legal Requirements
- Safety: testing and performance
- Design considerations
- Ejection
- Security
- Specialty Glazing Materials
  - Plastic; Glass-Plastic
  - Roof glass
  - Truck and van glazing materials
  - Bullet resistant glass
  - Photochromic; Electrochromic
  - Hydrophobic
  - Coatings
  - Off-highway glazing materials
- The Replacement Market
  - Finding the glass
  - Tinting materials: transmittance; reflectance; and performance
  - Windshield installation: sealant and procedure
  - Legal requirements
  - Windshield repair
  - Anti-theft

Instructor: Siegfried H. Herliczek
Fee $1265 1.3 CEUs

Fundamentals of Metal Fatigue Analysis
3 Days
I.D.# 94024

There is a potential for metal fatigue in any situation where a component is subjected to cyclic loads. Fatigue failures of various types are a key concern in increasing the reliability of products. Problems involving fatigue have become more severe with the demand for lighter weight structures and components. The effective use of fatigue analysis and predictive tools is critical for reducing the development time of new products. Two methods of metal fatigue analysis will be covered. The first is the stress-life approach. This method is used for high cycle or very long life fatigue problems where loads have fairly constant amplitude. Applications of this method include engine components, gears and shafts. The second method is the strain life approach, which is used for cases involving low cycle fatigue where loads may have a variable amplitude. Applications of this method include suspension and chassis components. The strain-life approach is also more useful when dealing with non-ferrous alloys. Other key
topics to be addressed include residual stress, shot peening, cycle counting methods and environmental effects. Extensive use of example problems and case studies will be used. The overall objective of the course is for participants to gain an understanding of the phenomenon of metal fatigue and most importantly learn what methods are available to predict and prevent failures.

**Learning Objectives**

By attending this seminar, you will be able to:

- Differentiate various fatigue analysis methods
- Identify factors which can adversely affect fatigue behavior
- Apply processes which can be used to improve fatigue behavior
- Describe methods for analyzing fatigue at notches
- Indicate the steps necessary to determine the life of components subjected to variable amplitude loading

**Who Should Attend**

This course is intended for design, analysis or test engineers who deal with fatigue problems.

**Prerequisites**

The participant needs little if any exposure to metal fatigue analysis methods. The participant should have had the standard undergraduate courses in stress analysis and material science.

**Topical Outline**

**DAY ONE**

- Overview of Metal Fatigue and Analysis Methods
- The Stress-Life Approach
  - The S-N diagram and endurance limit
- Modifying Factors
  - Size and shape
  - Surface finish and treatments
  - Types of loading
- Mean Stress Effects
- Residual Stress and Shot Peening
- Example Problems

**DAY TWO**

- The Strain-Life Method
  - Limitations on the stress-life method
  - Cyclic stress-strain behavior
  - The strain-life diagram and parameters
- Mean Stress Effects
- Variable Amplitude Loading
- Damage Summing Methods
  - The Miner-Palmgren Rule
  - Non-linear methods
- Example Problems

**DAY THREE**

- Cycle Counting Methods
- Analysis of Notches

- Stress-life method; Strain-life method
- Example Methods
- Environmental Effects

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**Laminated Glass: Design Considerations for Vehicle Door Systems Fast Track**

**40 Minutes**

I.D.# PD130810ON

The evolution in glass technology creates both opportunities and challenges which must be understood by today’s automotive designers and engineers for successful implementation. Because laminated glass has different structural properties than tempered glass, this 40 minute online short course will provide an overview of best practices for integration of the product into vehicle door systems based upon extensive testing and field experience.

**Major topics include:**

- Overview of Laminated Glazing
- Laminated Glazing Selection Criteria
- Automotive Glass Strength Characterization
- Static Stresses and Door Design Considerations
- Dynamic Stresses from Door Slam
- Laminated Glass Performance and Analysis Techniques
- Summary of Laminated Glazing Benefits

**Is this Fast Track for you?**

This online short course was developed for engineers and those in the automobile supply chain involved in all disciplines related to the design or development of glass. It is designed to provide a technology overview that is relevant to those who simply want an introduction to laminated glass, while providing sufficient technical detail on best practices to benefit seasoned glazing engineers.

**What You Will Receive**

- Three months of online access to the 40 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

**Instructors:** Peter Dishart & DeWitt W. Lampman

**Fee $79**
MATERIALS AND MANUFACTURING

Material Selection and Testing for Plastics

2 Days  
I.D.# C0134

Today’s necessity for quickly delivering products to market limits product development time and leaves less room for error and ‘re-dos.’ With so many plastic materials available, it is crucial that those involved in product design understand resin properties and how they affect part design and manufacturability. To help you make the best plastic choices the first time, this seminar provides an overview of polymer chemistry, explains the methods for testing properties of plastics and presents a method of systematic selection that will optimize your plastics material selection process.

Learning Objectives

At the conclusion of this seminar, attendees will be able to:
• Understand the properties of plastic materials
• Know what types of instruments are used in testing
• Demonstrate methods used to test the properties of plastic materials
• Possess the technical background necessary to select the optimum resin for a given application
• Apply measurements to the standards and specifications so the material and design meet an application’s service requirements

Who Should Attend

This seminar will benefit product and part designers, engineers, engineering managers and those involved in the development of plastic parts. Specifically designed to enhance on-the-job effectiveness for professionals at all levels of plastics part development, this course will provide an invaluable foundation for selecting plastic materials and understanding their capabilities and limitations.

Topical Outline

DAY ONE
• Introduction to Plastic Materials  
  • Definitions  
  • Thermoset vs. thermoplastics  
  • Good (and bad) characteristics  
  • General properties  
  • Brief history  
  • Economic “position” (commodity vs engineering vs specialty)  
• Plastics-General Overview  
  • Materials form; Shipment sizes  
  • Pre-compounded vs blended  
  • Drying/storing  
  • Handling

• Grades and lots  
• Regrinding and reuse  
• Polymer Chemistry Introduction/Review  
  • Molecular weight  
  • Distribution, dispersity index  
  • Morphology  
  • Molecular configuration  
• Process Related Property Variations  
  • Drying; Shrinking  
  • Rheology  
  • Additives

DAY TWO
• Properties of Plastics  
  • DIN vs ASTM  
  • Data shifts; Tests and their procedures  
  • Chemical resistance; Optical properties  
  • Color analysis  
  • Weathering resistance Abrasion resistance  
  • Flammability  
  • Electrical character  
  • Chemical (analytical) testing  
• Processing Properties  
  • Melt index  
  • Capillary remoter  
  • Shrinkage  
  • Thermal diffusion character  
• Simple Plastics Materials Selection  
  • Product needs assessment  
  • Systematic selection  
• Typical Materials Selection Errors  
• Plastics Materials Review  
  • The “Big Eight”  
  • Commodity polymers  
  • Engineering polymers  
  • Rubbers and elastomers

Instructor: Robert G. Speirs
Fee $1275 1.3 CEUs

Product Design with Aluminum Alloys

2 Days  
I.D.# C1418

Aluminum has a variety of properties that make it attractive for engineering of components (density, strength-to-weight ratio, corrosion resistance). Aluminum also has the widest range of manufacturing processes available for any of the engineering metals. Automobile and ground vehicle companies have effectively used aluminum to reduce mass and product costs while increasing the overall value and efficiency of vehicles. One
way to achieve these goals is to replace traditional materials, primarily steel and cast iron, with aluminum. There are also limitations that must be considered when selecting aluminum over alternative materials. This seminar will introduce the attendee to aluminum: available alloys, thermal and mechanical processes, casting processes, physical and mechanical properties and potential failure considerations. The discussion will include extensive use of product case studies where aluminum was used with various degrees of success. Aluminum will be compared with appropriate alternative materials. The seminar will stress that the effective use of aluminum requires consideration of key factors: in-service requirements, alloy type, temper and manufacturing process. The effective integration of these factors can reduce manufacturing costs and time. The first part of the seminar will focus on wrought alloys: forgings, extrusions, sheet and plate. The second part of the seminar will focus on cast alloys: casting processes, casting defects. The seminar will also cover other relevant manufacturing considerations: product forms, welding, surface treatments.

### Learning Objectives

By attending this seminar, you will be able to:

- Identify and describe an aluminum based on alloy number and temper designation
- List and describe the various strengthening mechanisms available for wrought and cast aluminum alloys
- Define the physical, mechanical, corrosion and thermal properties of aluminum alloys
- Compare the properties of aluminum to competing materials
- List and describe the various casting processes available for aluminum alloys
- Assess what defects must be considered for each casting process
- Select an aluminum alloy, temper and manufacturing process for a given application

### Who Should Attend

This seminar is intended for any engineer who deals with the material selection, design, development, and processing of aluminum components. The content of the seminar was developed for the engineer with limited experience with aluminum. For the engineer with more experience using aluminum the seminar will provide an overview of current information and techniques.

### Topical Outline

**DAY 1**

- Introduction to Wrought Alloys, Tempers and Applications
  - Alloying systems
  - Temper designations
  - Applications: past, current and potential
- Physical Properties - Mechanical
  - Static and dynamic deformation; buckling
- Physical Properties - Thermal
  - Deformation and stress; electrical conductivity
- Static Strength
  - Basic mechanical behavior; High temperature behavior
  - Failure theories
  - Creep and stress relaxation
- Strengthening Mechanisms
  - Overview of strengthening mechanisms
  - Grain size
  - Cold working
  - Alloying elements
  - Precipitation hardening
- Toughness
  - Absorption of elastic energy and plastic energy
  - Fracture mechanics - Fatigue Behavior
  - Crack growth behavior
  - Stress-life method; Strain-life method
  - Fracture mechanics method

**DAY 2**

- Corrosion and Surface Treatments
  - Behavior of aluminum
  - Key forms of corrosion
  - Anodizing
- Hot and Cold Working and Product Forms
  - Extrusion; forging; machining
- Wrought Alloys - Selecting Alloy, Temper and Process
  - Case studies
- Introduction to Cast Alloys, Tempers and Applications
  - Alloying systems
  - Impurities
  - Temper designations
  - Applications: past, current and potential
- Cast Defects
  - Grain structure
  - Porosity; Inclusions
  - Residual stress
- Casting Processes
  - Basics of casting
  - Processes - description, advantages and disadvantages
  - Semi-solid processes
- Cast Components - Mechanical and Fatigue Considerations
  - Strength of cast alloys
  - High temperature behavior
  - Defects and fatigue behavior
- Cast Alloys - Selecting Alloy, Temper and Process
  - Case studies
- Welding
  - Review of welding processes and potential problems
  - Behavior of aluminum

**Instructor:** Jess J. Comer

**Fee:** $1275 1.3 CEUs
Surface Texture: Specification and Control

1 Day  
I.D.# C1110

Surface texture is one of the most important topics in today’s world of design, development and performance. As tolerances are shrinking and performance demands are increasing, surface texture is rapidly becoming one of the most important aspects of engine and vehicle performance. Every moving component on a vehicle or engine is influenced by surface texture in one or more of the following ways: vibration, sealing, adhesion, traction, emissions, safety, durability, wear/failure analysis. Many of the industry’s top warranty issues (leaks, noise, vibration, etc.) are a direct result of surface texture implications. Rather than focus on the theories of surface texture, this course will focus on the applications of these concepts to automotive applications - thereby giving the attendees tools that they can immediately use as they solve automotive problems such as cylinder bores and emissions control, crankshafts, camshafts and early engine failures, brakes and NVH, wheel bearings and vibration, gaskets and sealing, bearings and durability, pistons and durability, and shaft straightness and vibration.

Learning Objectives
By attending this seminar, you will be able to:
• Communicate clear descriptions of surface texture in reports and product documentation
• Recognize roughness and waviness impacts on components
• Recognize measurement errors and avoid misinterpretations of results
• Specify surface texture according to ISO 1302
• Identify and specify functional wavelength regimes for surface texture

Who Should Attend
This topic bridges all fields within the automotive industry and is designed for engineers and technicians involved in: the specification of mechanical systems and components; failure analysis and warranty; quality control and measurement functions, manufacturing and process development. The areas of interest could include: sealing, sliding, cosmetic appearance, friction, leakage and more.

Topical Outline
• The Language of Surfaces
  • Roughness; Waviness
  • Form
• The Measurement of Surfaces
• Describing Wavelength Regimes
  • Separating roughness from waviness
  • Distortions that can occur in the data and how to deal with them

• Choosing the right filter cutoff
• Surface Texture Interactions with other Tolerances like GD&T
• Parameters
• Specifying Surface Texture

Instructor: Mark Malburg  
Fee $755 .7 CEUs

METALLURGY

Principles of Metallurgy

4 Hours  
I.D.# PD261322ON

This online course teaches the basic microscopic structures present inside of metals, how these structures and metal composition influence metal strength, and how these structures can be modified using common manufacturing processes to obtain specific mechanical properties. Several examples are presented to demonstrate how common alloying and manufacturing methods are used to modify the microscopic structures and properties of metals. It includes twelve modules followed by a quiz.

Major topics include:
• Composition
• Microscopic structures
• Crystal defects
• Diffusion
• Cold Working
• Annealing
• Solid Solution strengthening
• Precipitation Strengthening Heat Treatment
• Steel and Steel Heat Treating

Is this Metallurgy Online Course for You?
This course is targeted towards design, manufacturing, and quality engineers, and sales people and purchasing agents with technical backgrounds.

What You Will Receive
• Three months (from date of purchase) of online access to the four hour presentation
• Integrated knowledge checks to reinforce key concepts

3 ways to get a no-obligation price quote to bring a course to your company • Call SAE Corporate Learning at 1-724-772-8529
• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
Corrosion of Metals

5 Hours
I.D. # PD261328ON

This online course teaches about corrosion of metals. The physics of corrosion is explored as a background for the discussion of seven common types of corrosion (uniform, galvanic, crevice, pitting, intergranular, stress corrosion cracking, and dealloying). Students will learn why and how corrosion occurs and methods for controlling corrosion. It includes eleven modules followed by a quiz.

Major topics include:
• Introduction to electrochemical corrosion
• Aqueous corrosion
• Uniform corrosion
• Galvanic corrosion
• Crevice corrosion
• Pitting corrosion
• Intergranular corrosion
• Stress corrosion cracking
• Dealloying

Is this Metallurgy Online Course for You?
This course is targeted to design engineers, manufacturing engineers, and quality engineers. It is suggested that, as a prerequisite, you either take our Principles of Metallurgy online course (I.D. # PD261322, page 82) or have basic knowledge of the following topics: grains, grain boundaries, crystal lattice, substitutional solid solution, diffusion, phases, precipitation, precipitation hardening, microstructure, tensile testing.

What You Will Receive
• Three months of online access (from date of purchase) to the five hour presentation
• Integrated knowledge checks to reinforce key concepts
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $225

Corrosion of Metals: Chemistry of Corrosion

1 Hour
I.D. # PD261334ON

This online course covers the fundamental mechanisms involved in the aqueous (water based chemicals) corrosion of metals. The factors that influence the inherent corrosion behavior of a metal and the factors that influence metal corrosion rate will be discussed. The course takes one hour to complete.

Major topics include:
• Parts of an electrochemical corrosion cell
• Corrosion reactions
• Factors that influence the corrosion behavior of a metal
• Factors that influence the corrosion rate of a metal

Is this Metallurgy Online Course for You?
This course is targeted to design, manufacturing, and quality engineers, and sales people and purchasing agents with technical backgrounds. It is suggested that, as a prerequisite, you should be familiar with chemistry concepts such as ions, electrons, and chemical reactions.

What You Will Receive
• Three months (from date of purchase) of online access to the one hour presentation
• Integrated knowledge checks to reinforce key concepts
• Course workbook (.pdf, downloadable)
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $70

Corrosion of Metals: Galvanic Corrosion

1 Hour
I.D. # PD261336ON

This online course teaches why and how galvanic corrosion occurs and methods for controlling galvanic corrosion. The course content can be completed in one hour.

Major topics include:
• Galvanic corrosion cell components
• Factors that influence galvanic corrosion rate
• Galvanic series and its use
• Methods to control galvanic corrosion

Is this Metallurgy Online Course for You?
This course is targeted to design, manufacturing, and quality engineers, and sales people and purchasing agents with technical
backgrounds. It is suggested that, as a prerequisite, you have knowledge of the concepts covered in our Corrosion of Metals: Chemistry of Corrosion online course (I.D.# PD261334ON, page 83).

What You Will Receive

- Three months (from date of purchase) of online access to the one hour presentation
- Integrated knowledge checks to reinforce key concepts
- Course workbook (.pdf, downloadable)
- Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $70

Corrosion of Metals: Uniform Corrosion

1 Hour
I.D.# PD261335ON

This online course teaches about uniform corrosion of metals. Participants will learn why and how uniform corrosion occurs and methods for controlling it. References of textbooks and handbooks for more information are also provided. The course content can be completed in one hour.

Major topics include:

- Uniform corrosion mechanism
- Why uniform corrosion occurs
- Appearance of uniform corrosion
- Methods for controlling uniform corrosion

Is this Metallurgy Online Course for You?

This course is targeted to design, manufacturing, and quality engineers, and sales people and purchasing agents with technical backgrounds. It is suggested that, as a prerequisite, you have knowledge of the concepts covered in our Corrosion of Metals: Chemistry of Corrosion online course (I.D.# PD261334ON, page 83).

What You Will Receive

- Three months (from date of purchase) of online access to the thirty minute presentation
- Integrated knowledge checks to reinforce key concepts
- Course workbook (.pdf, downloadable)
- Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $39

Metallurgy of Precipitation Strengthening

2 Hours
I.D.# PD261329ON

This online course teaches about the microscopic changes that take place in a precipitation strengthened alloy and their effects on the properties of the alloy. The effects of the different heat treating steps (solution treatment, quench, and aging) and heat treating process parameters (solution treatment temperature and time, quench rate, and aging temperature and time) on the alloy microstructure and the effects on alloy strength are discussed. The course is divided into five modules followed by a quiz.

Major topics include:

- Phase diagrams
- Precipitation strengthening heat treatment

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Is this Metallurgy Online Course for You?
This course is targeted to design, manufacturing, and quality engineers. It is suggested that, as a prerequisite, you have knowledge of the concepts covered in our Principles of Metallurgy (I.D.# PD261322, page 82) online course.

What You Will Receive
• Three months (from date of purchase) of online access to the two hour presentation
• Integrated knowledge checks to reinforce key concepts
• Course workbook (.pdf, downloadable)
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $70

Metallurgy of Steel Heat Treating
5 Hours
ID # PD261327ON
This online course teaches about common heat treating processes and how they are used to modify the microstructure of steels to obtain specific mechanical properties. You will learn about the metallurgy of steel, the effects of heat treating temperature and cooling rate on microstructure properties, and the effects of the interaction between heat treating process parameters and steel composition on steel microstructure and strength. It includes eleven modules followed by a quiz.

Major topics include:
• Introduction
• Metallurgy of Steel
• Steel Phase Diagram
• Phase Transformations in Steel
• Annealing and Normalizing
• Through Hardening
• Case Hardening

Is this Metallurgy Online Course for You?
This course is targeted to design engineers, manufacturing engineers, quality engineers, and sourcing specialists. It is suggested that, as a prerequisite, you either take our Principles of Metallurgy (I.D.# PD261322, page 82) online course or have basic knowledge of the following topics: solid solution, substitution, interstitial, diffusion, effects of process temperature and time on diffusion and metallurgical changes, metallurgical phase, grain, grain boundary, precipitates and precipitation, tensile testing, and hardness testing.

What You Will Receive
• Three months (from date of purchase) of online access to the five hour presentation
• Integrated knowledge checks to reinforce key concepts
• Course workbook (.pdf, downloadable)
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $290
Metallurgy of Steel Through Hardening

1 Hour
I.D.# PD261330ON

This online course teaches about the metallurgy of the following steel through hardening processes: quench and temper, mar-tempering, and austempering. Participants will learn about the effects of heat treating temperature and cooling rate on steel microstructure and properties, and the effects of the interaction between heat treating process parameters and steel composition on through hardened steel microstructure and strength. This course takes one hour to complete.

Major topics include:
• Quench and temper
• Steel hardenability
• Common problems associated with quenching (distortion, cracking, retained austenite)
• Martempering; Austempering

Is this Metallurgy Online Course for You?
This course is targeted to design, manufacturing, and quality engineers, and sales people and purchasing agents with technical backgrounds. It is suggested that, as a prerequisite, you have knowledge of the concepts covered in our Principles of Metallurgy online course. (I.D.# PD261322, page 82).

What You Will Receive
• Three months (from date of purchase) of online access to the one hour presentation
• Integrated knowledge checks to reinforce key concepts
• Course workbook (.pdf, downloadable)
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $70

Metallurgy of Steel: Principles

3 Hours
I.D.# vvvvvv

This online course teaches the phases and microstructures that form in steels, their effects on steel properties, the microstructure changes that occur when steel is heated and cooled, and the effects of carbon content and cooling rate on the microstructures that form. Also, how to read the iron-carbon phase diagram will be discussed. All this information is applicable to understanding the effects of steel heat treating processes and heat treating process parameters on the microstructure and properties of heat treated plain carbon, low-alloy, and tool steels. The course is divided into six modules followed by a quiz.

Major topics include:
• Steel types and designations
• Metallurgical phases that form in steel and their effects on properties
• Steel phase diagram
• Metallurgical changes in carbon steel during cooling
• Metallurgical changes in carbon steel during heating
• Course Review

Is this Metallurgy Online Course for You?
This online course is targeted to design, manufacturing, and quality engineers, and sourcing specialists. It is suggested that, as a prerequisite, you have basic knowledge of solid solution, substitutions, interstitials, diffusion, effects of process temperature and time on diffusion and metallurgical changes, metallurgical phases, grains, grain boundaries, dislocations or the concepts covered in our Principles of Metallurgy online course. (I.D.# PD261322, page 82).

What You Will Receive
• Three months (from date of purchase) of online access to the two hour presentation
• Integrated knowledge checks to reinforce key concepts
• Course workbook (.pdf, downloadable)
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $180

Tensile Testing

I.D.# PD261308ON
Duration: 25 Minutes

This online course teaches about tensile testing of metals with a focus on how the testing is performed and tensile properties are measured. It includes one module followed by a quiz

Major Topics Include:
• How a tensile test is performed
• Tensile specimen shape
• Calculation of stress and strain
• Stress and strain curve
• How to determine elastic modulus, yield strength, tensile strength, and elongation from a stress-strain curve

Is this Metallurgy Online Course for You?
This course is targeted towards design, manufacturing, supplier quality and quality control engineers, sales people and purchasing agents with technical backgrounds.
MATERIALS AND MANUFACTURING

What You Will Receive
• Three months (from date of purchase) of online access to the 25-minute presentation
• Course handbook (downloadable .pdf’s)
• Integrated knowledge checks to reinforce key concepts
• Proof of Participation (Transcript)

Author: Industrial Metallurgists, LLC
Fee $39

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CATALOG KEY
You will see the following icons alongside the course descriptions. These icons indicate:
• delivery formats available for the course
• the course is part of an SAE certificate
• that it is an ACTAR approved course

Many courses are available in multiple formats. See page X to get more information on the learning formats offered by SAE. In addition to finding courses that fit your technology need, look for courses with icons that fit the way you want to learn.

Classroom – indicates the course is an instructor-led seminar or workshop offered in a classroom setting

Live, online – indicates the course is an instructor-led web seminar offered live and online via telephone and internet connection

Online, on demand – indicates the course is available online anytime the participant would like to access the course through the internet

Certificate – indicates the course is part of an SAE International curriculum-based, multi-course certificate. See a list of the multi-course certificates on page XII

ACTAR logo – indicates the course is an ACTAR approved course. For more information on ACTAR and ACTAR accredited courses, see page IX
MATERIALS AND MANUFACTURING

RELATED TRAINING SOLUTIONS
Some of our courses apply to more than one technology category. Consider these related courses described in other sections of this resource guide.

Sound Package Materials for Vehicle Noise Control
The two day seminar starts with the fundamentals of NVH and sound quality related to sound package materials and discusses the importance of various noise sources that impact the development of sound package treatments in a vehicle.
Read more about this course on page 93

Vehicle Sound Package Materials
This four-session web seminar provides a detailed understanding of the source – path-receiver relationship for developing appropriate sound package treatments in vehicles, including automobiles, commercial vehicles, and other transportation devices.
Read more about this course on page 93

Design for Manufacture and Assembly (DFM/DFA)
This seminar provides a functional understanding of the principles involved in conducting a Design for Manufacture/Design for Assembly study. DFM/DFA can support both manual and automated processes resulting in significant cost savings through simpler designs with fewer components.
Read more about this course on page 161

Design for Manufacturing & Assembly
Correctly applied, DFM+A analysis leads to significant reductions in production cost, without compromising product time-to-market goals, functionality, quality, serviceability, or other attributes. This seminar will include information on how DFM+A fits in with QFD, Concurrent Engineering, Robust Engineering, and other disciplines.
Read more about this course on page 162
NOISE, VIBRATION AND HARSHNESS

Includes acoustics, engine noise control, sound package materials, vibration, and harshness.

Acoustic Fundamentals for Solving Noise and Vibration Problems Web Seminar and Web Seminar RePlay

6 Hours
Web Seminar: I.D.# WB1309
Web Seminar RePlay: PD331309ON

This course provides an introduction to the characteristics of sound waves, human perception of sound, sound and vibration measurements, measurement facilities, and various noise sources and noise control principles. It will include an overview of sound pressure, power, intensity, decibels, and frequencies. Practical examples will be used to familiarize participants with the acoustic fundamentals for solving noise and vibration problems and the associated solution principles.

Learning Objectives

By connecting with this web seminar, you will be able to:

- Discuss the differences of various acoustic terminologies that are important to solve noise and vibration problems
- Define a relationship between sound pressure, sound power, and sound intensity
- Associate decibel to both sound and vibration
- Prepare effective acoustic specifications encompassing all variables that affect noise and vibration
- Select correct instrumentation for noise and vibration measurements recognizing the challenges of measurements
- Define the source-path-receiver relationship
- Determine the steps of noise and vibration source identification process for a given application
- Employ different noise control options to address specific noise and vibration issues

Who Should Attend

This fundamental Web Seminar will be especially valuable for technical staff, engineers, and managers with limited experience in noise and vibration. It is designed to be suitable for all areas of the mobility industry. An Associate degree in the field of science or technology is recommended; BS degree is preferred.

Topical Outline

Session 1
- Introduction
  - Waves
  - Pressure, power, intensity
  - Frequency
  - Human perception of sound
- Decibels
  - What is decibel
  - Addition and subtraction of decibels
  - Background noise
  - Linear averaging/spatial averaging
- Frequency
  - Frequency Analysis
  - Linear and logarithmic frequency
  - Filters

Session 2
- Human Perception of Sound
  - Equal Loudness contours
  - Frequency weighting of sound
  - Loudness, loudness level, articulation index
- Instrumentation and Facilities
  - Transducers
  - Spectrum analyzers
  - Anechoic/hemi-anechoic room
  - Reverberation room
NOISE, VIBRATION AND HARSHNESS TECHNOLOGY

• Sound power measurements
• Source-path-receiver relationship

Session 3
• Various Noise Sources
  • Product noise
  • Community Noise
  • Industrial noise
  • Vehicle noise
  • Aircraft noise
• Noise Control Principles
  • Sound package materials
  • Absorber, barrier, damper, isolator
  • Mufflers, resonators
  • Active and passive noise control

Diesel Engine Noise Control Web Seminar and Web Seminar RePlay

4 Hours
Web Seminar: I.D.# WB1041
Web Seminar RePlay: I.D.# PD331041ON

This Web Seminar provides an in-depth overview of diesel engine noise including combustion and mechanical noise sources. In addition, the instructor will discuss a system approach to automotive integration including combining sub-systems and components to achieve overall vehicle noise and vibration goals.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Identify and analyze commonly occurring diesel engine noise sources
• Understand how analytical and experimental techniques can be used to solve diesel noise issues
• Prescribe appropriate noise control analysis and solutions for specific diesel engine NVH issues

Who Should Attend
Those who wish to understand the root causes of many diesel engine noise issues, and how to use this understanding to better diagnose and control diesel engine-related noises.

Topical Outline
Session 1
• The Basics of Diesel Engine Noise
• Combustion Noise Forcing Functions
• Combustion Mode Switching

• Mechanical Forcing Functions in Diesels
• Separating Combustion and Mechanical Noise Sources
• Strategies for Reducing Forcing Functions

Session 2
• Surface Radiated Noise
• Exterior Covers: Radiated Sound and Simulation Modeling
• Gear Train Noise Issues and Countermeasures
• Drive-By Noise Contribution
• Diesel Engine Design Considerations for Low Noise
• Application Noise Issues

Instructor: Pranab Saha
Fee $535 .6 CEUs

Introduction to Contemporary Muffler Design Techniques

.5 Days
I.D.# C1352

Most muffler design in the automotive industry is accomplished by using “cut-and-try” methods that rely on what has worked in the past and/or extensive full-scale testing on engines for validation. New computer software aimed at muffler design can shorten the design cycle and yield more effective results.

This four hour seminar provides an introduction to the behavior of mufflers and silencers including a description of the two-port approach to muffler design. This seminar covers the acoustic simulation of muffler and silencer systems and the use of experimental methods to measure muffler performance. Following a review of basic muffler concepts and definitions, this seminar will focus on meeting design objectives such as insertion loss with a specified back pressure requirement. This seminar will show how modern software such as SIDLAB can be used to model both the acoustics and flow in achieving the design objective and the role that 1D engine simulations can play in providing important input. The final topic will cover optimizing muffler design to meet a specified design objective with a specified space constraint. The main focus is on IC-engine intake and exhaust systems, but most of the information is also applicable to any pipe or duct system.

Learning Objectives
By attending this seminar, you will be able to:
• Explain the underlying principles of mufflers and silencers
• Gain insight into muffler and silencer design concepts using contemporary software
• Understand experimental methods for measuring muffler and silencer performance

Instructor: Thomas Reinhart
Fee $415 .4 CEUs

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NOISE, VIBRATION AND HARSHNESS TECHNOLOGY

Who Should Attend
This course is designed for engineers and technical managers seeking an understanding of the principles of muffler design and an introduction to the use of muffler and silencer design software. In addition, other personnel from companies that design, purchase, or manufacture muffler or silencer systems will also benefit from the information presented in this seminar.

Topical Outline
• Overview of Engine Exhaust and Intake Systems
  • Definitions: TL, IL, etc.
  • Performance measures for intake and exhaust systems
• Engine Exhaust and Intake Systems Measurement Methods
  • Measurement of TL
  • Measurement of IL
• Design Approach for Exhaust and Intake Systems
  • Two-port method for modeling
  • Typical results for muffler system design
• Software for Engine Exhaust and Intake Modeling Design
  • Optimization to meet a specific design objective
  • Examples of muffler system design

Instructors: Tamer Elnady and Andrew F. Seybert
Fee $395 .4 CEUs

Introduction to NVH Aspects of Hybrid and Electric Vehicles

1 Day
I.D.# C1128

The influx of different hybrid and electric vehicle configurations has brought about unique NVH challenges from a variety of sources. NVH refinement is an important aspect of powertrain development and the vehicle integration process. While developing the NVH behavior of the vehicle is critical to satisfy customer expectations, it is also important to consider the influence of reduced exterior noise levels on pedestrian safety.

This seminar introduces participants to basic NVH principles and unique NVH challenges encountered in the development of HEV, ReEV, and EV including engine start/stop behavior, electric motor whine, driveline NVH, body structure, influence of noise from accessories, and sound quality development, as well as potential countermeasures.

Learning Objectives
Upon completion of this seminar, you will be able to:
• Articulate the basic principles of NVH
• Describe the relative importance of powertrain noise, wind noise, and road noise in the vehicle’s interior
• Identify the key sub-components of powertrain noise and means to control them
• Explain the key NVH issues specific to electrified vehicles and means to develop appropriate countermeasures
• Identify key metrics available to assess the NVH performance of electrified vehicles
• Develop an awareness of advanced NVH methodologies available to design the sound character of electrified vehicle

Who Should Attend
This seminar has been developed for engineers involved in all fields related to the design or development of electrified vehicles. Individuals involved with component design/release responsibilities in ICE, electric motor, transmissions, powertrain mounts, vehicle body, and chassis areas will find this course helpful.

Topical Outline
• Automotive NVH Fundamentals
  • Fundamentals of noise, vibration, and sound quality
  • Vehicle NVH
  • Powertrain-induced interior noise
  • Engine noise
  • Transmission noise
  • Driveline noise
  • Intake noise
  • Exhaust noise
  • Road-induced noise
  • Wind noise
  • Vehicle interior noise simulation for powertrain-induced noise
  • Vehicle interior noise simulation for road-induced noise
  • Vehicle sound quality
  • Vehicle exterior noise simulation
• HEV, ReEV, PHEV, and EV NVH
  • HEV, ReEV, PHEV, and EV architecture definition
  • “Road Map” for vehicle NVH development of HEV, ReEV, PHEV, and EV
  • ICE start/stop noise using case study examples
  • ICE start/stop vibration using case study examples
  • Active control for start/stop refinement using case study examples
  • Motor NVH using case study examples
  • HEV/EV driveline NVH using case study examples
  • Power electronics noise
  • Accessory noise
  • Application of powertrain-induced vehicle interior noise simulation
  • Application of road-induced vehicle interior noise simulation
  • Sound character of EV using case study examples
NOISE, VIBRATION AND HARSHNESS TECHNOLOGY

- Sound character of ReEV using case study examples
- Exterior noise considerations for EV and ReEV

<table>
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<tr>
<th>Instructor:</th>
<th>Kiran Govindswamy</th>
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<tr>
<td>Fee $755</td>
<td>.7 CEUs</td>
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Practical NVH Signal Processing Methods

2 Days  
I.D.# C0431

Signal processing has become a critical tool in optimizing vehicle noise. This seminar will help you to understand the foundation common to all NVH data acquisition equipment including digitizing, windows, aliasing, averaging techniques, and common analysis functions such as the power spectrum, transfer function and coherence. Fundamental concepts such as filtering, modulation, convolution, and correlation, as well as specialized techniques used in rotating machinery such as adaptive re-sampling and order tracking, will be covered. The seminar will also cover multi-input multi-output (MIMO) signal processing, array based solutions for force identification, source and path characterization and data visualization. Brief introductions to emerging concepts will also be explored and computer demonstrations, physical experiments and case studies will be used to illustrate applied, real-world problems.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the fundamental controls typical in modern spectrum analysis tools
- Interpret NVH data and judge its relevance to physical phenomena
- Extract new types of useful information from NVH data
- Implement new signal processing techniques

Who Should Attend

NVH technicians, engineers and managers who want to understand how NVH data is produced and interpreted will find this seminar valuable. The material is presented at a level suitable for beginners, but offers the more experienced practitioners new insight into the concepts presented through the illustrations and demonstrations that are included.

Topical Outline

- Properties of the FFT
  - Sampling and digitizing
  - Aliasing and filters
  - Leakage and windows
  - Averaging techniques
  - Autopower, crosspower and coherence
- Transmissibility and isolation
- Measuring and interpreting the transfer function
- Rotating Machinery Basics
  - What is an order?
  - Rotation synchronous data acquisition methods
  - AM and FM modulation effects
  - FIR, IIR and re-sampling filters
  - Up-sampling down-sampling and adaptive re-sampling
- Time Frequency Methods
  - Short time Fourier transform
  - Gabor expansion and Gabor transform
  - Orthogonality, invertability and the dual function relationship
  - Gabor order tracking
  - Introduction to wavelets
- Fundamentals of Multi-Input-Multi-Output (MIMO) System Analysis
  - Review of Single-Input-Single-Output (SISO) systems
  - Introduction to Single-Input-Multiple-Output (SIMO) systems
  - Partial correlation concepts
  - Coherent output power
  - Statistical errors in basic estimates
  - Conditioned spectral analysis
- Forces and Sources in MIMO Systems
  - Least squares solution techniques
  - Force estimation technique Conditioned Source Analysis (CSA)
  - Case history: transfer path analysis
  - Case history: model correlation and updating
- Introduction to Data Classification and Pattern Recognition
  - Techniques for building and analyzing feature vectors
  - Recognition engines: neural networks and hidden Markov models
  - Applications: machine noise recognition, vision based gear mesh quality

Instructor: Michael F. Albright

Fee $1225 1.3 CEUs
Sound Package Materials for Vehicle Noise Control

2 Days
I.D.# 92032

A similar course is available as a live, online web seminar - Vehicle Sound Package Materials – see course description below.

The sound package materials for vehicle noise control seminar provides a detailed and thorough analysis of three different classes of acoustical materials - namely absorbers, barriers, and dampers, how they are different from each other, and acoustical properties that materials should possess for optimum vehicle noise control. The seminar addresses new advances in acoustical materials, primarily in absorption materials that impact the vehicle acoustics. The seminar covers ways to evaluate the acoustical performance of these materials using different test methods, including material, component, and vehicle level measurements. The two day seminar starts with the fundamentals of NVH and sound quality related to sound package materials and discusses the importance of various noise sources that impact the development of sound package treatments in a vehicle.

Learning Objectives
By attending in this seminar, you will be able to:
• Identify various descriptors that are used in NVH and sound quality while working with sound package materials
• Recognize various noise sources and paths in a vehicle
• Identify three different classes of acoustical materials
• Describe ways that acoustical materials work and how they differ from each other
• Road map for vehicle sound package development
• Distinguish test methods used to evaluate the acoustical performance of material

Who Should Attend
Designed for OEM or supplier employees responsible for various noise activities, such as design, evaluation, trouble-shooting, procuring, supplying, and/or manufacturing noise control treatments and parts, this seminar will also benefit those with responsibilities including the areas of manufacturing, design, engineering, process, noise and release engineering, supervision or management. Attendees should have an undergraduate engineering degree and/or a working knowledge of noise control and automotive acoustics.

Topical Outline
• Fundamentals of NVH and Sound Quality
  • Defining acoustical performance of acoustical parts
  • Definition of terms
  • Human response to sound
• Various noise and vibration instrumentation
• Vehicles Noise Sources and Solutions
  • The noise system
  • Vehicle noise sources
  • Road and wind noise
• Miscellaneous noise sources
  • Noise control solution - source, path, receiver
  • Noise control system using sound package materials
• Materials for Vehicle Noise Control
  • Absorber, including case studies and test methods
  • Barrier, including case studies and test methods and the effect of holes
  • Damper, including case studies and test methods
  • Isolator
• Different Automotive Measurements
  • Vehicle
  • Component
  • Material

Instructor: Pranab Saha
Fee $1325 1.3 CEUs

Vehicle Sound Package Materials Web Seminar and Web Seminar RePlay

8 Hours
Web Seminar: I.D.# WB1204
Web Seminar RePlay: I.D.# PD331204ON

A similar course is available as a classroom seminar - Sound Package Materials for Vehicle Noise Control – see course description above.

This four-session web seminar provides a detailed understanding of the source – path-receiver relationship for developing appropriate sound package treatments in vehicles, including automobiles, commercial vehicles, and other transportation devices. The course provides a detailed overview of absorption, attenuation (barrier), and damping materials and how to evaluate their performances on material, component, and vehicle level applications. A significant part of this course is the case studies that demonstrate how properly designed sound package materials successfully address vehicle noise issues.

Learning Objectives
By participating in this web seminar, you will be able to:
• Identify various descriptors that are used in acoustics while working with sound package materials
• Identify three fundamentally different sound package materials that are used in the industry
NOISE, VIBRATION AND HARSHNESS TECHNOLOGY

• Explain how these materials work and how to improve their performance
• Describe how various measurements are made and why they are necessary on a material level, component level, and vehicle level
• Prescribe appropriate sound package materials for specific NVH issues
• Construct proper protocols for combining different sound package materials for different components so that the final vehicle meets the required acoustic target

Who Should Attend
This web seminar will be especially valuable for those new to the vehicle sound package area and those interested in how absorbers, barriers, and dampers work, how they are different from each other, how they interact with each other in an application, and what one needs to be aware of while making measurements so the results are meaningful. The course is also designed for OEM or supplier engineers and those in roles involved with design, evaluation, trouble-shooting, procuring, releasing, supplying, and/or manufacturing noise control materials and parts for passenger cars and light trucks, heavy trucks, off-highway vehicles, farm machinery, and other transportation systems including aircraft, watercraft and rail transit.

Topical Outline
• Vehicle Noise Sources and Solutions
  • The noise system – sources
  • Ranking noise paths
  • Source-path-receiver relationship
  • The noise control system using sound package materials
  • Calculating Onboard Energy Storage Needs
  • Sound Package Material – Absorber
    • Application
    • Primary function
    • Effect of various parameters
  • Sound Package Material – Absorber (cont’d)
    • How it works
    • How to improve performance
    • Case studies
    • Measurements
• Sound Package Material – Barrier
  • Application
  • Primary function
  • How it works
  • How to improve performance
  • Case studies
  • Measurements
• Sound Package Material – Damper
  • Application
  • Primary function
  • How it works
  • How to improve performance
  • Case studies
  • Measurements
  • Case studies
  • Measurements
  • Component and Vehicle Level Noise Measurements

Instructor: Pranab Saha
Fee $620 .8 CEUs

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Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate.

Intended to provide a guide towards deeper knowledge in a specific area, SAE’s multi-course certificates outline required courses that offer foundational knowledge of the subject. Some certificate programs also feature additional electives designed to broaden your exposure to more specific aspects of the technology studied. PLUS—completion of many of the multi-course certificate programs equates to graduate credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems and Kettering’s 40-credit M.S in Mechanical Engineering. Visit training.sae.org/collegecredit for more information.

SAE offers these multi-course certificate programs:
• Transmission/Drivetrain
• General Management and Leadership
• Professional and Legal Issues
• Diesel Technology
• SI Engine
• Vehicle Dynamics
• Product Engineering Tools and Methods
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RELATED TRAINING SOLUTIONS
Explore these courses related to noise, vibration, and harshness listed in other sections of this resource guide.

Brake Noise Problem Resolution
This course will provide you with an overview of the various damping mechanisms and tools for analyzing and reducing brake noise. A significant component of this course is the inclusion of case studies which will demonstrate how brake noise squeal issues have been successfully resolved.
Read more about this course on page 12

Introduction to Brake Noise, Vibration, and Harshness
This seminar provides an introduction to brake NVH, including a concise summary of the various brake NVH problems, current lab and vehicle measurement techniques and SAE global standards which are utilized to characterize the noise correctly in order to get the best option/solutions quickly.
Read more about this course on page 19

Vibration Analysis Using Finite Element Analysis (FEA)
The course reviews basic concepts of vibration analysis and illustrates how they are implemented in FEA to simulate product behavior. The most common types of vibration analysis such as modal, time response, and frequency response will be covered.
Read more about this course on page 185
POWER AND PROPULSION

Includes vehicle powertrain and its various components, internal combustion systems and their emissions control, hybrid and electric vehicles, and fuels.

POWERTRAIN AND DRIVETRAINS

A Familiarization of Drivetrain Components

2 Days
I.D.# 98024

A similar course is available online, on demand – A Familiarization of Drivetrain Components e-Seminar – see course info below.

An efficient, robust, and quiet running drivetrain is as essential to customer satisfaction as styling and interior creature comforts. In this seminar, you will be exposed to various methods that can be used to accomplish this goal. 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.


Learning Objectives

By attending 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.

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POWER AND PROPULSION

Topical Outline

DAY ONE
• Clutch (dry/wet)
• Pressure Plate (Cover)
  • Direct pressure
  • Indirect pressure
  • Belleville
  • Over center springs
• Disc
  • Hub
  • Facing support member
• Torsional damper -- damper springs; co-axial damper springs; damper friction devices
• Facings - Organic; Ceramic/metallic; cushion types
• Linkage Hydraulic
  • Cable
  • Mechanical
• Transmission
• Automatic
  • Hydraulically controlled
  • Electronically controlled
  • Planetary or epicyclical gearing
  • Hydraulic multi-disc clutches
• Torque Converters
  • Impeller
  • Turbine
  • Stator
  • Lock-up clutch
• Manual
  • Synchronized
  • Non-Synchronized
  • Electronically shifted
  • Gear rattle
• Propshaft
• Cardan Joints
  • Torsional excitation -- cancellation (two or more joints)
  • Secondary couple
• Constant Velocity Joints
  • Rzeppa type
  • Others
• Axle
  • Rigid -- Semi-float; Full-float; Carrier type; Banjo type
• Steering
  • Independent
• Gearing -- Spiral bevel; Hypoid
• Differentials
  • Two pinion; Four pinion
  • Limited slips
  • Full locking
• Plate types -- spring loading of plates; springs between side gears and plates; springs between gears; gear loading of plates

DAY TWO
• Axle (continued from Day One)
• Transfer Case
• Full Time
  • The requirement for a differential -- bevel differential; planetary differential
• Part Time
  • Two-wheel drive; Locked four-wheel drive
• Wheel Ends
  • Independent
  • Live vs. Dead Spindle
  • Bearing architectures
• Brakes
  • Disc; Drum
  • Hydraulics
  • Master Cylinder, Proportioning valve
  • Electronic Control of Brakes and Torque
  • Anti-Lock Brake Systems

Instructor: Joseph Palazzolo
Fee $1415 1.3 CEUs

A Familiarization of Drivetrain Components e-Seminar

5.25 Hours
I.D.# PD130555ON

A similar course is available as a classroom seminar –
A Familiarization of Drivetrain Components – see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this five and a quarter hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This is divided into seven video modules and a coordinated handbook.

View the complete description and a video demo at training.sae.org/eseminars/drivetraincomponents.

What You Will Receive:
• 365 Day access
• through MyLearn.sae.org
• Links to streaming video modules
• Course Handbook (downloadable .pdf’s, subject to DRM)
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### POWER AND PROPULSION

- Online Pre-test (self-test, immediate results)
- Online Post-test (self-test, immediate results)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

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<tr>
<th>Instructor:</th>
<th>Joseph Palazzolo</th>
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<td>Fee $295</td>
<td>0.6 CEUs</td>
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Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

### Automotive Powertrain and Battery Cooling Airflow Systems: A Vehicle Perspective

**2 Days**  
**I.D.# C0616**

Designing more fuel-efficient vehicles requires that considerations be given to the thermal management requirements of vehicle propulsion systems. Exterior appearance, vehicle function, and thermal limits all have a direct impact on the design of the cooling airflow system. For hybrid and all-electric vehicles, batteries and thermal management present unique integration challenges. To address these challenges, suppliers and vehicle manufacturers must work as partners in the selection and packaging of batteries and under-hood cooling components. Critical to a successful design effort is a thorough understanding of the vehicle-level trade-offs and thermal issues that affect system performance.

This two-day seminar will provide attendees a vehicle-level perspective of powertrain and battery cooling airflow systems, including the unique challenges of hybrid and all-electric vehicles. Product design constraints related to front-end, batteries, and underhood components will be discussed. Special emphasis will be placed on the numerous battery integration issues and thermal management characteristics. A lumped capacitance model will be used to pull together battery thermal analysis concepts and the trade-off with energy required for cooling. Attendees will also learn about cooling airflow (fan & ram), HEV/EV battery thermal management, heat generation rate, grille openings, thermal recirculation, system resistance, cooling drag, and powertrain heat rejection. The radiator heat transfer equation will be used to describe the influence of vehicle-level and subsystem requirements on powertrain cooling. Included in this seminar is the SAE paper “A Systems Engineering Approach to Engine Cooling Design; The 44th L. Ray Buckendale Lecture.”

Case studies will be used to reinforce concepts and attendees should bring a calculator for these in-class activities.

#### Learning Objectives

By attending this seminar, you will be able to:
- List fundamental considerations of grille openings and under-hood airflow systems
- List battery thermal management requirements and integration issues
- Describe options for HEV/EV battery thermal management
- Conduct a steady-state analysis of a low temperature cooling airflow system
- Use the fan/ram airflow map to track system operation and performance
- List major factors and considerations in airflow system resistance and optimization
- Estimate installed-powertrain radiator heat rejection for system analysis
- Conduct an analysis of a powertrain cooling system proposal against thermal limits
- Draft alternatives for program management discussions on cooling system trade-offs

#### Who Should Attend

This course is designed for OEM and supplier engineers, managers, and sales personnel involved with powertrain and/or battery thermal management systems or components or individuals that interface with program management on these issues. Engineering students and CAE analysts will find the product perspective beneficial.

#### Topical Outline

**DAY ONE**

- OEM vehicle perspective
- Powertrain cooling airflow system
- Underhood package and cooling fan alternatives
- Suppliers
- System & sub-system requirements
- Thermal recirculation
- HEV and EV Battery Thermal Management
- HEV/EV vehicle classifications
- Battery thermal characteristics
- Heat generation rate
- Internal and external heating
- Lumped capacitance model
- Cooling system options
- Thermal management system characteristics
- Electric machines and power electronics
- Low temperature cooling airflow system calculation
- Vehicle - BTMS integration issues and challenges
- Some current vehicle design solutions
- Current technology, challenges, future development
- Underhood airflow patterns

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DAY TWO

- Thermodynamics Review
  - First Law
  - Radiator heat transfer equation
  - Radiator effectiveness and pressure drop
  - SCFM
  - Total-pressure
- Powertrain Heat Rejection
  - Estimating radiator heat rejection; SAE Dynamometer engine test procedures
  - Engine mean effective pressure (MEP)
  - Engine specific heat rejection (SHR)
  - Engine oil temperature
- Front-End Airflow
  - Airflow patterns; idle, ram, exit, underhood
  - Airflow restrictions; system resistance, underhood, grille opening
  - Sizing cooling openings; inlet total-pressure recovery
  - Ram airflow and cooling drag
- Cooling Fans
  - Classification and Specific speed
  - Characteristic curves and performance matching
  - Axial fan systems, design parameters, shroud immersion and tip clearance
  - Fan laws
  - Shrouds
  - System airflow road map - fan and ram
- Powertrain Cooling System Case Study
  - Define a system to meet thermal and product requirements
  - Evaluate system alternatives
  - List and discuss options for program management trade-off discussions
- Wrap-Up Discussions

Instructor: Jack Williams
Fee $1317 1.3 CEUs

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Fundamentals of Automotive All-Wheel Drive Systems

1 Day
I.D.# C0305

A similar course is available online, on demand – Fundamentals of Automotive All-Wheel Drive Systems e-Seminar – see course info below.

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.

Students with limited experience with the total drivetrain should consider participation in A Familiarization of Drivetrain Components. See course description on page 37.

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 components, 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.

Topical Outline
- Front wheel drive and rear wheel drive vehicle architectures
  - Engine layout - Transverse vs. longitudinal
  - Transmission layout - Transaxle vs. longitudinal

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TRANSMISSION/DRIVETRAIN CERTIFICATE PROGRAM

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

This program familiarizes you with key drivetrain components and how those components function as a system. Complete this certificate to increase your expertise within the drivetrain body of knowledge and, at the same time, earn the SAE Certificate of Achievement.

training.sae.org/certificate/transmission_drivetrain

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Catalog Key
- Classroom
- Live, online
- Online, on demand
- Certificate
- ACTAR approved
POWER AND PROPULSION

- Axle layout - Independent vs. beam
- Powerflow - typical power transmission arrangements
- Part time, full time, and on demand all wheel drive systems
  - Modes of operation
  - Performance benefits
  - Usage profiles
  - Twin systems
- Benefits of all-wheel drive as compared to two-wheel drive
  - Performance
  - Weight
  - Packaging
- Quantifying all-wheel drive traction and mobility benefits
  - Vehicle dynamics
  - Stability Acceleration
- Auxiliary axle disconnect systems--Function; Design
- Basic vehicle dynamics performance and the effect of AWD on performance
  - Oversteer; Understeer; Neutralsteer
  - Traction Effects; Stability Effects
- Couplers vs. biasing devices
  - Functions of couplers
  - Functions of biasing devices
  - Types - mechanical, electrical, speed sensing, torque sensing
- Mechanical vs. electrical implementation in AWD systems
  - Active control
  - Passive control
- Effects of AWD driveline configuration on NVH and weight
  - Consequences of axle ratio selection
  - Halfshaft and propshaft options
- Basic control strategies and logic
- Advanced propulsion concepts and systems
  - Active differentials
  - Independent wheel control
  - Hybrid electric all-wheel drive

Instructor: Joseph Palazzolo
Fee $265 .5 CEUs

Fundamentals of Gear Design and Application

2 Days
I.D.# C0223

Through informative discussions and detailed explanations, this seminar will provide a solid and fundamental understanding of gear geometry, types and arrangements, and design principles. Starting with the basic definitions of gears, conjugate motion, and the Laws of Gearing, those attending will be given the tools needed to understand the inter-relationship and coordinated motion operating within gear pairs and multi-gear trains. Basic gear system design process and gear measurement and inspection techniques will also be explained. In addition, the fundamentals of understanding the step-wise process of working through the iterative design process required to generate a gear pair will be reviewed, and attendees will also briefly discuss the steps and issues involved in design refinement and some manufacturing considerations. Also, an explanation of basic gear measurement techniques, how measurement equipment and test machines implement these techniques, and how to interpret the results from these basic measurements will be covered.

Learning Objectives
By attending this seminar, you will be able to:
- Describe the “Law of Gearing,” conjugate action and specifically, involute profiles
- Review the various definitions and terms used in gearing
- Identify the function and operation of all gear arrangements
- Appraise preliminary design considerations and the gear system design process
- Explain practical gear measurement and inspection techniques, tools and equipment
- Recognize “Best Practices” in regards to gear system design
- Discuss some of the new and automated gear design systems

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Fundamentals of Automotive All-Wheel Drive Systems e-Seminar

4.5 Hours
I.D.# PD130556ON

A similar course is available as a classroom seminar—Fundamentals of Automotive All-Wheel Drive Systems—see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this 4.5-hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. It is an excellent follow-up to SAE’s A Familiarization of Drivetrain Components e-Seminar (which is designed for those who have limited experience with the total drivetrain).

View the complete description and a video demo for this course at training.sae.org/eseminars/awdsystems

Instructor: Joseph Palazzolo
Fee $775 .7 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

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Who Should Attend

The intended audience for this seminar is powertrain engineers, engineering directors and managers, component suppliers, vehicle platform powertrain development specialists, and those involved in the design and application of geared systems and assemblies. This seminar will appeal to anyone who is interested in gears, gear systems, design development or measurement and inspection techniques. More specifically, anyone responsible for the following will benefit:

- Mechanical power transmission system design, development, durability assessment and application
- Application and development of geared systems technologies
- Management of transmission designers and manufacturers
- Supply of components and sub-systems to mechanical power transmission system manufacturers

Prerequisites

Attendees should have an undergraduate engineering degree to attend this program. This seminar is intended for powertrain engineers, engineering directors and managers, component suppliers, vehicle platform powertrain development specialists, and those involved in the design and application of geared systems and assemblies.

Topical Outline

DAY ONE

- Principles of Gears
  - Purpose of gears
  - Basic concepts -- Law of gearing; common tooth forms
  - Classification of gears
  - Definitions and terms used in gearing
  - Velocity ratio
  - Pitch surfaces
- Gear Tooth Action
  - Conjugacy
  - Profile curves
  - Surface of action
  - Profile sliding
- Gear Geometry and Nomenclature
  - Principle of planes
  - Tooth nomenclature; Blank nomenclature
- Gear Arrangements
  - Simple gear train;
  - Compound gear train -- ratios
  - Epicyclic -- configurations (solar, planetary, star); ratios; tooth number selection and build requirements; application
- Preliminary Design Considerations
  - Gear type selection
  - Preliminary estimate of size
  - Stress formulations
  - Gear Drawing Data

DAY TWO

- Gear System Design Process
  - Calculation of gear tooth data
  - Gear rating practice
- Gear Design Process
  - Layout
  - Root geometry
  - Backlash
- Gear Measurement and Inspection
  - Dimension over pins; Pin diameter
  - Modify pin diameter and dimension over pins
  - Pin contact point
  - Charts - involute; lead; red liner
  - Dimension sheet
- Gear Design Systems and Best Practices
  - Common proportions
  - Interchangeability
  - Tooling considerations
  - Mounting considerations
  - Best practices
  - Application

Instructor: William Mark McVea
Fee $1225 1.3 CEUs

Fundamentals of Modern Vehicle Transmissions

3 Days
I.D.# 99018

A similar course is available online, on demand – Fundamentals of Modern Vehicle Transmissions e-Seminar – see course info below.

Starting with a look at the transmission’s primary function -- to couple the engine to the driveline and provide torque ratios between the two -- this updated and expanded seminar covers the latest transmission systems designed to achieve the most efficient engine operation. Current designs, the components and sub-systems used, their functional modes, how they operate, and the inter-relationships will be discussed.

A manual transmission display will be used to explain ratios and how they function within the driveline. Automatic transmission design will illustrate the concept of automatic control and hydro-mechanic decision theory and implementation. Attendees will have the opportunity to supplement these theoretical concepts with practical, “hands-on” experience using the various transmission models and components provided. Mechatronics, toroidal transmission functions, and the future of the automatic transmission will also be discussed.
POWER AND PROPULSION

Continuously Variable Transmission (CVT) systems, which represent a fundamental shift in the way power is transmitted from the primary source to the remainder of the driveline will be the focus of in-depth coverage on the third day of this seminar.

Learning Objectives
By attending this seminar, you will be able to:
• Explain the development, operational aspects and design principles of passenger vehicle and light truck transmission systems, their major components and sub-systems
• Describe the operational parameters and inter-relationships of each of the sub-systems
• Apply basic design synthesis and analysis techniques for each of the major components and sub-systems
• Compare and contrast ‘stepless’ to ‘stepped’ transmission technology
• Identify and describe the function and operation of all major components and sub-systems by participating in hands-on demonstrations
• Recognize the limitations, technological trends, and potential new products under consideration
• Summarize the direction of new passenger car transmission designs and systems

Who Should Attend
This seminar is intended for anyone not familiar with the operational theories or functional principles of modern vehicle transmission systems. As the material covered is targeted at a number of design and engineering disciplines, attendees should have a minimum of two years design experience in the automotive powetrain field, or preferably a B.S. in engineering or related field.

Topical Outline
DAY ONE
• Overview of Mechanical Power Transmission in a Passenger Vehicle and Light Truck -- Manual transmission; automatic transmission; continuously variable transmission (CVT)
• Theory, Function and Operation of Manual Transmission -- Design; main components; common configurations
• Vehicle Powertrain Requirements and Specifications Assessment
• Shift Strategy Analysis and Control System Implementation
• Components and Sub-systems -- Shifters, clutches, synchronizers, gears, shafts
• Basic Gear Theory and Application Development
• Powerflow Analysis
• Synchronizer Operation and Analysis
• Lubrication and Cooling Requirements Review
DAY TWO
• Development and Layout of the “Automatic” Transmission -- Front-wheel drive; rear-wheel drive; four-wheel drive
• Functionality -- Torque converter operation; gear systems; gear design considerations; type; layout; NVH (Noise, Vibration and Harshness); epicyclic powerflow
• Extension of Gear Theory to Epicyclic Gear-trains
• Design and Operation of Clutches and Bands
• Application of One-Way/Over-Riding Clutches
• Powerflow Analysis of Torque Converters, Epicyclic Gear Sets
• Review of Shift Strategy
• Implementation of Shift Strategy Through Hydro-Mechanical Control Systems
• Simple Shift Model Analysis
• Lubrication and Cooling Requirements Review
DAY THREE
• CVT Design and Operation -- Theory and function; typical layout; main components
• Technological Development of the CVT
• Basic Theory of Friction Drives
• Toroidal Drive Technology -- Theory of operation; main components; benefits and limitation of the technology
• Functionality and Characteristics of CVT Components, Sub-systems -- Gearbox housing; variators; forward clutch; converter housing; input shaft; selector shift valve; differential; output shaft; mechatronic control unit; belt/push chain
• CVT Power-Flow -- Torque converter; primary variator; secondary variator; output shaft
• Mechatronics -- Torque converter operation; general implementation; CVT application
• CVT Manufacturing -- Theory and operation; general implementation; CVT application
• Future Technologies -- “Manualized” automatics, automated manuals; DCT, SSCT, DSCT

Instructor: William Mark McVea
Fee $1695 2.0 CEUs

Fundamentals of Modern Vehicle Transmissions e-Seminar
14 Hours
I.D.# PD1304190N
A similar course is available as a classroom seminar—Fundamentals of Modern Vehicle Transmissions – see course info above.

Convenient, portable, and with core content from the instructor-led seminar (view seminar description above), this 14 hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into nine video modules, accompanied by a handbook.
High-Performance Differentials, Axles, & Drivelines

2 Days  I.D.# C1113

Every automobile has a differential and most have axles, yet the exact function of these is not common knowledge. 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.

The seminar begins by defining the axle fundamentals and operation followed by an in-depth review of original equipment axles, differentials, torque bias, hypoid gears, and rebuild steps. The different manufacturing and service techniques required for different gear architectures is also reviewed. The seminar concludes with a unique applications-specific workshop and industry trends discussion. 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.

Topical Outline

DAY ONE

• Axle Fundamentals
  • Lube flow
  • Venting
  • Housing reaction loads
• Axle housing types
  • Beam axles - Banjo / Salisbury
  • Independent axles
  • Quick change axles
• Axle tubes
• Axle shaft retention methods
• Common axle identification
• Axle rebuild
  • Common axle problems
  • Axle disassembly; Axle Reassembly
  • Component inspection
• Differentials
  • Theory and practice of open differential
  • Factory installed limited slip differentials
  • Torque bias ratio explanation
  • Teardown and rebuild process
  • Review preload and friction modifier

DAY TWO

• Aftermarket differentials
  • Review advantages and disadvantages of the following:
  • Open differentials; Locking differentials
  • Limited slip differentials
  • Spool and mini-spools
  • Helical differentials
### Introduction to Powertrain Calibration  
**Engineering Web Seminar**

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<th>Instructor:</th>
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**4 Hours**  
I.D.# WB1346

Driven by the need for lower emissions, better fuel economy and improved drive quality, optimized powertrain calibrations are required for the many different vehicle configurations on today’s roadways. While powertrain components such as the internal combustion engine, transmission, and hybrid electric powertrain are somewhat familiar to the automotive industry, the control theory, calibrations and system interactions between these components are a relatively unfamiliar aspect.

This Web Seminar will introduce participants to the concepts behind optimized powertrain calibrations and how they impact fuel consumption, exhaust emissions, and vehicle performance. Participants will also gain exposure to the role that the calibration plays in the system level interactions of the various powertrain components.

Each participant will be asked to view the recording from the one-hour SAE Vehicle/Powertrain Calibration Engineering: What Is It and Why Is It For You? Telephone/Webcast as a course requirement.

**Learning Objectives**

By connecting with this Web Seminar, you will be able to:

- Describe the role of calibration in powertrain and vehicle performance
- Identify the fundamental requirements that drive powertrain calibration development
- List the major international regulatory agencies
- Identify the driving factors for complexity of powertrain systems
- Identify the powertrain system interactions that are influenced by calibration
- Recognize tools used in the development of powertrain calibrations
- Diagram the high level calibration process flow

**Who Should Attend**

This Web Seminar is intended for anyone who would like a better understanding of powertrain calibration and how it influences vehicle performance and drivability. Engineering students with an automotive interest through automotive professionals will gain insight into the calibration process and its system impact. It will also be beneficial to those involved in the specification, design, development, testing and planning of vehicles and powertrains. Product planners and program managers will find the overview aspects helpful.

**Prerequisites**

A background in mechanical or electrical engineering will assist in gaining maximum benefit from the material presented. Experience or training in engine or transmission engineering is helpful, but not essential.

**Topical Outline**

**Session 1**

Requirements, Boundary Conditions and Complexity
- Fundamental requirements driving powertrain calibration  
  - Regulations
  - Vehicle Requirements; Environmental requirements
- Overview of the factors driving complexity in powertrain calibration systems  
  - Global requirements
  - Fuels
  - Product hardware

Calibration Functional Objectives
- Overview of some basic powertrain calibration tasks including base engine, transmission, OBD, aftertreatment, vehicle driveability
- Base Engine Calibrations  
  - Steady state models (air charge, exh backpressure, knock thresholds)
  - Single point optimizations (spark, AFR, VVT, EGR, FUP, etc.)
  - Simple transients
- In-vehicle validation of dyno cals  
  - Steady state correlation
  - Transient conditions
  - Knock behavior and fuel sensitivity

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• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
POWER AND PROPULSION

- Vehicle-specific Calibrations
  - Pedal progression
  - Drive/shift quality
  - Emissions
  - Performance
- Location-Specific Calibrations
  - Customer expectation of “normal” behavior in all climates
  - Hot weather (component protection)
  - Cold Weather (Emissions, startability, drive quality)
- Altitude (Emissions, startability, drive quality, performance)

Session 2
- Systems - How they interact
  - What is a powertrain system?
  - Powertrain subsystem calibration and interactions (engine, aftertreatment, transmission, hybrid, control)
  - Overview of some basic powertrain components and their effects on the overall system
  - Communication between systems and components
  - The calibration engineer’s role in the overall development process as the bridge between hardware and controls
- Calibration Tasks
  - Testing environments for calibration engineers including simulations, engine test cells, powertrain test cells, chassis dynamometer test cells and test track/field testing
  - Tools of the trade - industry standard tools and specialized tools that calibration engineers use
  - Using test data to create a calibration including modeling, optimization and table generation

Instructor: Julian Blair, Greg Banish, Talus Park, Chi Binh La
Fee $405 .4 CEUs

INTRODUCTION TO GEARS

This seminar is designed to provide gear novices with a general understanding of gear nomenclature, geometry, and arrangements. Starting with the basic definition of gears, conjugate motion and the “Laws of Gearing”, you will gain a solid understanding of gearing and the fundamentals of rotary motion transfer through gear-trains. Gear classifications, tooth forms and geometry, and very high-level application considerations, manufacturing processes, and inspection techniques will be covered.

Attendees will receive a copy of the book, Gear Design Simplified, by Franklin D. Jones & Henry H. Ryffel.

LEARNING OBJECTIVES

By attending this seminar, you will be able to:
- Describe the “Law of Gearing”, conjugate action and involute profiles
- Identify the various gear types and configurations
- Articulate the various definitions and terms used in gearing
- Identify the function and operation of all gear arrangements
- Articulate basic design considerations, nomenclature and inter-relationship of gear forms and motions
- Describe the various manufacturing processes and inspection techniques commonly used in industry today

WHO SHOULD ATTEND

This seminar is designed for individuals with little or no previous experience in gear systems. Engineers new to the field of gearing, sales and marketing people responsible for interacting with gear engineers, component suppliers, and vehicle platform powertrain development specialists who have not been previously involved in gear system specification or design will benefit from this course.

TOPOGRAPHIC OUTLINE

- Principles and Purpose of Gears
- Basic Concepts
  - Law of Gearing
  - Common Tooth Forms
- Classification of Gears
- Definitions and Terms Used in Gearing
- Gear Tooth Action
- Conjugacy
- Gear Geometry and Nomenclature
  - Tooth and blank nomenclature
- Gear Arrangements
  - Simple and compound gear train

TRANSMISSION/DRIVETRAIN CERTIFICATE PROGRAM

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

This program familiarizes you with key drivetrain components and how those components function as a system. Complete this certificate to increase your expertise within the drivetrain body of knowledge and, at the same time, earn the SAE Certificate of Achievement.

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POWER AND PROPULSION

- Ratios: What They Mean and How to Calculate
- Epicyclic
  - Configurations (Solar, Planetary, Star)
  - Ratios
- Gear Measurement and Inspection
- Charts - Involute, Lead, and Red Liner
- Dimension Sheet

Instructor: William Mark McVea
Fee $785 0.7 CEUs

Introduction to the Planetary Gear Train: Principles and Practices

1 Day
I.D.# C1350

The planetary gear train is a core component of the automatic transmission system. The ability of the planetary gear train to deliver reliable gains in power, durability, higher torque-to-weight ratios, and configuration flexibility has enabled this gear set to become a key component of the automotive powertrain. A fundamental understanding of planetary gear trains is critical for individuals working in the automotive and industrial transmission fields.

In this introductory one-day seminar on the basic principles of the planetary gear train, the instructor will guide participants through the basic structure and the various types of planetary gear trains. In addition, participants will be introduced to ratio calculation methods, gear train arrangements and power flow, component life estimation, and related NVH issues. Together, the principles and practices presented in this seminar will provide participants a fundamental and practical understanding of this important technology.

Learning Objectives
By attending this seminar, you will be able to:
- Identify key components of the planetary gear train structure
- Explain relevant terms and theories
- Evaluate gear train arrangements
- Identify issues surrounding gear stress and NVH
- Evaluate ratio calculation methods and ratio change mechanisms

Who Should Attend
This course is intended for all individuals interested in gaining a fundamental understanding of automobile planetary gear train design, development, and application in the automotive and industrial transmission fields.

Topical Outline
- Planetary Gear Train Structure
- Gear Terms and Theories
- Planetary Gear Types and Ratio Calculation Methods
- Automatic Vehicle Planetary Geartrain Arrangements
- Geartrain Power Flow
- Ratio Change Mechanism
- Gear Component Load/Stress and Associated Durability Life Estimation
- Geartrain NVH (Noise, Vibration and Harshness) Issues

Instructor: Joseph Chen
Fee $755 0.7 CEUs

Powertrain Selection for Fuel Economy and Acceleration Performance

2 Days
I.D.# C0243

Developing vehicles that achieve optimum fuel economy and acceleration performance is critical to the success of any automotive company, yet many practicing engineers have not received formal training on the broad range of factors which influence vehicle performance. This seminar provides this fundamental understanding through the development of mathematical models that describe the relevant physics and through the hands-on application of automotive test equipment. Attendees will also be introduced to software used to predict vehicle performance.

The course begins with a discussion of the road load forces that act on the automobile (aerodynamic, rolling resistance, and gravitational) followed by a review of pertinent engine characteristics. This background information is then used to show how appropriate gear ratios for a vehicle transmission are selected and to develop models for predicting acceleration performance and fuel economy. The models form the basis for the computer software used to predict vehicle performance. Participants will also use an in-vehicle accelerometer, GPS fifth-wheel, and an OBDII scanner to measure vehicle performance.

Learning Objectives
By attending this seminar, you will be able to:
- Explain the basic operation of the components in an automotive powertrain
- Calculate road loads on a motor vehicle
- Select appropriate gear ratios for a given engine/chassis combination
- Predict the effect of gear selection, body design, and weight on the fuel economy of a vehicle
- Explain and utilize the mathematical models for predicting the acceleration of an automobile
POWER AND PROPULSION

• Explain and utilize the mathematical models for predicting the fuel economy of an automobile
• Use computer software for predicting vehicle fuel economy and performance

Who Should Attend
As this seminar is designed for automotive engineers involved in the design and development of automotive powertrains (with special value for entry-level engineers and others seeking to develop a fundamental understanding), attendees should have a degree in mechanical engineering or a related field, be able to apply Newton’s second law of motion, and be familiar with spreadsheets and simple computer programming concepts.

Topical Outline
DAY ONE
• Course Introduction/Powertrain Configuration
  • Powertrain layout: front-wheel drive, rear-wheel drive, four-wheel drive
  • Powertrain components: engine, clutch/torque converter, transmission, drive shaft, differential, tires
• Road Load Forces and Power
  • Vehicle freebody diagram
  • Aerodynamic forces
  • Rolling resistance forces
  • Gravity forces
• Vehicle Coastdown Test
  • Theory behind coastdown test
  • GPS fifth-wheel
  • SAE Recommended Practice J1263
• Vehicle Ttractive Effort
  • Characterization of internal combustion engines
  • Characterization of pneumatic tires
• Drivetrain Selection
  • Vehicle design criteria
  • Selection of top gear ratio
  • Selection of low gear ratio
  • Selection of intermediate gear ratios
DAY TWO
• Analysis of Power and Torque Flow in Drivetrain Components
  • Clutches
  • Standard & planetary gear sets
  • Axles and differentials
  • Manual transmissions
  • Automatic transmissions
  • Torque Converters
• Acceleration Performance Prediction
  • Vehicle acceleration modeling
  • Effects of drivetrain component selection
• Road Load and Acceleration Power Testing Laboratory
  • In-vehicle accelerometer
  • GPS fifth-wheel
  • SAE Recommended Practice J1491
• Fuel Economy Prediction
  • Vehicle fuel economy modeling
  • EPA driving cycles
  • CAFE standards
  • Effects of drivetrain component selection
  • SAE recommended practice J1256
  • Emissions prediction
  • Demonstration of Vehicle Performance Software
    • DOE Advisor
    • Commercial packages
    • Effects of drivetrain component selection

Instructor: Craig J. Hoff and Gregory Davis
Fee $1325 1.3 CEUs

Powertrain Controls (PTC) - Ford Online Course

6 Hours
I.D.# PD111013ON

The Ford Powertrain Controls (PTC) online course introduces the critical role the powertrain controls system plays in providing excellent vehicle performance, fuel economy, driveability, and emissions. The course describes the powertrain controls system components, including sensors and actuators. The information is presented from a functional, interface diagram, and p-diagram perspective, to enable reliable and robust powertrain operation.

This 6-hour online course is intended to stimulate systems interaction thinking by emphasizing powertrain controls interactions with internal and external interfaces and to help you understand powertrain control systems, prevent late design changes, reduce warranty costs, and improve customer satisfaction.

Major topics include:
• Powertrain Controls Overview
• Powertrain Controls Hardware
• Powertrain Controls Software/Calibration and Diagnostics
• Powertrain Controls Reliability and Robustness
• Powertrain Controls Interfaces
• Sensors and Actuators
• Powertrain Controls Modes of Operation

Is this SAE/Ford Online Course for you?
This course is geared toward powertrain, product development, quality, and manufacturing engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.
Power and Propulsion

What You Will Receive

• Three months of online access to the six hour course
• Proof of Participation

Fee $215

Powertrain As-Installed Driveline Subsystems (PAIDS) - Ford Online Course

8 Hours
I.D.# PD111014ON

Powertrain as-installed subsystems have a common fundamental function to perform in harmony, enabling the engine to power the vehicle and/or accessories. There is a need to avoid issues such as idle roughness and to realize these are system interaction issues. For example, modal alignment affects idle roughness, and improving idle roughness can affect fuel economy.

This 8-hour Ford Online Course describes the function and major interfaces of powertrain as-installed driveline subsystems. It also discusses Design Verification System (DVS) metrics/performance requirements for each subsystem and how each subsystem affects other subsystems.

Major topics include:
• Introduction to Driveline
• Drive Axles
• Driveshafts/Halfshafts
• Transfer Case/PTU/Coupling/RDU

Is this SAE/Ford Online Course for you?
This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

• Three months of online access to the six hour course
• Proof of Participation

Fee $275

Powertrain As-Installed Stationary Subsystems (PAISS) - Ford Online Course

12 Hours
I.D.# PD111015ON

Powertrain as-installed subsystems have a common fundamental function to perform in harmony, enabling the engine to power the vehicle and/or accessories. There is a need to avoid issues such as idle roughness and to realize these are system interaction issues. For example, modal alignment affects idle roughness, and improving idle roughness can affect fuel economy.

This 12-hour Ford Online Course discusses hardware design, function, and major interfaces of powertrain as-installed stationary subsystems. It also discusses Design Verification System (DVS) metrics/performance requirements for each subsystem and how each subsystem affects other subsystems.

Major topics include:
• Accelerator Controls
• Air Induction
• Engine and Transmission Cooling
• Exhaust
• Fuel
• Powerplant Mounts

Is this SAE/Ford Online Course for you?
This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

• Four months of online access to the six hour course
• Proof of Participation

Fee $395

Powertrain Driveability - Ford Online Course

3 Hours
I.D.# PD111016ON

Driveability is the result of a system’s interaction between the powertrain, the vehicle, and the customer. Driveability concerns can arise in any mode of operation and have a common factor that all are the result of a change in engine/torque speed. Driveability is a key customer-driven Powertrain attribute. Improving driveability is critical to improving customer satisfaction and competitiveness of vehicles.

Is this SAE/Ford Online Course for you?
This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

• Three months of online access to the six hour course
• Proof of Participation

Fee $275

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• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
All Powertrain Product Development engineers must know how their area of subsystem responsibility could affect vehicle Driveability. This 3-hour Ford Online Course will provide knowledge of driveability fundamentals. With this knowledge, you can better determine actions to improve the customer’s perception of driveability.

**Major topics include:**
- The Customer’s Perspective
- Systems and Interfaces that Impact Driveability
- Evaluating a Vehicle’s Driveability Performance

**Is this SAE/Ford Online Course for you?**
This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

**What You Will Receive**
- Three months of online access to the three hour course
- Proof of Participation

**Fee** $115

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**Powertrain Performance Feel - Ford Online Course**

**3.5 Hours**
I.D.# PD111017ON

In addition to NVH, Driveability, and Shift Quality, Performance Feel is among the four Powertrain attributes that directly influence customer satisfaction. It is defined in terms of the availability of power to the end customer and is the customer perception of performance that includes the effects of vehicle acceleration, accelerator control characteristics, shift character, and sound quality.

This 3.5-hour Ford Online Course is intended to increase the awareness of vehicle Performance Feel issues, target setting process, and the interactions and controls that affect Performance Feel.

**Major topics include:**
- Performance Feel from the Customer’s Perspective
- Performance Feel from an Engineering Perspective
- Metrics and Targets of Performance Feel
- Performance Feel Design Considerations

**Is this SAE/Ford Online Course for you?**
This course is geared toward powertrain, product development, quality, and manufacturing engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

**What You Will Receive**
- Three months of online access to the 3.5 hour course
- Proof of Participation

**Fee** $125

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**Planetary Geartrain Design, Development, and Applications for Automatic Transmissions**

**2 Days**
I.D.# C1351

A comprehensive and practical understanding of planetary gear trains is critical for individuals involved with the design and development of automatic transmissions. A key component of the automatic transmission system, the planetary gear train is able to deliver reliable gains in power, durability, higher torque-to-weight ratios, and configuration flexibility.

This two-day seminar will provide participants an advanced and comprehensive presentation on the topics of planetary gear train design, development, and applications for automatic transmissions. The instructor will guide participants through an increasingly complex set of topics including planetary gear train requirements, case study, and future trends in advanced transmission design and development.

**Learning Objectives**
By attending this seminar, participants will be able to:
- Explain relevant terms and theories
- Identify and select key components of the planetary gear train structure
- Evaluate ratio calculation methods and ratio change mechanisms
- Evaluate and compare gear train arrangements
- Identify and solve gear stress and NVH issues
- Anticipate and address manufacturing concerns
- Identify future trends in gear train design and development

**Who Should Attend**
This course is intended for all individuals desiring an advanced and comprehensive understanding of automobile planetary gear train design, development, and application in the automotive and industrial transmission fields.

**Topical Outline**
**DAY ONE**
- Planetary Carrier Arrangement for Installation
- Planetary Gear Train Construction and Ratio Selection Case Study
- Gear Ratio Change and Shifting Mechanisms
POWER AND PROPULSION

- Planetary Gear Train Design- Stress and Life Calculations
- Planetary Gear Train System Simulation
- Power Flow Issues in Complicated Drive Train Systems
- Ratio Change Mechanisms and Related Control Methods
- Planetary Pinion Speed, G-Load, Thrust Washer and Bearing Subsystem Design
- Planetary Gear Train Testing and Failure Mode Analysis

DAY TWO
- Multiple Pinion Arrangements with Assessment
- Lube Method and its Effect on Planetary Gear Train Life
- Planetary Efficiency and Fuel Economy Estimation
- Planetary Pinion Pin Location, Carrier Deflection, and Load Sharing
- Planetary Gear Train NVH Issues
- Duty Cycles and System NVH
- Planetary Component Manufacturing and Process Issues
- Future Trends in Advanced Transmission Development
- Course Summary and Conclusion

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 as well as individuals from OEMs, suppliers, emissions service companies, research facilities and universities will gain modern knowledge of diesel filter performance.

Prerequisites
Students should have some technical insight into the performance of exhaust emission aftertreatment. Attendees with science or technology background (mechanical/chemical engineering, chemistry, physics) will benefit substantially from this seminar.

Topical Outline
DAY ONE
Porous Media Basics for Diesel Particulate Filters
- Pore space and structure definitions (definitions of relevant length scales, derivation of “pore metrics” such as correlation lengths, lineal path distributions.)
- Simplified representations of structures (unit cell models based on granular, cylindrical and composite collectors.)
- Flow resistance descriptors (Darcy permeability, Forchheimer coefficient, inertial loss coefficient as functions of wall micro-geometry, cell density, wall thickness, plug length)

Filtration Concepts for Diesel Particulate Filters
- Particle transport and deposition phenomena -- Condensed vs. vapor phases in diesel exhaust; Diesel fractal soot aggregate basics; Diffusional transport; Thermophoretic transport;

ENVIRONMENT AND EMISSIONS CONTROL

Advanced Diesel Particulate Filtration Systems
2 Days
I.D.# C0502

As diesel emissions regulations have become more and more stringent, diesel particulate filters (DPF) have become possibly the most important and complex diesel aftertreatment device. This seminar covers many 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 as well as individuals from OEMs, suppliers, emissions service companies, research facilities and universities will gain modern knowledge of diesel filter performance.

Prerequisites
Students should have some technical insight into the performance of exhaust emission aftertreatment. Attendees with science or technology background (mechanical/chemical engineering, chemistry, physics) will benefit substantially from this seminar.

Topical Outline
DAY ONE
Porous Media Basics for Diesel Particulate Filters
- Pore space and structure definitions (definitions of relevant length scales, derivation of “pore metrics” such as correlation lengths, lineal path distributions.)
- Simplified representations of structures (unit cell models based on granular, cylindrical and composite collectors.)
- Flow resistance descriptors (Darcy permeability, Forchheimer coefficient, inertial loss coefficient as functions of wall micro-geometry, cell density, wall thickness, plug length)

Filtration Concepts for Diesel Particulate Filters
- Particle transport and deposition phenomena -- Condensed vs. vapor phases in diesel exhaust; Diesel fractal soot aggregate basics; Diffusional transport; Thermophoretic transport;
Direct interception mechanism; Inertial transport mechanism;
Other phenomena (electrical effects, sticking, entrainment by exhaust flow)
• Continuum filtration theory -- Deep-bed filtration regime;
Cake filtration regime reconstruction of filter media
• True-to-the-geometry representations (digital reconstruction of filter media, micro-flow simulation with Lattice-based techniques and discrete particle dynamics. Examples applied to granular ceramic extruded filters, sintered metal filters, foam filters and fibrous textile filters.)

Diesel Filter Types: Materials and Configurations in Practice
• Materials aspects
  • Ceramics -- Oxide based: Cordierite, Mullite, other (Tialite/Aluminum Titanate, etc.); Non-oxide based: Recrystallized Silicon Carbide (R-SiC), Siliconized Silicon Carbide (Si-SiC), Silicon Nitride
  • Metallics (high temperature alloys) -- Sintered grains and fibers
• Configurations
  • Wall-flow honeycombs (square, triangular, symmetric vs. asymmetric channels.)
  • Pleated, foiled (sheet-based) designs
  • Fibrous, textile cartridges
  • Foam-based designs
  • Flow-through particulate collectors

DAY TWO
Applications, Performance Optimization and Modeling of Diesel Particulate Filters
• Filter backpressure/particulate loading -- Porosity, permeability, pore structure issues; Role of catalyst coatings; Filter size effects (length, diameter, cell density, wall thickness); Microstructure of soot deposits (physical and chemical properties); Soot deposition conditions and role on soot structure: Steady state, transients, cycles; Modeling aspects
• Filter Regeneration
  • Soot reactivity and structure -- Oxidation mechanisms (thermal, catalytic, NO2); Kinetic descriptions
  • Types of regeneration technologies -- Raising exhaust temperature by post-injection and/or by exhaust-port injection in combination with DOxC; Fuel borne additive-assisted regeneration; Catalyst coating-assisted regeneration; Reactive species-assisted regeneration (NO2-assisted, non-thermal plasma, etc.)
• Simulation Techniques for Diesel Particulate Filters -- Brief history of DPF performance modeling; Backpressure -- Theory, insights and lessons; Modeling: demonstrations, validations; Regeneration -- Theory, insights and lessons; Modeling: demonstrations, validations
• Ash Effects -- Ash production, transport, deposition and thermal history; Ash effects on filter thermal management, catalyst activities, and filter sizing

Instructor: Athanasios Konstandopoulos and Mansour Masoudi
Fee $1325 1.3 CEUs

Automotive Heat Transfer
2 Days
I.D.# C1230
Heat transfer affects the performance, emissions and durability of the engine as well as the design, packaging, material choice and fatigue life of vehicle components. This course covers the broad range of heat transfer considerations that arise during the design and development of the engine and the vehicle with a primary focus on computational models and experimental validation covering the flow of heat from its origin in the engine cylinders and its transfer via multiple paths through engine components. Specifically, the course will cover heat transfer design considerations related to the following: engine cooling and lubrication systems as well as bay-to-bay breathing; exhaust system and after-treatment components; tail pipe gas temperatures, as well as thermal interactions between the engine and its exhaust system with the components in the vehicle under-hood and under-body; turbochargers; passenger cabin HVAC system, including windshield de-icing; battery cooling; heat exchangers and challenges associated with predicting thermal mechanical fatigue life of components.

Learning Objectives
By attending this seminar, you will be able to:
• Formulate solutions to heat transfer problems to optimize component design for durability and cost
• Make more reliable predictions of engine in-cylinder heat transfer rates (and therefore thermal stresses and fatigue life) for engine components, namely, the cylinder head, piston, cylinder liner, valves and ports
• Optimize design decisions for above engine components by improving trade-offs between material choices, design, durability, packaging, heat flow map and cost
• Specify thermal boundary conditions for under-hood and under-body CFD models early in a vehicle development program when only high level engine and performance metrics have been defined.
• Predict energy losses due to bay-to-bay breathing
• Describe techniques to facilitate thermal management of exhaust aftertreatment devices (DOC, SOC, particulate filters) and tail pipe exit gas temperatures for diesel vehicles
POWER AND PROPULSION

Who Should Attend
This course will be valuable to engine and vehicle engineers dealing with heat transfer issues. Specifically thermal and structural analysis engineers will learn best practices for making reliable analysis predictions. Hardware release engineers will gain a better appreciation of the limits and capabilities of the analysis and measurement technologies that drive their decisions. Supervisory and managerial persons with the responsibility for solving thermal problems that arise during sub-system design and development will gain a better appreciation of the uncertainties and trade-offs behind the thermal decisions for which they are ultimately responsible. Vehicle thermal engineers will gain knowledge to assist them in making design and packaging decisions in the early stages of vehicle development. This unique course will give in-depth insights into thermal considerations spanning the entire vehicle, providing subsystem specialists with an overall perspective of the other vehicle system issues and constraints with which they may not be familiar.

Topical Outline
Day One
• Introduction
  • Engine and exhaust components
  • Heat transfer CFD
• Engine In-Cylinder Heat Transfer
  • Background
  • Benchmark in-cylinder measurements
  • Interaction of heat transfer with combustion
  • Zero & multi-dimensional modeling
  • Standard and modified wall functions
  • Low Reynolds Number Model
  • Heat transfer coefficients
  • Validation with measurements
• Engine Component and Sub-System Heat Transfer
  • Overview
  • Piston, liner, head and valve temperatures
  • Bay-to-bay breathing
  • Engine cooling system considerations
  • Engine lubrication system considerations
Day Two
• Exhaust System Heat Transfer
  • Interaction with under-hood components
  • Design decisions early in a vehicle program
  • Turbochargers
  • After treatment devices
  • Tail pipe gas temperatures
  • Materials, properties and temperatures
  • Thermo-mechanical fatigue
• Heating, Ventilation and Air Conditioning
  • Passenger compartment human comfort
  • Energy transactions and heat transfer parameters

Instructor: Raj P. Ranganathan
Fee $1225 1.3 CEUs

Catalytic NOx Control Technologies for Diesel and GDI Engines Web Seminar
6 Hours
I.D.# WB1237
Lean burn engines (diesel and GDI) boast higher fuel economy and cleaner emissions than conventionally tuned engines while producing equivalent power. They employ higher combustion chamber compression ratios, significant air intake swirl and precise lean-metered direct fuel injection. The downfall of lean-burn technology, however, is increased exhaust NOx emissions (due to higher heat and cylinder pressure) and a somewhat narrower RPM power-band (due to slower burn rates of lean mixtures). Removal of NOx from exhausts is a critical need for emission standards and ambient ozone requirements. This three session Web Seminar will examine the various catalytic processes for lean burn applications, including Selective Catalytic NOx Reduction (SCR), NOx Trap Technologies (i.e. LNT, NSR), and the combination of SCR, NOx Trap and Hydrocarbon NOx Reduction (LNC). It will focus in on SCR NOx fundamentals, equipping participants with the basic concepts for NOx control and important design parameters for SCR NOx catalyst. The course will examine the system design for SCR in diesel applications including passenger cars and heavy duty trucks, including SCR catalysts, SCR integration with diesel particulate filter, key sensor development catalyst durability issues and urea control.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Define NOx catalysis and identify key acronyms
• Describe in-use issues
• Cite key elements in NOx catalyst design for diesel applications
• Define SCR design for passenger cars and heavy duty applications
• Identify available sensors for SCR catalyst performance monitoring
• Determine where lean NOx traps may be appropriate versus SCR NOx control
Who Should Attend
This Web Seminar will be especially valuable for mechanical, metallurgical and chemical engineers, materials scientists, and chemists involved in the design, operation and calibration of a NOx emission control system for both mobile and stationary source applications, such as automobiles, trucks, buses, ships, locomotives, stationary engines, small engines, etc. It will also help the newly hired engineer assigned to an emission control team, the seasoned veteran who just transferred to the emission control group, sales people responsible for emission controls, plant managers concerned about meeting new regulations with catalytic controls, and regulators now involved in transmission technologies. Participants should have a basic familiarity with automotive emissions for gasoline engines, diesel engines or off-road applications. The Fundamentals of Catalytic Converter Integration for Emission Control Web Seminar RePlay is a recommended prerequisite for those with less than three years of experience with catalytic converters. See page 71 for information on this course.

Topical Outline
Session 1
Lean NOx Catalysis
• NOx reduction catalytic approaches
• Lean NOx reduction fundamentals
• Hydrocarbon NOx reduction (LNC)
• NOx traps technologies (LNT, NSR or NAC)
• SCR Cataytic NOx reduction (ammonia based)
• Combination SCR/NOx traps

Session 2
SCR NOx Catalyst
• SCR NOx catalytic approaches (Vanadia and Zeolite)
• Performance characteristics of SCR NOx catalysts (Vanadia and Zeolite)
• Comparison of commercial issues with lean NOx traps and SCR

Session 3
SCR Catalyst Design Mobile Applications
• Passenger cars
• Heavy duty systems
• Auxiliary equipment design
• Sensor performance
• Catalyst durability

Instructor: Ronald Heck
Fee $535 .6 CEUs

Combustion and Emissions for Engineers
3 Days
I.D.# 97011
Public awareness regarding pollutants and their adverse health effects has created an urgent need for engineers to better understand the combustion process as well as the pollutants formed as by-products of that process. To effectively contribute to emission control strategies and design and develop emission control systems and components, a good understanding of the physical and mathematical principles of the combustion process is necessary. 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.

Learning Objectives
By attending this seminar, you will be able to:
• Identify and describe the important processes in combustion and emission
• Identify the formation mechanisms and reduction strategies of pollutant species in combustion systems
• Recognize the effects of engine design and operating conditions on combustion and emission
• Explain the technology and the logic behind after-treatment of pollutants
• Identify the underlying laws and principles used in combustion and emission black-boxed computer programs
• Explain the role chemical kinetics plays in the design of low-emission combustion systems
• Identify design trade-offs between increasing engine performance and maintaining low emission characteristics

Who Should Attend
Engineers working on the design of combustion engine components, software development and application for modeling of thermal-fluid, combustion and emissions processes, and those working on the reduction of harmful pollutants emissions will find this course valuable.

Topical Outline
DAY ONE
• Air Composition
• Concept of “Complete Combustion”
• A/F & Stoichiometric (A/F) ST, and (Equivalence Ratio)
• Lean, Rich, Stoichiometric Mixture
• First and Second Law and Applications in Combustion Systems
• Adiabatic Flame Temperature, Heat of Reaction (or Heating Value) and Their Usage
• Thermodynamic and Chemical Equilibrium
• Demonstration Applications of Equilibrium Using Computer Simulation (SuperState)
Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems

3 Days
I.D.# C0707

On-board diagnosis of engine and transmission systems has been mandated by government regulation for light and medium vehicles since the 1996 model year. The regulations specify many of the detailed features that on-board diagnostics must exhibit. In addition, the penalties for not meeting the requirements or providing in-field remedies can be very expensive. 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 include a review of the California Air Resources OBD II regulation, providing students with a firm foundation for reading and understanding the requirements, including the in-use rate portion of the regulations and how to properly calculate and output the required rate information. Relationships between the regulation and various SAE and ISO recommended practices will be reviewed. 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

Instructor: Bruce Chehroudi
Fee $1725 2.0 CEUs
POWER AND PROPULSION

• 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 designed for engineers involved in either the design or control of on-board diagnostic systems for engines or transmissions for light and medium duty on-road vehicles. Individuals working in the heavy duty industry may also find the information interesting, but should note that the examples will be geared towards spark ignition engines and light and medium duty regulations. In addition, engineers involved in engine and transmission hardware will benefit by obtaining a better understanding of the design of OBD systems. Engineers new to the area of OBD system design and engineers involved in the design of control systems wishing to obtain a better understanding of OBD requirements will also find the course valuable.

Topical Outline
DAY ONE
• Fundamental Design Objectives for OBD Systems
• Basic Design Features for OBD Systems
• Exercise: “Customers” and their OBD Requirements
• Overview of the World Wide OBD Regulatory Structure
• California Air Resources Board (CARB) Regulatory Process
• How to use the CARB Light/Medium Regulation
  • Malfunction and diagnostic system requirements
  • Enforcement of malfunction and diagnostic system requirements

DAY TWO
• CARB Regulation - an in-depth look at:
  • In-use rates
  • Comprehensive component requirements
• Introduction to a Diagnostic Design Process (Box, Graves, Bisgaard, Van Gilder, et al)
• Defining “Good” vs. “Bad” Systems
• Exercise: Defining Good vs. Defective Systems
• Anatomy of an On-Board Diagnostic
• Diagnostic Modeling
• Exercise: Induction System Modeling
• Understanding and Dealing with Variation
• Decision making processes
• Design guidelines for Exponentially Weighted Moving Averages (EWMA)

DAY THREE
• SAE J1979 - An Overview
• Exercise: Finding Information in J1979

• System Design for Diagnosibility
• Overview of Regulatory Requirements Related to OBD
  • In-use Enforcement
  • Emissions warranty
• OBD Certification Process
• The Relationship between the Control and OBD System Design

Instructor: John Van Gilder
Fee $1745 2.0 CEUs

Evaporative and Refueling Emission Control

2 Days
I.D.# C0928

All gasoline powered vehicles and equipment create exhaust and evaporative and refueling emissions. Unlike exhaust emissions, which occur only when the engine is operating, evaporative emissions (evap emissions) occur all the time. Controlling evap emissions to PZEV levels is as challenging as controlling exhaust emissions. It becomes even more important in the case of plug-in hybrid electric vehicles (PHEV) and extended range electric vehicles (EREV) which generate evaporative fuel vapors, but have no place to burn/consume the vapors when the engine does not operate for extended periods of time. Constantly changing evaporative regulations including new test procedures for accommodating future EREVs and PHEVs vehicle evap systems, new test fuels to reflect changing commercial gasolines, identifying and controlling new sources of fuel vapor emissions, etc., require that individuals working in this area have a solid understanding of both regulatory and system design issues for evap emissions control.

This comprehensive seminar introduces the participants to the principles of gasoline evaporative fuel vapor generation (diurnal, hot soak, running loss, and refueling) from the vehicle fuel tank, fuel vapor storage in activated carbon canisters, and fuel vapor desorption and consumption in engine combustion. The seminar begins with an analysis of gasoline and gasoline/ethanol blends and estimation of their vapor pressures and vapor generation. In-depth analysis of various vapor generations as a function of fuel properties (ethanol content, Reid Vapor Pressure, etc.) and ambient conditions will be presented. Activated carbon canister design, OBD II leak detection, hydrocarbon permeation, and CARB and EPA evaporative test procedures will also be covered. Participants will have the opportunity to apply the knowledge gained by designing a sample evaporative and refueling emissions control system in class.

Participants are asked to bring a calculator for use in classroom exercises.
Learning Objectives
By attending the seminar, you will be able to:
• Identify various sources of evaporative fuel vapor emissions
• Predict the effects of ethanol on evaporative emissions
• Estimate diurnal and refueling vapor generation
• Analyze the differences in the test procedures: U.S., Europe, and Asia
• Explain activated carbon canister operation: loading, purging, vapor redistribution, and back-purge
• Identify potential solutions to induction hydrocarbon emissions
• Estimate the effect of altitude on evaporative emissions

Who Should Attend
This course is designed for engineers in all fields related to the design and development of evaporative and refueling emission control systems including platform fuel system design engineers for fuel tanks, onboard refueling vapor recovery systems, evaporative emission control canisters, fuel vapor lines, vapor purge lines, purge and vent valves, etc. Air induction system design engineers dealing with induction hydrocarbon adsorbers, powertrain fuel delivery design engineers responsible for canister purge vapors, powertrain calibration engineers responsible for evaporative canister purge and evaporative emission diagnostics, and environmental engineers who deal with state and federal emission regulations, will all find the seminar valuable.

Topical Outline
DAY ONE
• Introduction
  • Evaporative and refueling emission control system
  • Why and how to control fuel vapor emissions
• Fuel and Fuel Vapor Pressure
  • Hydrocarbon fuels
  • Oxygenated fuels and non-ideal solutions
  • Estimation of vapor pressures of ideal (hydrocarbon fuels) and non-ideal solutions (oxygenated fuels)
  • Flexible Fuel Vehicles (FFV) and fuel commingling
  • Vapor pressure and boiling point estimation
• Fuel Vapor Generation
  • Diurnal, hot-soak, running loss
  • Refueling - liquid seal and mechanical seal, hot tank/cold dispensed fuel, cold tank/hot dispensed fuel, RVP, air entrainment and vapor recirculation, etc.
  • Effect of altitude on vapor generation and fuel boiling in running loss test
  • Effect of oxygenates on fuel vapor generation and fuel boiling in running loss test
DAY TWO
• Carbon Canisters
  • Adsorbents and isotherms

• Activated carbons
• Adsorption/desorption phenomena
• Canister vapor loading, purging, redistribution, and back-purge
• Canister design
• Evaporative and Refueling Emission Control System Design
  • Test procedures - EPA & CARB 3-day test, EPA-ORVR, EPA & CARB 2-day test, ECE and other global EVAP test procedures, etc.
  • Canister sizing - determine optimum size
  • Purge air volume requirement
• Miscellaneous Evaporative Emission Control Topics
  • Hybrid and plug-in hybrid evaporative emission control
  • Pressurized/sealed and bladder fuel tank for evaporative emission control
  • Evap OBD II leak detection
  • Permeation losses - effects of materials, temperature, fuel composition, etc.

Instructor: Sam Reddy
Fee $1275 1.3 CEUs

Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems
1 Day
I.D.# C0235

Designing more efficient and robust emission control components and exhaust systems results in more efficient performance, reduced backpressure and fuel penalty, and higher conversion efficiency. This course will help you to understand the motion of exhaust flow in both gasoline and diesel emission control components including flow-through and wall-flow devices such as catalytic converters, NOx adsorbers, diesel oxidation catalysts, diesel particulate filters as well as flow through the overall exhaust system. Discussions will also cover: flow recirculation in inlet cones, flow maldistribution and its effect on conversion efficiency in flow throughs, non-uniform particulate deposit in diesel filters, and roots of non-uniformity in flow distribution due to exhaust system design such as bends.

Learning Objectives By attending this seminar, you will be able to:
• Describe how exhaust stream is distributed in flow-throughs in gasoline or in diesel emission components and in wall-flow components (catalytic converters, NOx adsorbers, DOC, diesel particulate filters), including in inlet cones, exit cones, bends, elbows, flow constrictions, and in other components of an exhaust system
• Design exhaust systems yielding higher conversion efficiency, lower backpressure, faster light-off, and optimal performance
• Design diesel particulate filter systems yielding more uniform soot distribution in filters, thus lowering both filter backpressure and its peak regeneration temperature
• Describe connections between flow distribution and thermal performance such as light-off and radial and axial temperature gradients

Who Should Attend
This seminar is intended for engineers, managers, designers, researchers and technical associates who wish to gain deeper insight into developments and optimization of exhaust systems and components. This also includes professionals involved with catalyst and emission components and exhaust sensors.

Topical Outline
• Flow-throughs (e.g. catalytic converters or NOx adsorbers)
  • The basics: flow distribution; roots of and various contributors to pressure drop; effect of geometry; effect of surface area, length and diameter; role of catalyst; etc.
  • How to optimize the performance
  • How to measure the pressure drop
• Wall-flows (e.g. diesel particulate filters)
  • The basics: flow distribution; roots of and various contributors to pressure drop; effect of geometry such as wall thickness, cell density, plugs, and aspect ratio; transport and deposit of particulate in filters and its effect on the filter performance; role of exhaust flow on regeneration
  • How to optimize the performance
  • How to measure the pressure drop
• Inlet and exit cones: flow recirculation in cones and its effect on backpressure and performance (e.g. conversion efficiency, particulate deposit, light-off, etc.)
• Similar analysis of other exhaust system components such as pipes, bends, elbows, and constrictions and expansions in the path of the exhaust flow

Instructor: Mansour Masoudi
Fee $755 .7 CEUs

SAE DIESEL TECHNOLOGY CERTIFICATE PROGRAM
Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

Designed to equip you with a solid understanding of diesel engines, emissions and aftertreatment strategies, and related components, the program requires completion of courses that address these areas and then facilitates further depth in aftertreatment technologies through a menu of electives. training.sae.org/certificate/dieseltech.

Exhaust Gas Recirculation (EGR) for Diesel Engines
2 Days
I.D.# C1214
Meeting the requirements of heavy-duty engine emissions regulations is a challenge for all engine manufacturers. Since the introduction of Exhaust Gas Recirculation (EGR) in medium and heavy-duty diesel engines, these systems have become more sophisticated and tightly integrated with emission control systems.

This 2-day seminar will explore the advantages and disadvantages of EGR and the most effective implementation of various EGR systems. This seminar will begin by defining EGR and why it is used in diesel engines, along with an explanation of the mechanisms by which EGR is able to reduce NOx. This seminar will then move into implementation of EGR systems and examples of these systems on medium and heavy-duty diesel engines. In addition, the impact of EGR on various engine components will be discussed and will include EGR coolers, valves and piping. Finally, a section will be devoted to the comparison between EGR and SCR and their future roles in reducing NOx emissions, as well as their impact on fuel efficiency and CO2 emissions. Emphasized in this comparison is the use of EGR in novel combustion systems and its ability to reduce emissions in-cylinder.

Learning Objectives
By attending this seminar you will be able to:
• Define EGR
• Recognize the different types of EGR systems used in diesel engines
• Evaluate the overall advantages and disadvantages of EGR systems in diesel engines
• Identify the impact of EGR on the combustion process
• Identify the impact of EGR on NOx and PM emissions
• Compare and evaluate EGR and SCR systems as a means to meeting emissions regulations

Who Should Attend
This seminar is designed for engineers and managers working in diesel combustion and emissions control technologies.

Topical Outline
DAY ONE
• Fundamentals of Exhaust Gas Recirculation
  • Defining EGR; Purpose of EGR
  • How EGR works
  • Why EGR is used in diesel engines
• Types of EGR Systems and Implementation
  • HPL EGR
Power and Propulsion

- LPL EGR
- Combination HPL and LPL
- Venturi-Assisted EGR
- Dedicated EGR

Advantages and Disadvantages
- EGR in general
- HPL EGR; LPL EGR

Impact of EGR
- On emissions, fuel economy, & engine wear

Opportunities for Unique EGR System Implementations
- Air-Augmented EGR systems
- EGR filtration systems

EGR System Design
- Calculations
- Modeling and Simulation
- Controls
  - System delay and control
  - Model-Based control system
  - Optimizing for BSFC, for smoke, for NEDC
  - Strategy for hybrid EGR
  - Throttle control valve

DAY TWO
- Impact of Turbocharging on EGR Performance
- EGR Coolers and Mixers
  - Installation
  - Design
  - Effects of EGR
- Examples of Production EGR Systems
  - Cummins
  - Volvo
  - Mack
  - Detroit Diesel
  - Navistar
- Issues and Challenges of EGR Implementation
  - Primary issues
  - Power density
  - Component design
  - Performance and combustion
  - Components
- Effect of EGR on Diesel Combustion
  - Emissions; Fuel consumption
  - Torque and power
  - Temperature
- EGR and Selective Catalytic Reduction (SCR) Systems Comparison
  - General comparisons
  - Future roles in reducing emissions

Ignition Issues and Their Impact on Engine Performance, Efficiency and Emission

2 Days
I.D.# C0131

Improved understanding and control of ignition and thereby combustion are critical in dealing with the problems of pollutants formation, engine performance, and fuel economy. This seminar will provide you with basic knowledge and recent advances in combustion-initiation (ignition) issues to more intelligently evaluate and harness their potentials. Thermodynamic and fluid mechanical properties of the unburned charge near the spark plug and at the time of ignition strongly affect the quality of the combustion and therefore the emission of the pollutants from the engine. Furthermore, a weak ignition limits engine performance and drivability. The so-called cyclic variability, which affects and bounds the lean and knock limits of an engine design is to a great degree influenced by the ignition system. Equally important, the ignition system can and is being used to provide local in-cylinder information on air-fuel ratio, misfire, knock, and mass fraction burned in each individual cylinder. Hence, great potential exists for applications of this information for individual cylinder control strategy to attain a more fuel efficient and environmentally compatible engine.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the important processes in ignition and its relation to engine performance, efficiency, and emission
- Explain the combustion process in internal combustion engines
- Apply ignition strategies for reduction of engine pollutants
- Recognize the effects of ignition system design and engine operating conditions on combustion and emission
- Describe the technology and the logic behind the current and future ignition-based engine diagnostics
- Assist in the design of critical components such as combustion chambers and exhaust systems
- Identify key design components of an ignition system for optimum combustion chamber design and low engine emission of pollutants

Who Should Attend

This seminar will be especially valuable for engineers, technical and project managers, researchers, and academicians involved in ignition and combustion/emission aspects of the combustion engines. Currently, the design strategy of many components in these engines is affected by combustion and emission control measures to meet customer’s, federal and local government’s demands and regulations. Therefore, engineers working on the design of components for high efficiency and performance

Instructor: Magdi Khair
Fee $1245 1.3 CEUs
of combustion engines as well as those directly and indirectly involved in ignition and emission reduction strategies will highly benefit from this seminar.

**Topical Outline**

**DAY ONE**
- A Concise Background on Combustion in Spark Ignited (SI) Engines
  - Cylinder pressure traces
  - MBT and ignition timing
  - Flame propagation issues
  - Combustion characterization
  - Cyclic variability
- Ignition Fundamentals
- Spark Ignition
  - Function of ignition system
  - Commonly used ignition systems
  - What determines the amount of ignition energy
- Four Phases of Spark Ignition
  - Pre-breakdown, breakdown, arc, and glow discharge

**DAY TWO**
- Effects of Some Key Parameters on Combustion, Emission and Performance
  - Higher power and/or energy
  - Longer duration discharge
  - Multiple spark plugs
  - Different spark plug designs
- Alternative Ignition Methods
  - Corona ignition system
  - Plasma-jet ignition system
  - Flame-jet ignition system
  - Activated radical (AR) ignition
  - Others
- Diagnostic and Control Opportunities
  - Use of spark voltage for monitoring combustion
  - Spark spectroscopy
  - Ionization measurement for engine health monitoring & diagnostics
- Ignition Systems for Highly Diluted Mixtures
- Conclusions

**Instructor:** Bruce Chehroudi

**Fee:** $1225 1.3 CEUs

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**Selective Catalytic Reduction for Diesel Engines**

2 Days  
I.D.# C0913

Stringent requirements of reduced NOx emission limits in the US have presented engineers and technical staff with numerous challenges. Several in-cylinder technical solutions have been developed for diesel engines to meet 2010 emission standards. These technologies have been optimized and have yielded impressive engine-out results in their ability to reduce emissions to extremely low levels. However, current and state-of-the-art in-cylinder solutions have fallen short of achieving the limits imposed on diesel emissions for 2010. To help meet emissions requirements, the catalyst industry has developed exhaust emission reduction technologies with impressive levels of performance. These technologies include hydrocarbon selective catalytic reduction (SCR), NOx absorber catalysts, and urea SCR.

This seminar will begin with an explanation of NOx formation in diesel engines and in-cylinder methods for reducing these emissions. The aftertreatment systems for NOx reduction will be explained and the advantages and disadvantages of these emission reduction technologies will be discussed.

In this two-day seminar, the primary focus is on urea SCR and its technology will be fully examined. The important chemical reactions and methods for improving SCR performance by encouraging desirable reactions and avoiding undesirable reactions are explained. Additionally, the components and control of a urea SCR system are detailed and the necessary sensors for its control are described. The SAE paper *Laboratory Testing of Urea-SCR Formulations to Meet Tier 2 Bin 5 Emissions* is included in the course materials.

**Learning Objectives**

By attending this seminar you will be able to:
- Identify how NOx is formed in diesel engines
- Identify the in-cylinder means for reducing NOx
- Evaluate NOx aftertreatment technologies for diesel exhaust.
- Describe the characteristic of selectivity in catalytic aftertreatment
- Apply selectivity to urea SCR
- Describe the features and components of a complete urea SCR system
- Learn how to optimize the control of a urea SCR
- Distinguish the differences between various catalytic SCR formulations
**Power and Propulsion**

**Who Should Attend**

This seminar will benefit engineers and technical staff who are developing urea aftertreatment systems for diesel engines, including catalyst engineers who supply NOx aftertreatment systems to the diesel industry. Also benefiting will be suppliers of other NOx reducing technologies, such as EGR components and fuel injection systems, as well as on-highway and off-highway diesel engine technical staff.

**Prerequisites**

Attendees should have knowledge of how a diesel engine operates, including its 4-stroke operation. Additionally, attendees should have basic knowledge of the emission formation mechanism in internal combustion engines.

**Topical Outline**

**DAY ONE**
- **Introduction**
  - On-Highway diesel emission regulations
  - Non-Road diesel emission regulations
  - Passenger car diesel emission regulations
  - Light-Truck diesel emission regulations
  - EURO IV Regulations
  - EURO V Regulations
  - NOx regulations in Japan
  - Drivers for controlling NOx
- **NOx Formation in Diesel Engines**
  - Diffusion combustion model
  - The Zeldovich Mechanism
  - Pressure/Crank angle diagram
  - Heat release rate
- **In-Cylinder Means for NOx Reduction**
  - Injection timing retard
  - Multiple injections/combustion cycle
  - Charge air cooling
  - Exhaust gas recirculation
- **NOx Aftertreatment Systems for Diesel Engines**
  - Lean NOx Catalysts (LNC), DeNOx Catalysts, HC SCR
  - Lean NOx Trap (LNT), NOx Adsorber Catalyst (NAC also NAK), and NOx Storage Reduction (NSR)
  - Selective Catalytic Reduction (SCR) using urea reductant
  - Derivatives: Ammonium Carbamate, Combination LNT/SCR
- **Urea SCR Technology**
  - Chemical reactions
  - Advantages/Disadvantages of the urea SCR system
  - Notable demonstration

**DAY TWO**
- **Components of the Urea SCR System**
  - Catalyst -- Extruded substrate; Coated substrate
  - Catalyst Type -- Vanadia/Titania/Tungsten; Iron Zeolite; Copper Zeolite
  - Catalyst volume and space velocity considerations
  - Urea injection system -- Air-Assist systems; Airless systems
  - NOx sensors
  - Urea specifications and suppliers
- **System Calibration and Control Considerations**
  - Effect of NH3/NO
  - Effect of NO2/NO
  - Ammonia slip
  - Exhaust architecture
- **Regulatory and Market Considerations**
  - Urea Infrastructure -- Bottles; Dispensers; Co-Fueling
  - End-user and urea refills
  - The Japanese experience
  - The European experience
  - Plans for USA manufacturers
  - Commercial vehicle market projections
- **Urea Production and Distribution**
  - The A.D. Little Report
  - The European experience
  - Passenger car diesel emission regulations
  - Light-Truck diesel emission regulations
- **SCR Options and Configurations for Future NOx Limits**
  - On-Highway heavy-duty diesels
  - Non-Road diesel engines
  - Passenger car diesels
  - Light-Truck diesels
  - Cold weather operation
- **Closing and Evaluations**

**Instructor:** Magdi Khair

**Fee:** $1325 1.3 CEUs

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**SAE SI Engine Certificate Program**

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

Designed to familiarize you with key spark ignition engine components and technologies and how they function as a system, completing this certificate delivers a fairly deep level of engine expertise and, at the same time, an SAE credential. Complete the SI Engine Certificate and earn seven or eight graduate credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems and Kettering’s 40-credit M.S. in Mechanical Engineering. Visit training.sae.org/collegecredit. View the list of required and elective courses and additional information on enrolling in this SAE certificate program: training.sae.org/certificate/siengine

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HYBRID AND ELECTRIC VEHICLES

Energy Efficient Motor Drives and Power Electronics for EV, HEV, and PHEV Applications

4 Days
I.D.# C1045

Electric motor drives have emerged as one of the differentiating technologies in electric vehicles (EV), hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV). As a result, it is critical for engineers and technical decision-makers to understand the various energy-efficient motor drive technologies and how to apply them. Likewise, power electronics is one of the key technologies enabling the shift from conventional gasoline/diesel engine powered vehicles to electric vehicles (EVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs). Of particular importance are the power electronics converters used in EVs, HEVs, and PHEVs, which include rectifiers, unidirectional and bidirectional DC-DC converters, inverters, and battery chargers.

The first two days of this seminar begins with an introduction to the principle of power electronics followed by a thorough coverage of various converters. The unique aspects of power converters in EVs, HEVs, and PHEVs are addressed, including vehicle to grid technology and battery chargers. Distinctive characteristics of the operation of EV converters, such as uncontrolled rectification of permanent magnet motors, are covered in detail. Modeling and simulation of different power converters are demonstrated with hands on examples and hardware-in-the-loop concepts are briefly covered.

The second two-day module begins by defining energy-efficient motors and EV/HEV/PHEV motors. Following an in-depth study of induction motor drives, permanent magnet (PM) brushless motor drives, and switched reluctance (SR) motor drives, attendees will understand the core motor drive technology for EVs, HEVs and PHEVs. The course concludes with information on in-wheel motors, emerging motor technologies, and electric variable transmission (EVT) motor systems.

Learning Objectives

By attending this seminar, you will be able to:
• Identify energy-efficient motors
• Identify EV/HEV/PHEV motors
• Explain the differences between induction, brushless, and SR motor drives for EVs/HEVs/PHEVs
• Explain the differences between various in-wheel motors
• Identify a sound methodology for sizing EV/HEV/PHEV motors
• Describe how to approach finite element and thermal analyses of motors
• Describe EVT motor systems and various emerging motor technologies
• Explain the basic principle of power electronics and the operation principle of different converters
• Describe the uniqueness of EV/HEV/PHEV power converters
• Identify the appropriate power converter topology for different powertrain applications
• Identify passive components for power converters
• Model power converter circuits used in an EV/HEV/PHEV
• Select the semiconductor devices for major power converters in an EV/HEV/PHEV
• Describe vehicle to grid and battery charger technology
• Explain the implementation principle of hardware in the loop tools
• Identify emerging power electronics technologies

Who Should Attend

This course is designed for those who work in engineering, marketing, or manufacturing of powertrain systems or other electrical and mechanical aspects of EVs, HEVs, and PHEVs. In addition, this course can be valuable to those involved in renewable energy or transportation systems that utilize electric motors. Individuals new to the field of power electronics, electric motors and drives will benefit most from the material. This course is not intended for individuals with significant experience with power electronics or motor drives.

Prerequisites

An undergraduate degree in engineering or a strong technical background is highly recommended. Attendees should have taken an undergraduate or graduate course in basic electric circuits and/or basic electric machines, basic electric circuits, and basic electronics or be familiar with resources such as:
• Electric Circuits: J David Irwin: Basic Engineering Circuit Analysis, John Wiley & Sons
• Electronic Circuits (chapter 1 to 5 of Sedra and Kenneth C. Smith, Microelectronic Circuits, Oxford University Press

Topical Outline

DAY ONE
• Introduction to Power Electronics
• Modeling of power electronics
POWER AND PROPULSION

- Rectifiers
- Unidirectional DC-DC converters
- Bidirectional DC-DC converters
- Thermal Management of Power converter
- Power electronics building blocks
- Hardware in the loop (HIL)

DAY TWO
- Isolated DC-DC converter
- Inverter
- Introduction to motor drives
- Special Operations
- Battery Charger
- Vehicle to Grid (V2G)
- Emerging Power Electronics Technologies
- Learning Assessment

DAY THREE
- Overview of Energy-Efficient Motors
- Overview of EV/HEV/PHEV Motors
- Induction Motors
- PM Brushless AC (BLAC) Motors
- PM Brushless DC (BLDC) Motors
- SR Motors
- Design and Analysis of Motors
- Power Converters for AC and SR Motors

DAY FOUR
- Induction Motor Drives
- PM BLAC Motor Drives
- PM BLDC Motor Drives
- SR Motor Drives
- In-wheel Motors
- Emerging Motor Technologies
- EVT Motor Systems
- Learning Assessment

Instructors: Chris Mi and K. T. Chau
Fee $1655 2.6 CEUs

Fundamentals of Hybrid and Electric Vehicles
2.5 Days
I.D.# C1232

Electric and hybrid vehicles are still relatively new products and are undergoing developmental refinements as the technology moves towards maturity. There are challenges related to the fundamentals of the technologies, the availability of various materials and sub-systems, cost targets and customer demands. The technology is complex and multi-disciplinary involving system integration of diverse components. This course will cover the interdisciplinary aspects of electric and hybrid vehicles where engineers of various disciplines have to work together to develop the system. The fundamentals, design philosophies for electric and hybrid vehicles, component selection and sizing, and modeling and control strategies will be covered. Existing electric and hybrid vehicle models such as Nissan Leaf, Ford Focus, Tesla Roadster, Chevy Volt, Toyota Prius, Chevy Malibu, Ford Fusion etc. will be used as case studies. Participants will learn about the future trends in battery, power electronics and motor drive technologies.

Learning Objectives
By attending this seminar, you will be able to:
- Describe the pros and cons of different types of EVs and HEVs
- Perform basic designs of EV and HEV systems using series, parallel and series-parallel architectures
- Size an EV or HEV powertrain
- Size components for EVs or HEVs, including electric motors, power electronics and energy sources
- Develop specifications for EV/HEV systems and components
- Define the testing procedures for EVs and HEVs
- Discuss the emerging technologies, engineering challenges, and development trends in EVs and HEVs

Who Should Attend
This fundamental overview course is designed to provide an introduction to electric and hybrid vehicles for engineers in electrical, mechanical, chemical, automotive, and other related fields who are interested in the EV/HEV design, development, modeling, manufacture and marketing.

Topical Outline
DAY ONE
- Introduction to EVs and HEVs
  - Why electric vehicles and hybrid electric vehicles?
  - Environmental impact
  - Well-to-wheel efficiency analysis
  - How HEVs achieve improved powertrain efficiency/fuel economy and reduced pollutions
  - Interdisciplinary nature of EVs and HEVs
  - Future of EVs and HEVs
  - Opportunities in EVs and HEVs
- Vehicle Fundamentals
  - Roadway fundamentals
  - Tractive force and power requirements
  - Tire-road force mechanics
  - Powertain component sizing
  - Energy storage requirements
  - Vehicle performance: acceleration, gradeability, maximum speed, fuel economy
- Electric Vehicles/Electric Power Transmission Path
  - Components of electric drivetrain
  - EV powertrain sizing example
POWER AND PROPULSION

- Hybrid Vehicles/System Architectures
  - Series, parallel, series-parallel HEVs: relative advantages, disadvantages
  - Charge sustaining and charge depleting hybrids
  - Mild, power and energy hybrids
  - Plug-in electric vehicles
- HEV Powertrain Sizing Example
  - Component sizing and calculations
  - Mass analysis and packaging
  - Series HEV design example
  - Parallel HEV design example
  - Series-parallel HEV design example
- HEV Control Strategies
  - Vehicle supervisory controller
  - Mode control strategies (series, parallel or series-parallel options)
  - Modal control strategy (series, parallel and series-parallel controls)
  - Regenerative control
  - Power-split control strategy
- EV/HEV Modeling and Simulation
  - Vehicle and sub-system models
  - Modeling and simulation platform
  - Modeling examples using Matlab/Simulink
  - Commercial packages for simulation
  - Vehicle performance and analysis

DAY TWO
- Energy Storage Systems
  - Batteries: lead acid, nickel-metal hydride and Li-ion batteries
  - Ultracapacitors
  - Fuel cells
  - Compressed air
  - Hybridization of energy source
  - Battery management systems
- Electrical Machines and Drives
  - Fundamentals of electric motor drives
  - Sizing of electric motors for EV and HEV
  - AC and DC electric machines
  - Induction motor drives
  - Permanent Magnet (PM) synchronous motor drives
  - Interior PM motor drives
  - PM brushless DC motor drives
  - Switched reluctance motor drives
- Power Semiconductors and Electronics
  - Power semiconductors in hybrid-electric powertrains
  - DC-DC converters
  - Battery chargers
  - Wireless power transfer
- High Voltage System
  - Safety issues
  - System example schematics
  - Motor Drive System Modeling and Simulation
- PM motor drive simulation
- Induction motor drive simulation

DAY THREE (ends at 12:30 PM)
- Controls and Communications
  - Microcontrollers and DSPs for controls and communication
  - In-vehicle communications network
  - Controller Area Network (CAN)
  - Advanced communications protocols
- Current EVs and HEVs
  - Nissan Leaf
  - Tesla Roadster
  - Ford Focus
  - Chevy Volt
  - Toyota Prius
  - Toyota Camry
  - Ford Fusion
- Special Topics
  - Off-road vehicles
  - Auxiliary Systems for EV/HEVs
  - Electromagnetic compatibility (EMC) issues
  - Thermal management
  - System integration issues
  - After sales: reliability and servicing
- Emerging Technologies
  - Non rare-earth machine technologies
  - Post silicon devices: Silicon Carbide and Gallium Nitride
  - Vehicle-to-grid technologies
  - Smartgrid technologies

Instructor: Iqbal Husain and Yilmaz Sozer
Fee $1595 1.7 CEUs

Fundamentals of Hybrid Electric Vehicles

3 Days
I.D.# C0511

One of the fastest growing automotive fields, hybrid electric vehicles (HEVs), presents both opportunities and challenges. HEVs are more fuel-efficient and environmentally friendly compared to conventional vehicles. Optimizing the power intake in HEVs allows the engine operation to be kept within the range designed for best fuel economy and lowest emission, while the motor/generator system either provides additional power input, or generates electricity using the excessive power from the engine. It also recovers the kinetic energy during braking or coasting. These advantages have attracted worldwide development interests for HEVs in the automotive industry. Global sales of hybrid vehicles continue to grow.
The challenges presented in HEVs include power electronics, electric motors and generators, batteries, power management, thermal management, and system integration. Additional challenges related to after-sales issues include reliability, gracefully degradable operation, and servicing.

This three-day seminar will cover the fundamentals of HEVs. In an easy-to-understand format, the course will explain the engineering philosophy of HEVs, the component selection and design, modeling, and control of HEVs. Some existing HEV models such as the Toyota Prius, Honda Civic, Mercury Mariner, Saturn VUE and Camry will be used as case studies.

**Learning Objectives**

By attending this seminar, you will be able to:
- Describe the pros and cons of different types of HEVs
- Implement fundamental HEV design parameters
- Develop specifications for HEV systems and components
- Perform basic design of HEV systems, using parallel, series, or complex topologies
- Develop models and perform simulations of HEVs; simulate the fuel economy and emissions of HEVs
- Size a HEV powertrain
- Size HEV components, including motors, energy sources and motor controllers
- Calculate the regenerative braking performance of a HEV
- Describe the testing procedures for HEVs
- Compare and contrast hydraulic hybrid and electric hybrid systems
- Discuss the emerging technologies, engineering challenges, and development trends in HEVs

**Who Should Attend**

This fundamental overview course is designed to provide an introduction to HEVs for engineers in electrical, mechanical, automotive and other related fields who are involved or interested in HEV development, design, modeling, manufacturing and marketing.

**Topical Outline**

**DAY ONE**

- Introduction to Hybrid Electric Vehicles
  - Environmental impacts of HEVs
  - Interdisciplinary nature of HEVs
  - Configuration of HEVs, parallel, series and complex HEVs
  - State-of-the art HEVs
  - HEVs vs. diesel engine vehicles
  - The future of HEVs
  - Opportunities in HEVs
- HEV Fundamentals
  - Vehicle resistances
  - Traction and slip ratio models
- Vehicle dynamics
- Transmission: gear transmission, CVT and planetary gear systems
- Vehicle performance: maximum speed, gradeability and acceleration
- Fuel economy and improvement
- Braking performance
- Sizing of HEV powertrains
- Vehicle modeling
- Power management
- Vehicle control
- HEV Modeling and Simulation
  - Vehicle model
  - Modeling and simulation basics
  - Vehicle performance
  - Modeling examples using ADVISOR
- Power Electronics
  - The need for power electronics in HEVs
  - Overview of power electronics circuits in HEV powertrains
  - Fundamentals of power electronics
  - Bidirectional DC/DC converter
  - Inverter and motor control
  - Regenerative braking and rectification

**DAY TWO**

- Series HEV Powertrain Design
  - Concepts of hybridization
  - Hybrid architecture
  - Series hybrid configuration and functionality
  - Operation patterns, advantages
  - Control strategies
  - Power management
  - Sizing of major components
  - Design examples
  - Modeling of series HEVs
- Parallel HEV Powertrain Design
  - Parallel architecture and operation modes
  - Torque coupling
  - Speed coupling
  - Torque and speed coupled architecture
  - Control strategies and power management
  - Design example and modeling using ADVISOR
  - Mild hybrid and micro hybrid
  - Complex hybrid
  - Plug-in hybrid
- Electric Propulsion Systems
  - Fundamentals of electric motor drives
  - DC motor drives
  - Induction motor drives
  - Permanent magnet synchronous motor drives
  - Brushless DC PM motor drives
  - Switch reluctant motor drives
  - Sizing of electric motors and power electronics in HEVs
Fundamentals of Hybrid Electric Vehicles and Related Technologies

2 Days
I.D.# C1234

Driven by high fuel prices, environmental regulations, and consumer demand, the market for hybrid electric vehicles has experienced rapid growth. Every major automotive company produces a HEV with approximately fifty different HEV models on the market and over five million HEVs having already been sold. To meet current and future demands in the HEV and PHEV markets, success will depend on engineering and support personnel having and maintaining a thorough understanding of HEV related technologies.

This two-day seminar will cover the fundamentals of HEV in an easy-to-understand format. This seminar will explain how HEVs save fuel, how they are classified in terms of powertrain system architecture and an in-depth look at the hybrid powertrain architectures of Power-split and P2 HEV. Also explained will be the design, modeling, and control of HEVs and component selection. Existing HEV models, such as the Toyota Prius, Honda Civic, GM Volt, AUDI Q5, and VW Touareg will be used as case studies throughout the seminar.

Please note this seminar will be presented in Mandarin Chinese. The hand-out materials will also be in Mandarin Chinese.

Learning Objectives

By attending this seminar, you will be able to:

• Explain the major resources and regulatory drivers of hybrid electric vehicle development
• Identify the system architectures of hybrid electric vehicles that have been commercialized from 1997 to the present
• Describe and identify basic hybrid components and architectures and explain HEVs’ differences from conventional vehicles
• Identify the main HEV development considerations for various vehicle systems
• Recognize basic layouts of light, medium, and full hybrid vehicle powertrains
• Compare advantages and disadvantages of different hybrid architectures
• Identify and understand how HEV drive systems of the Prius and P2s work and the challenges they meet
• Describe and evaluate HEV emerging technologies, engineering challenges, and development trends

Who Should Attend

This seminar is designed for individuals working in engineering, marketing, and manufacturing of powertrain systems along with other electrical and mechanical aspects of HEVs, including PHEVs and REEVs. Information presented in this seminar may

Instructor: Abul Masrur and Chris Mi
Fee $1645 2.0 CEUs

DAY THREE

• HEV Energy Storage
  • Battery basics
  • Lead acid battery, nickel-metal-hydride battery, and Li-ion battery
  • Fuel cell
  • Ultra capacitor
  • Flywheel
  • Hybridization of energy source
• Fuel Cell Vehicles
  • Configurations
  • Design examples
• Current HEVs
  • Toyota Prius
  • Honda Civic
  • Mercury Mariner
  • Toyota 2007 Camry
  • Saturn VUE
  • ISE truck
  • Military HEV
• Special Topics
  • Military applications
  • Novel topologies
  • Antilock braking (ABS) of HEVs
  • HEV testing
  • System integration issues
  • Hydraulic hybrid vehicle architecture vs. electric hybrid systems
  • User level issues - reliability, servicing
• Emerging Technologies of HEV
  • Electric motors
  • Power electronics, silicon-carbide devices
  • Thermal management
  • EMC issues
also be of value to those working with renewable energy and transportation systems.

Topical Outline

DAY ONE

• Introduction to HEV/PHEV/BEV
  • The foundations of HEV/PHEV/BEV
  • Why are HEVs needed?
  • How do HEVs save fuel?
• HEV/EV/PHEV Classification -Mixed Degree
  • Hybrid overview
  • Micro HEV
  • Mild HEV
  • Full HEV
  • PHEV/REEV
  • BEV
• Classification of HEV/PHEV Powertrain
  • Series HEV Powertrain
  • Powersplit HEV Powertrain
  • Parallel HEV Powertrain
  • Two mode HEV Powertrain
• HEV: Technological Trends
  • Overview
  • Powersplit, the leading HEV technology
  • The rise of P2 machines
  • The major automotive corporation’s hybrid technology
  • The applications of hybrids
• HEV/PHEV: Engines and Transmissions
  • Fuel-efficient engines for HEVs/PHEVs
  • Transmissions for HEVs/PHEVs
  • Optimizing the powertrain’s fuel efficiency

DAY TWO

• Theory and Analysis of Powersplit
  • Planetary gear unit
  • Kinematics and Dynamics of Planetary Gear Unit
  • Powersplit and e-CVT
  • Functionalities of Powersplit
  • Applications
• Theory and analysis of P2s
  • P2 machines
  • P2s principle
  • Challenges of developing P2 Machines
  • P2’s technology application and analysis
• Related Technologies of HEV/PHEV/BEV
  • Electric motor and Power Electronics
  • Battery Systems and BCU
  • HEV/PHEV/BEV control technology
  • Regenerative braking system
  • Others

Instructor: Zhihui Duan
Fee $1275 1.3 CEUs

Introduction to Hybrid Powertrains
Web Seminar and Web Seminar RePlay

2 Hours
Web Seminar: I.D.# C0903
Web Seminar Recording: PD330903ON

Hybrid powertrains have been on the market for more than a decade and have become one of the most successful alternative powertrains available today. More than a million hybrids are sold globally per year, primarily in Japan and the US. Some OEMs estimate that up to 80% of their light-duty vehicles may require some level of hybridization to meet upcoming CAFE regulations in the United States. Hybrids are also starting to make inroads into markets in Europe, and have recently been introduced to Chinese and Indian markets, among others.

Basic information on hybrids is scattered among information sources, and is often difficult to synthesize. In this two-hour Web Seminar, energy storage systems, inverters, motor-generators, and DC-DC converters are explained, as well as design considerations for both light-duty and heavy-duty vehicle powertrains and developing trends such as plug-in, flywheel and hydraulic hybrids.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Describe the efficiency improvements that hybrid vehicles achieve with respect to conventional vehicles
• Identify common components of hybrid powertrains
• Recognize basic layouts utilized in light, medium, and heavy-duty hybrid vehicle powertrains
• Compare the advantages and disadvantages of different hybrid architectures
• Summarize hybrid powertrain applications that are on the market today
• Explain upcoming HEV developments

Who Should Attend
This course is designed for the engineer, manager, or marketing professional who needs a quick overview of the design and manufacture of hybrid vehicle powertrains. Industry professionals who want a broad yet concise overview of the technological aspects of current and upcoming hybrid powertrains will benefit. Anyone who is unfamiliar with basic hybrid technology, yet whose job will be impacted by hybrid vehicles in the future, will benefit from this Web Seminar. A basic understanding of road vehicle construction and operation will be helpful.

Topical Outline

• Types of hybrids
  • Gasoline-electric hybrids (HEV)
• Diesel-electric hybrids (HEV)
• Hydraulic hybrids (HH)
• Hybrid-electric powertrain components
  • Energy storage systems
  • Motor controllers; Motor-generators
  • DC-DC converters
  • Safety interlocks and circuits
  • Ancillary systems
• Series hybrid architectures
  • Advantages and disadvantages of series hybrids
  • Upcoming commercialization of series hybrids
• Parallel hybrid architectures
  • Engine-assist systems; Through-the-road systems
• Series-parallel hybrid architectures
  • Power-split hybrids
  • GM “two-mode” hybrids
• Plug-in Hybrids
  • Advantages and disadvantages of PHEVs
  • Early PHEV conversions
  • Commercialization of PHEVs
  • Design considerations for PHEVs
• Hybrid vehicle trends and developments
  • Effects on IC engine development
  • Research and development trends

Instructor: Jack Rosebro
Fee $260 .2 CEUs

Principles of Electric Drives Web Seminar
8 Hours
I.D.# WB0941

Electric drives are found in hybrid, plug-in hybrid, and hydrogen fuel cell vehicles, as well as battery electric vehicles. More than two million hybrid vehicles worldwide utilize electric drive components, and battery technology has matured enough to enable major manufacturers to develop light-duty and commercial electric vehicles for mass production and sale beginning in 2010-2012. It is also likely that many conventional vehicles will incorporate some form of idle-stop or stop-start system comprised of a low-output electric drive, as an integral part of efforts to meet U.S. CAFE fuel economy standards and EU CO2 emission requirements.

Industry professionals who are looking for a general understanding of the structure and components of vehicular electric drives will benefit from this course, which will cover theory, design, operation, and diagnostics of all major components used in electric drives (battery packs, inverters, motor-generators, DC-DC converters, and charging apparatus) as applied to all forms of vehicles, including charge-sustaining hybrids, plug-in hybrids, fuel cell hybrids, and battery electric vehicles. Battery chemistry, charging systems, power conversion, switching techniques, and traction motor construction will be discussed in detail.

Learning Objectives
• Explain the design, function, and interactions of all major components of a typical electric vehicle powertrain
• Describe the operation, attributes, and behavior of battery packs, inverters, motor-generators, on-board and off-board charging systems, and DC-DC converters across all ranges of performance
• Identify the different design configurations and requirements of electric drives in hybrids, plug-in hybrids, fuel cell hybrids, and battery electric vehicles
• Classify different types of battery packs, inverters, motors, and DC-DC converters
• Analyze the design and construction of a given electric powertrain, and evaluate its particular attributes and drawbacks
• Assess fault detection and protection strategies and circuits as well as on-board diagnostic requirements
• Appraise technical limitations of electric drive components, as well as design and technological trends that may address such limitations

Who Should Attend
Powertrain engineers, electrical engineers, project planners, project managers, technical writers, safety officers, component specialists, component suppliers, and anyone else who is professionally impacted by the development of electric vehicle technology will be able to use this information to help them transition to working with electric drives. Participants should have a basic knowledge of electric circuits. This is an introductory Web Seminar; a mechanical or electrical engineering degree is helpful but not necessary.

Topical Outline
Session 1
Battery Packs, Capacitors, and Energy Management
• Calculating Onboard Energy Storage Needs
• Battery Chemistries and Lithium-Ion Sub-Chemistries
• Electrolytic Double Layer Capacitors
• Combination Systems (Hybrid Battery-Capacitor Systems)
• Battery Pack Performance
• Integrating an Energy Storage System into the Chassis
• System Relays and Power-on Sequences
• Battery Management Systems and Communication with the CAN Bus
• Thermal Management Systems and Considerations
• System Degradation
• Onboard Management Systems and Considerations
• Failure and Diagnostic Modes

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- Recycling and Recovery of Battery Cell Material
  Session 2
- External Charge-Discharge Systems and DC-DC Converters
  • Charging Systems for Electric Vehicles
  • Inductive and Conductive Charging
  • Charger-to-Vehicle Communication
  • Power Supply Considerations
  • Vehicle-to-Grid Systems
  • Switching Power Supplies and DC-DC Converters
  • Packing and Thermal Management of DC-DC Converters
  • Failure and Diagnostic Modes
  • Power Requirements of Drive-By-Wire Systems

Inverters and Fundamentals of Power Electronics
• Power Transistors And Switching Operation
• Basic Motor Control Producing AC Waves from a DC Supply
• Capacitors in Inverters
• Pulse-Width Modulation
• PWM Inefficiencies
• Overmodulation and Six-Step Control
• Space-Vector Modulation
• Boost Converters
• Thermal Management of Inverters
• Circuit Protection
• Failure and Diagnostic Modes
• Upcoming Power Electronics Developments and Enhancements

Synchronous and Asynchronous Motor-Generators
• Flux Linkages and Rotating Magnetic Fields
• Rotor and Stator Construction
• Torque Production, Motor-Generator Types
  • Permanent-Magnet
  • Induction; Reluctance
  • Enhanced Lundell Motor-Generators
• Operation in Motor, Generator, and High-Speed Modes
• Field-Weakening
• Choosing a Motor-Generator, Thermal Management of Motor-Generators
• EMF Considerations
• Failure Modes and Diagnostic Strategies

Selecting the Optimal Battery Chemistry for HEV, PHEV, and EV Applications

2 Days
I.D.# C1133

Selecting the right chemistries for different applications has a significant impact on cost and performance of electric vehicles. The power and energy required for different vehicle applications are directly linked to the chemistry of the battery. This course will cover advantages and disadvantages of various battery chemistries for different transportation applications, such as mild hybrids, extended range and plug-in, as well as full electric vehicles. Fundamentals of battery chemistries from materials science and engineering perspectives will be discussed. Potentials and limitations of various battery components, i.e. positive electrodes, negative electrodes, different classes of electrolytes, various engineering and science aspects of binders and conductive diluents, as well as current collectors will also be covered. Cell designs for different battery chemistries, as well as potential new battery designs on hybrid electrodes necessary to meet different vehicle performances will also be covered.

Learning Objectives
By attending this seminar, you will be able to:
• Select the proper battery chemistries for your applications
• Reduce cost and improve performance of batteries for your applications
• Improve safety aspects of batteries for your applications
• Select proper format and design for electrodes, cells, and batteries for your applications
• Select battery components and understand their impacts on cost and performance

Who Should Attend
This course is designed for engineers and scientists who are working on hybrid electric, plug-in hybrid electric and electric vehicles who are designing cells and batteries, preparing and evaluating battery materials, and doing research on battery materials, battery design, battery modeling and battery testing. Chemical, electrochemical, mechanical, and electrical engineers as well as material scientists will benefit from this course.

Topical Outline
DAY ONE
• Basics of Battery Component Chemistries
  • Electrode processes and dynamics in batteries
  • Electrolyte functions and interface chemistries
  • Role of current collectors, binders, conductive diluents and their dynamic interactions with electrodes and electrolytes
  • Review of Electrode Materials and their Corresponding Performances and Degradation Mechanisms

Instructor: Jack Rosebro
Fee $620 .8 CEUs

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Power and Propulsion

DAY TWO

- Electrolyte Formulation and its Dynamics Coupling with Electrode Materials
  - Formulation and optimization of liquid electrolytes, potentials and limitations
  - Design and optimization of polymeric and gel electrolytes, new possibilities
  - Science, engineering of solid ceramic electrolytes and their future prospects
  - Design and formulation of hybrid electrolyte for future batteries
- Future Generation of Lithium-ion Battery, Smart and Hybrid Electrode and Electrolyte
  - Science and engineering of future electrode formulation and design
  - Science and engineering based electrolyte formulation and design
  - Science and Engineering based electrode, cell, and battery design

Instructor: G. Abbas Nazri
Fee $1265 1.3 CEUs

Common Rail Diesel Fuel Injection

1 Day
I.D.# C0920

The improved efficiencies of the modern diesel engine have led to its increased use within the mobility industry. The vast majority of these diesel engines employ a high-pressure common rail fuel injection system to increase the engine’s fuel-saving potential, emissions reduction, and overall performance.

This one-day seminar will begin with a review of the basic principles of diesel engines and fuel injection systems. Diesel and alternative fuels will be discussed, followed by current and emerging diesel engine applications. The majority of the day will be dedicated to the common rail system itself, beginning with a comprehensive overview of the complete system. The instructor will then introduce the main subsystems, including hydraulics and controls. Finally, the subsystems will then be broken-down into their respective components.

Learning Objectives
By attending this seminar you will be able to:
- Identify the basic principles of diesel engines and diesel fuel injection
- Distinguish the main properties of diesel and diesel alternative fuels
- Compare and evaluate various diesel engine applications
- Describe the main systems and sub-systems of common rail diesel fuel injection and how these systems interact
- Identify the main design features of the common rail components
- Discuss basic common rail control strategies

Who Should Attend
This course will benefit engineers and other individuals involved in the design, application, and service of common rail diesel engines utilized in passenger cars, light/medium/heavy-duty trucks, and off-highway vehicles, including marine and farm machinery.

Topical Outline
- Basic Principles of Diesel Engines
- Basic Principles of Diesel Fuel Injection
- Diesel and Alternative Fuels
- Applications -- Passenger car; Light-duty; Heavy-duty; Off-highway; Pressure history
- Common Rail System Overview
  - Low-pressure system
  - High-pressure system
  - Controls
  - Hydraulic Components
    - Pumps -- Radial piston; Inline piston
    - Rails
    - Injectors -- Solenoid; Piezo
    - Nozzles
    - Control valves -- Pressure control valve; Metering unit; Pressure relief valve
    - High-pressure lines
- Controls
  - Overview
  - Requirements
  - Functions
  - Components
  - ECU

Catalog Key

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129
Compact Heat Exchangers for Automotive Applications

2 Days
I.D.# 97002

Rapid advances have been made in the range of available designs and operational parameters as well as in the fundamental understanding of compact heat exchangers (CHEs). Since the majority of modern heat exchangers used for heating and cooling systems for vehicular applications are CHEs, keeping up to date with these advances is essential. This seminar will help you understand and be able to apply comprehensive information about the intricacies of CHE design, performance, operating problems and state-of-the-art-technology for car and truck applications.

Learning Objectives

By attending this seminar, you will be able to:

- Describe current state-of-the-art vehicular heat exchangers and how they relate to the current heat exchanger technology of other industries
- Explain the interaction, feedback and importance of problem specifications, thermal-hydraulic design, mechanical design, manufacturing and cost considerations and trade-offs based on the component and system design approaches for vehicular heat exchanger design
- Assess in-depth -NTU, P-NTU and MTD methods of heat exchanger analysis and articulate advantages and limitations of each method
- Perform exchanger pressure drop analyses, taking into account pressure drop associated with the core (entrance, exit, friction, form drag and momentum effects) and flow distribution devices (manifolds, headers, tanks, bends, fittings, etc.)
- Explain theoretical solutions for developed and developing laminar and turbulent flows in heat exchangers
- Apply empirical correlations for various fin and surface geometry’s used in vehicular heat exchangers
- Utilize theoretical solutions to extend the applicability range of empirical solutions
- Describe and implement detailed, step-by-step procedures for the design and performance of single-phase heat exchangers -- radiators, heaters, oil coolers and charge air-coolers
- Determine how to choose specific fin or surface geometry’s for vehicular applications
- Optimize heat exchanger designs to work with a large number of variables associated with the design
- Computerize heat exchanger design and performance calculations
- Describe the engine cooling system from the radiator and heater design point of view
- Describe the components of the air-conditioning system and implications for the design of condensers and evaporators
- Utilize basic principles of vaporization and condensation for the design of condensers and evaporators
- Articulate design and rating procedures for condensers and evaporators
- Describe system design considerations for the design of engine cooling and air-conditioning heat exchangers
- Discuss future trends and technology developments of vehicular heat exchangers

Who Should Attend
This course is intended for product and design engineers and academicians seeking the latest developments in the field, and engineers involved in software development for heat exchanger design and heating and cooling systems.

Topical Outline

Day One
- Automotive Heat Exchangers - Functions and Types
- Heat Exchanger Design Logic/Procedure
- Single-Phase Heat Transfer and Pressure Drop Analysis
- Discussion
- Heat Transfer/Flow Friction Characteristics and Correlations
- Plate-Fin and Tube-Fin Rating and Sizing Procedures
- Vaporization and Condensation Principles
- Condenser and Evaporator Design

Day Two
- Automotive Air-Conditioning System
- Engine Cooling System
- Auto A/C Heat Exchangers Performance Testing
- Charge Air and Exhaust Gas Cooling
- Heat Exchanger Design from System Design Considerations
- State of the Technology and Future Trends in CHEs

Instructor: Joe Borghese
Fee $1275 1.3 CEUs

More information can be found on the SAE website.
Diesel Engine Technology

2 Days
I.D.# 93014

A similar course is available online, on demand – Diesel Engine Technology e-Seminar – see course info below.

As diesel engines become more popular, a fundamental knowledge of diesel technology is critical for anyone involved in the diesel engine support industry. This course will explain the fundamental technology of diesel engines starting with a short but thorough introduction of the diesel combustion cycle, and continue with aspects of engine design, emission control design, and more. An overview of developing technologies for the future with a comprehensive section on exhaust aftertreatment is also included.

The text, Diesel Emissions and Their Control, authored by Magdi Khair and W. Addy Majewski is included with the seminar.

Learning Objectives

By attending this seminar, you will be able to:
• Summarize the technological advances in modern diesel engines
• Evaluate the sources of emissions from diesel engines and the influence of engine component design on curbing these emissions
• Explain diesel exhaust aftertreatment systems and their effectiveness in reducing emissions
• Recognize the importance of fuel injection parameters to performance and emission control

Who Should Attend

You should attend this seminar if you are involved in diesel engine support industries such as catalytic converters, lube oils, gaskets, and turbocharger suppliers, and if you are not well versed with diesel engines although they play a major role in your career’s survival.

Topical Outline

• The Case for the Diesel Engine (Brief)
  • Fuel consumption
  • Emissions
  • The diesel and the future
  • Advantages and disadvantages of diesel engines
  • Thermal efficiency of diesel vs gasoline engines
  • Compression ratio limitations in diesel engines
• The Diesel Combustion Process
  • SI four-stroke
  • CI four-stroke
  • The diesel combustion cycle
• Basic Types of Diesel Engines
  • Open chamber - direct injection (DI)
  • Prechamber - indirect injection (IDI)
• General Characteristics of DI & IDI Engines
  • Peak combustion pressure and temperature
  • Combustion severity
  • Rate of pressure rise
  • Noise
  • Fuel economy
  • Application
  • Emissions
• The Diesel Fuel Injection System
  • Functions of the diesel fuel injection system
  • Types of diesel fuel injection systems
  • Pump-line-nozzle systems (in-line pump)
  • Pump-line-nozzle systems (distributor pump)
  • Pump-line-nozzle systems (unit pump)
  • Unit injector systems
  • Common-rail injection systems
  • Details of an in-line pump
  • Operation of an in-line pump
  • Multi-hole injector holder and nozzle
  • Line dynamics and delivery valves
  • Mechanical governors and boost control devices
  • Engine installation and spray details
  • Operation of a distributor pump
  • Another type of distributor pump
  • Mechanically-controlled unit injector
  • Moving towards electronically-controlled systems
  • Motivation for using electronically-controlled systems
  • Basic electronic injection system
  • Electronically-controlled in-line pump
  • Visual differences between mechanical & electrical pumps
  • Electronically-controlled distributor pumps
  • Single solenoid valve electronically-controlled UI
  • Electronically-controlled UI system
  • Electronically-controlled common-rail system
  • The HEUI system
  • Operation of a HEUI system
  • Development of injection pressure in HEUI
  • Desired injection flexibility
  • Operation differences between HEUI-A & HEUI-B
  • The HEUI-B injection system
  • HEUI-A and HEUI-B injectors
• Air Management - Supercharging & Turbocharging
  • The purpose of air charging
  • Methods of air charging
  • Supercharger drives
  • Types of superchargers
  • Schematic representation of supercharger types
  • Sample performance map of a supercharger
  • Photographs of two centrifugal superchargers
POWER AND PROPULSION

• Sample performance map of a centrifugal supercharger
• Types of turbochargers
• Schematic representation of a turbocharging system
• Exhaust and charge airflow through a fixed geometry turbocharger
• Anatomy of a turbocharger
• Energy conversion in a turbocharger
• The importance of A/R in a turbocharger design
• Cutaway in a modern turbocharger
• Sample performance map of a turbocharger
• Waste-gated turbocharger
• Variable geometry turbocharger
• Combination system - wave charging
• Turbocompounding
• Sequential turbocharging
• Emissions Formation in Diesel Engines
• Hydrocarbon
• Carbon monoxide
• Nitrogen oxides
• Particulate matter
• Smoke
• Emission Standards
  • Europe
  • North America
• Steps Towards the Modern Diesel Engine
  • Injection
  • Combustion
  • Induction
  • Oil consumption
  • Engine electronics
  • Other design parameters
• Current and Future Technologies
  • Exhaust gas recirculation
  • Multiple injections
  • Auxiliary emission control devices (aftertreatment)
  • Fuels and emulsions

Diesel Engine Technology e-Seminar

13 Hours
I.D.# PD130812ON

A similar course is available as a classroom seminar—Diesel Engine Technology—see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this nearly 13 hour e-Seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into an introduction and eight modules.

View the complete description and a demo for this course at training.sae.org/eseminars/det

What You Will Receive:
• 365 Day access through MyLearn.sae.org
• Links to streaming video modules
• Course Handbook (downloadable .pdf’s, subject to DRM)
• Online Pre-test (self-test; immediate results) & Post-test (submit to SAE)
• CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Magdi Khair
Fee $645 1.3 CEUs

Quantity discounts and Site License options are available—call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote

SAE DIESEL TECHNOLOGY CERTIFICATE PROGRAM

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

Designed to equip you with a solid understanding of diesel engines, emissions and aftertreatment strategies, and related components, the program requires completion of courses that address these areas and then facilitates further depth in aftertreatment technologies through a menu of electives. Complete the Diesel Technology Certificate and earn eight graduate credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems and Kettering’s 40-credit M.S. in Mechanical Engineering. Visit training.sae.org/collegecredit for more information. View the list of required and elective courses and more information on enrolling in this SAE certificate program: training.sae.org/certificate/dieselttech.
Engine Failure Investigation and Analysis

2 Days
I.D.# C1344

Engines can and do experience failures in the field in a variety of equipment, vehicles, and applications. On occasion, a single vehicle type or equipment family will even experience multiple engine failures leading to the inevitable need to determine what the most likely cause of one or all of those failures was. This comprehensive seminar introduces participants to the methods and techniques used to determine the most likely cause of an individual engine or group of engine failures in the field.

The seminar begins with a review of engine design architecture and operating cycles, integration of the engine into the vehicle itself, and finally customer duty cycles and operating environments. Special emphasis is placed on the number and type of subsystems that not only exist within the engine (diesel and gasoline) but are used to integrate the engine into the overall vehicle package. Following this review, participants learn about failure types, investigation techniques, inspection methods, and how to analyze the available evidence using their own knowledge of engine and vehicle operating characteristics to determine the most likely cause of an engine(s) failure. The seminar concludes with a review of actual engine failure case studies that were investigated and resolved using the same process and methods taught during the course.

Learning Objectives
By attending this seminar, you will be able to:
- Analyze engine failure claim narratives
- Analyze and interpret engine and/or vehicle warranty data
- Determine what physical evidence to gather and review when investigating an engine failure claim(s)
- Evaluate the physical evidence associated with an engine failure claim(s)
- Reconcile the physical evidence with the narrative and warranty evidence
- Determine the most likely cause of engine failure based on the available evidence

Who Should Attend
This course has been developed for engineers and technical professionals in all fields related to the investigation, analysis, and root cause determination of engine failures in various types of vehicles and equipment used in both on road and off road applications. In addition, this course can be valuable to individuals involved with handling and processing customer warranty and insurance claims for engine related issues.

Individuals directly involved in the investigation of engine failure and failure related issues will benefit most from this material. Please note that this course is not intended to provide an in-depth discussion of individual component failure modes within the engine. The focus of the course is the process used to gather and analyze the information and evidence necessary to make a determination as to the cause of an engine failure in the field.

Prerequisites
- Professional technical certification or 2 year technical degree is highly recommended
- Bachelor’s degree in Mechanical Engineering is recommended
- A basic knowledge of and familiarity with engine operation, design, and vehicle installations is required
- A basic knowledge of vehicle operational environments and duty cycles is recommended

Topical Outline
DAY ONE
- Engine Design Overview
  - Operating Cycles - compression ignition and spark ignition
  - Architecture
  - Subsystems - Turbo/supercharger, oil supply, cooling, emissions
  - Subsystem crossover and interaction
- Vehicle Integration and Packaging
  - Mounting
  - Fuel supply
  - Air supply
  - Emissions
  - Cooling
  - Controls
- Operational Profile
  - Climate
  - Environment
  - Duty Cycle
  - Operator Specific Habits
- General Failure Classification
  - Thermal
  - Lubrication
  - Fuel/Air Combustion
  - Mechanical
  - Diesel Runaway
- Failure Points
  - Joints and Gaskets
  - Vehicle Systems
  - Subsystems and Components
  - Evidence and Indicators

DAY TWO
- Investigation
  - Reviewing the claim
  - Service history/fleet maintenance
Power and Propulsion

3 ways to get a no-obligation price quote to bring a course to your company • Call SAE Corporate Learning at 1-724-772-8529 • Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org

Gasoline Direct Injection (GDI) Engines

3 Days 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 will be especially 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 as well as those directly and indirectly involved in mixture preparation and emission reduction of harmful pollutants from these engines will highly benefit from this course. Environmental engineers desiring to expand their understanding of fuel spray formation, combustion and emissions from GDI engines will benefit, as well as, engineers active in the development and application of software for the modeling and design of combustion chambers, fuel spray dynamics, combustion and emission issues.

Topical Outline

DAY ONE

• Combustion Systems
  • Relative position of spark plug and fuel injector
  • How to achieve homogeneous and stratified charge -- spray-, wall-, and air-guided combustion systems
• Fuel Injection System
  • Fuel injection system requirements
  • Fuel injector requirements and classification
• Fuel Spray Characteristics
  • Spray atomization requirements
  • Sac spray consideration
  • After-injection
  • Fuel spray penetration and cone angle
  • Split injection; Sprays characteristics of injectors
  • Effects of ambient pressure (density) on spray
  • Spray characterization (GDI)

DAY TWO

• Mixture Formation
  • In-cylinder flow characteristics and GDI combustion
  • Fuel-air mixing process
  • Spray-wall interactions
  • Cold start and wall wetting issues
• Combustion Process and Control Strategies
  • Engine Operating Modes and Fuel Injection Strategies
  • Early-injection, late-injection, stoichiometric operation
  • Operating mode transition
• Split Injection Strategy
  • Two-stage, split, and post injection
• Combustion characteristics
  • Homogeneous-charge and stratified-charge combustion
• Effects of Engine Operating and Design Parameters on GDI Combustion

Instructor: Robert Kuhn
Fee $1275 1.3 CEUs
High Performance Engine Design and Development

1 Day
I.D.# C0725

Ever since Beau de Rochas patented the four stroke cycle in 1862, engineers have pursued the development of high performance engines for road and racing applications at an accelerated pace. While this course will not cover such ancient history, it will focus on engine design and development advances over the last 40 years from “BC to AD” ("Before Cosworth to After Duckworth"), covering the concepts and designs behind the modern racing engines for series including Formula One, Indy Cars, the IRL, and NASCAR.

This course will help you determine how to design a championship-winning racing engine including many of the key calculations that support the pursuit of power. Attention to detail on every aspect of engine design is emphasized with focus on applying simple math, physics, and even plain old common sense, rather than relying heavily on sophisticated software.

The course begins with a review of the major advances in engine design, then explores the design of the engine's primary systems and structures including oil systems, cam drive systems, water systems, inlet systems, exhaust systems, cylinder heads, cylinder blocks, and sumps. It will then explore how combustion works and how to analyze the major parameters involved in burning different fuels. This will be followed by the design and optimization of inlet and exhaust systems and applying mathematics via simple excel spreadsheets to determine the key factors for cam design, port design, inlet and exhaust tuning, and turbocharger/supercharger matching for those formulae that permit the use of boost to increase the inlet pressure. The day concludes with a discussion and opportunities to continue design exercises that will allow attendees to put into practice several of the key concepts learned throughout the seminar.

Detailed course notes and illustrations are provided along with example calculations to enable the attendee to calculate the key parameters required in the design and development of racing engines.

Learning Objectives

By attending this seminar, you will be able to:

• Describe the key parameters and choices facing the high performance engine designer
• Consider a variety of tips and solutions which can be applied by both design and development engineers to enhance the performance of competition engines
• Select “the least worse design solution” for any particular problem
• Summarize the major advances in engine design over the past 40 years

Who Should Attend

This course is for individuals with a thirst to improve their understanding of what makes a racing engine a championship winner. It can be valuable to those responsible for engine design, component design, and overall engine performance calculations or those who are merely interested in the subject.

Topical Outline

• Engines from BC to AD  A brief outline of racing engine history covering the design and development of several famous racing engines to highlight how fundamentally different approaches to design and manufacturing can generate championship winning engines for various classes of racing
• Detailed Design of Engine Systems
  • How does a modern racing engine work and why?  
  • Review of fundamental systems of the modern racing engine
• Engine Structures
  • Designing from the inside out, focusing on performance design
  • Adding the structures to integrate the load paths throughout the engine core
• Combustion
  • How any given fuel burns and what the combustion processes are that underpin performance
  • Combustion kinetics and fuel chemistry to enable calculation of energy release, peak combustion temperatures, and tail pipe emissions for any fuels or fuel mixtures.
  • Major fuel types and how to deal with any fuel starting from its basic chemical equations
• Engine Tuning
  • Inlet systems
  • Exhaust systems
  • Simple math for optimizing tuning orders and lengths
  • Camshafts
• Turbocharging and Supercharging
  How to calculate the requirements and the major performance parameters before starting the design process
• Discussion and Design Exercise
  How to design the next engine to move the boundaries of engine performance forward again

**Learning Objectives**

By attending this seminar, you will be able to:

- List the typical sensors, the sensory information they collect and describe the use of that information as it addresses improved fuel economy and reduced combustion emissions
- Describe the significance, technology, and application of:
  - Direct Injection (DI) of both gasoline and diesel fuels
  - Homogeneous Charge Compression Ignition (HCCI)
  - Displacement on Demand (DoD) Systems
  - Variable Cam Timing (VCT) and Variable Valve Timing (VVT)
  - Variable Compression Ratio (VCR) engine designs
- Explain the fundamental physics of the various technologies
- Specify the operational parameters and inter-relationships of each of the sub-systems of the enabling hardware
- Describe the basic design synthesis and analysis techniques for each of the major operational improvement technologies

**Who Should Attend**

This intermediate level seminar is appropriate for a number of design and engineering disciplines including, but not limited to: design engineers and engineering managers, automotive engine designers, component suppliers, engine test and development engineers, design services managers, and others who require the technological knowledge to perform their respective job functions.

**Prerequisites**

Individuals should have a practical understanding of current internal combustion technology and systems such as that covered in the SAE seminar *The Basics of Internal Combustion Engines* (ID# C0103, page 157), or its equivalent. An undergraduate engineering degree, or a strong technical background, is highly recommended. Basic knowledge of algebra and physics is essential.

**Topical Outline**

**DAY ONE**

- Operation of ECM and Sensor Systems
  - Information requirements
  - Use and distribution of collected information
  - Control theories and implementation of fuel management strategies
- Direct Injection (DI) of Both Gasoline and Diesel Fuels
  - Overview and historical perspective of DI technologies -- Gasoline; Diesel; DI hardware review
  - Potential and proven benefits of DI -- Theory; Aspects of gasoline combustion; Aspects of diesel combustion; Engine hardware development
- Homogeneous Charge Compression Ignition (HCCI) Technologies
  - Overview and historical perspective of HCCI technologies

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**Instructor:** Geoff Goddard

**Fee:** $1725 .7 CEUs

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**Internal Combustion Systems: HCCI, DoD, VCT/VVT, DI and VCR**

3 Days  
I.D.# C0613  
Societal and regulatory demands to lower emissions and increase engine-operating efficiencies have forced engine designers to adopt new technologies and control strategies. This has resulted in dramatic evolutions of the technology of internal combustion engines and their support systems in recent years. These operational management strategies have evolved into more robust control systems and sensory packages, which in turn has driven the need for more accurate and specific information being communicated between the various systems found within a modern automobile.

This seminar will expose you to the emerging technologies in engine design and operation that can significantly improve operational efficiencies. The fundamental science and implementation technology of the various internal combustion engine systems will be presented. Attendees will learn how the Engine Control Module (ECM) uses information related to the operational status to implement real-time running efficiency of the engine. You will also learn how the ECM effects changes in the operation of the engine through the control systems that manage its operation. With this understanding, you will be able to derive your own set of improvement criteria that could be made to address the limitations of current engine technology.
POWER AND PROPULSION

- Hardware review
- Gasoline based HCCI -- Theory; Aspects of gasoline combustion; Engine development
- Diesel based HCCI -- Theory; Premixed HCCI; Historical direct inject systems; Current technology direct inject systems; Water injection systems for HCCI control
- The chemistry of HCCI -- Alternative fuels; Fuel blends; Fuel additives
- HCCI control -- Operating range extension; Key parameters for control; Control strategies
- Kinetics of HCCI combustion

DAY TWO
- Displacement on Demand (DoD) Systems
  - Theoretical improvements to engine system performance and efficiency
  - Historical mechanisms to implement DoD systems
  - Modern approaches to DoD systems
- Variable Cam and Valve Timing (VCT, VVT)
  - General theory and potential system benefits of varying valve timing
  - Variable cam timing or phasing -- Benefits associated with VCT; Mechanisms to implement VCT; Modern approaches to VCT systems
  - Variable valve timing -- Benefits associated with VVT; Mechanisms to implement VVT systems; Modern approaches to VVT systems

DAY THREE
- Variable Compression Ratio (VCR) Engine Designs
  - Theoretical improvements to engine system performance and efficiency
  - Mechanisms to implement VCR technology
  - Modern approaches to VCR systems
- General Discussion
  - Use of alternate fuels
  - Implementing dual-fuel engines
  - Engines designed to run multiple fuels (not dual-fuels)
  - Control strategies for implementing and combining above technologies
  - Emerging technologies; New technologies

Instructor: William Mark McVea
Fee $1625 2.0 CEUs

Introduction to Commercial and Off-Road Vehicle Cooling Airflow Systems Web Seminar and Web Seminar Recording

12 Hours
Web Seminar: I.D.# WB1240
Web Seminar Recording: I.D.# PD331240ON

Vehicle functional requirements, diesel emission regulations, and subsystem thermal limits all have a direct impact on the design of a powertrain cooling airflow system. Severe duty cycles, minimal ram air, fouling, and sometimes unconventional package layouts present unique challenges to the designer. This Web Seminar introduces many airflow integration issues and vehicle-level trade-offs that effect system performance and drive the design.

This Web Seminar introduces engineers and managers to the basic principles of diesel cooling airflow systems for commercial and off-road vehicles. Participants will learn about vehicle/product constraints, integration issues, cooling airflow, system resistance, fans, shrouds, radiators, coolers, estimating heat rejection, thermal recirculation, and overall system performance. Basic concepts will be reinforced with examples and a cooling performance calculation of a diesel cooling system.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
- Define vehicle requirements and many cooling airflow system integration issues
- Describe heat exchanger sizing considerations, design alternatives, and thermal effectiveness
- List fan/shroud aerodynamic design parameters, guidelines, and installation effects
- Apply the fan laws to evaluate alternative designs
- Calculate fan operating point and airflow using component pressure-loss coefficients
- Estimate engine heat rejection to coolant, including Exhaust Gas Recirculation (EGR)
- Calculate steady-state thermal performance of a diesel cooling airflow system

Who Should Attend
OEM and supplier engineers and managers who are involved with vehicle cooling systems, or who interface with vehicle program management on these issues, will benefit from this seminar. Graduate-level students interested in cooling systems will also find it instructive.
Topical Outline

Session 1: Vehicle Perspective
- Overview Typical Cooling Airflow Systems
- Design Drivers
- A Classification of Vehicle Cooling Systems
- Industrial Air-cooled Heat Exchanger Assemblies
- Impact of System & Sub-system Requirements
- Thermal Recirculation
- Design Challenges

Session 2: Key Concepts - System Heat Transfer Equation and Pressure Losses
- 1st Law of Aerodynamics
- Radiator Heat Transfer Equation
- Definition of Standard Air
- Airflow Terminology and Standard Cubic Feet per Minute (SCFM)
- Bernoulli's Equation and Ram Pressure
- Pressure Loss Coefficient
- Vehicle Air Flow Restrictions - Flow Energy Losses
- Construct a System Pressure Loss Curve

Session 3: Fan Airflow
- Fan Classification and Specific Speed
- Fan Characteristic Curve and System Matching
- Air Performance Test Chambers (AMCA)
- Axial Fan Systems, Pusher and Puller
- Exercise the Fan Laws to Evaluate Design Alternatives
- Shroud Design Considerations
- Vehicle Installation Effects - Fan Position, Tip Clearance, Radiator Proximity

Session 4: Fan and Ram Airflow Map
- Ram Airflow
- Flow Energy Balance Equation
- Fan Operation with Ram; Ram Total-Pressure Recovery
- Calculate System Loss Curve, Fan Operating Point and Cooling Airflow

Session 5: Compact Heat Exchangers
- Thermal Classification of Heat Exchangers
- Compact Heat Exchangers in Vehicle Applications
- Radiator Effectiveness and Louvered Fins
- Charge Air Coolers, Performance Calculation Against Requirements
- Air-Side Fouling Study and Heat Exchanger Design Considerations
- Thermal Accumulation Calculation

Session 6: Estimating Powertrain Heat Rejection
- SAE Dynamometer Gross Power Test Procedures
- Dynamometer Data on Engine Heat Rejection
- Brake Mean Effective Pressure (BMEP), A Power Density
- Specific Heat Rejection (SHR) Characteristic Curve
- EGR Heat Rejection to Coolant
- Evaluation of Diesel Cooling System
- Tools and Methods for System Development

Piston Ring Design/Materials

2 Days
I.D.# 86009

The purpose of this course is to provide an overview of the factors in the cylinder kit assembly of natural gas, gasoline, and diesel engines that affect oil consumption, ring and cylinder bore wear, and blow-by. This course includes background and the evolution of designs and materials currently employed in modern engines as well as providing an overview of computer models, designs, and material systems that can be utilized to optimize the performance of new engines. An overview of the trends in materials and designs employed in U.S., European and Japanese engines will be presented.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the function of each ring and its interaction with other components within the cylinder kit to provide oil consumption and blow-by control
- Identify available computer models and instrumentation that is available to predict and measure the function of each of the components in the cylinder kit on oil consumption and blow-by control
- Compare the base systems and facing material systems and the trade-offs associated with each of the material systems, i.e., wear rate, scuff resistance, etc.

Who Should Attend

If you are an engineer associated with engine design and development and interested in understanding the function and design considerations within the cylinder kit system, you would benefit from attending.

Topical Outline

- Evolution of piston ring designs/materials -- diesel engines
- Evolution of piston ring designs/materials -- gasoline engines
- Outline of Nomenclature & Ring Design Methodology, including Referencing to Various Published Standards i.e. -- SAE, DIN, ISO
- Systems Parameters & Their Interaction with Piston Rings to Cause Variations in Performance
  - Cylinder bore geometry; Cylinder bore finish
  - Piston design; Power density; Operating speed; Engine lubricants
- Typical Procedures/Equipment Employed to Measure Dimension Properties of Piston Rings
- Developed Models Aiding in Cylinder Kit Design
- Determining the Effect of Design Parameters on Oil Consumption, Ring Function, Cylinder Bore Distortion, Friction & Wear Rates -- Unique test set-up procedures and their utilization

Instructor: Jack Williams
Fee $855 1.2 CEUs

Instructor: Harold E. McCormick
Fee $1235 1.3 CEUs
Practical Race Car Data Acquisition: RPM and Speed Analysis Fast Track

80 Minutes
I.D.#PD230834ON

Two of the most important and commonly used components in racing data acquisition today are engine RPM and speed analysis. These two channels of data give race teams and engineers critical information that can be used every day to help quantify changes in both the driver and the race vehicle. This 80-minute, online short course focuses on race car data acquisition, highlighting cornering speeds, engine acceleration rates, gear selection, engine RPM curves, shift times, throttle on/off, engine acceleration, wheel spin, brake lock, cornering speed, ignition cutout and much more. Whether you are a weekend racer or a professional data acquisition engineer, you will find the components of this course fundamental to successful data analysis in the real world. From hardware installation to software interpretation, this course will give you confidence and additional insight into these key pieces of data analysis.

Major topics include:
- Introduction
- Set-up for Acquiring Engine RPM Data
- Acquiring and Analyzing Engine RPM Data
- Interpreting RPM Results
- Set-up for Acquiring Speed/MPH Data
- Interpreting Speed/MPH Results
- Alternative Analysis Strategies

Is this Fast Track for you?
The Practical Race Car Data Acquisition: RPM and Speed Analysis Fast Track is designed for the racer - from the professional road racer to the weekend racer - or the engineer who is incorporating data acquisition into their race team strategy and want to maximize the abilities of their system as quickly as possible. This course does not require any pre-requisite, as the content will unfold from the basics, up to the more advanced features of these important data acquisition sensors. The knowledge gained in this course can be applied the next day at any level of racing without any additional training or experience.

What You Will Receive
- Three months of online access to the 80 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Dave Scaler
Fee $149

Race Engine Calibration for Optimal Performance e-Seminar

7 Hours
I.D.#PD130701ON

This course does not have a classroom counterpart. The engine control module (ECM, or on-board computer) is the tool used to control the fuel injection rate, fuel injection timing, ignition timing, rate of exhaust gas recirculation (EGR), and other functions. In this course, the instructor provides a practical introduction to ECMs, including the uses for the various sensors. He discusses the specific methods used to incorporate the various sensor signals into the ECM’s control systems for the fuel injection rate, fuel injection timing, and ignition timing. Background information includes an understanding of the desired air/fuel ratio and optimum ignition timing. While examples are tailored around the application of the ECM to Formula SAE race engines, this e-Seminar is useful for improving any engineer’s understanding of the functions of the ECM for other types of race engines as well as production engines.

Convenient, portable, and with core content from the instructor-led seminar (course I.D.# CO602), this e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This course offers six video modules; more than two hours of bonus material and software demonstrations; and a glossary of acronyms, accompanied by a handbook.

View the complete course description and a video demo at training.sae.org/eseminars/raceenginecalibration.

What You Will Receive:
- 365 Day access through MyLearn.sae.org
- Links to streaming video modules (4.5 hour course, 2.5 hours of bonus material)
- Course Handbook (downloadable .pdf’s, subject to DRM)
- Online Pre-test (self-test, immediate results)
- Online Post-test (self-test, immediate results)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Ronald D. Matthews
Fee $265 .7 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.
The Basics of Internal Combustion Engines

2 Days
I.D.# C0103

A similar course is available online, on demand – The Basics of Internal Combustion Engines e-Seminar – see course info below.

In your profession, an educated understanding of internal combustion engines is required, not optional. This two-day technology survey seminar covers the most relevant topics - ranging from the chemistry of combustion to the kinematics of internal components of the modern internal combustion engine - for maximum comprehension. Attendees will gain a practical, hands-on approach to the basics of the most common designs of internal combustion engines, as they apply to the gaseous cycles, thermodynamics and heat transfer to the major components, and the design theories that embody these concepts.

Learning Objectives
By attending this seminar, you will be able to:
• Discuss in detail the basic functioning and component interaction in a modern internal combustion engine, specifically; two and four-stroke cycles as they relate to reciprocating and rotary engine designs
• Describe the general thermodynamic concepts governing the operation of an internal combustion engine and its various cycles
• Compare the principle operational differences of the various fuels used in internal combustion engines, their availability, and understand the applicability of each
• Discuss the function and operation of all major components and systems within a modern internal combustion engine - identify the operational principles behind the timing and working relationships among all internal components, and articulate the importance of this inter-relationship
• Recognize the limitations of the current designs and implementations of the modern internal combustion engine
• Perform a basic assessment and evaluation of new, cutting-edge designs and new powertrain initiatives as they apply to the mobility industry

Who Should Attend
Designed for powertrain engineers, component suppliers, vehicle platform powertrain development specialists, and those involved in the application, design and discussion of engines. It is recommended that seminar attendees have an undergraduate engineering degree.

Topical Outline

DAY ONE
• Fundamental Operating Procedures
  • Open circuit
  • Closed circuit
  • Internal combustion
  • External combustion
  • Spark ignition
  • Compression ignition
• Engine Technology
  • 2-stroke
  • 4-stroke
  • Pistons, connecting rods and crankshaft
  • Valvetrain, camshaft and timing gear
  • Engine block, cylinder and head geometry
  • Manifold, surface finish, track length
  • Fuel systems, carburetors, fuel injection
  • Turbo- and super-charger
  • Ignition, timing and spark advance
• Fuel Delivery Systems
  • Air intake systems
  • Fuel delivery
  • The problem of part throttle operation
  • Intake manifold design and tuning
  • Turbo-charging
  • Super-charging
  • Introduction to emissions
  • Fuel management and control theory
  • Fuel injection
  • ECU operation
  • Sensors and instrumentation
• Valve Train
  • Operation
  • Arrangement -- Push-rod; Single overhead cam shaft (SOHC) design; Dual-overhead cam shaft (DOHC) design
  • Camshaft function and design considerations
  • Valve timing
  • Valve-train design considerations

DAY TWO
• Component and Event Timing
  • Valve actuation timing
  • Valve timing diagram
  • Spark ignition event and timing
  • Compression ignition injection event and timing
• Fuels & Combustion
  • Definition of hydrocarbon based fuels
  • Stoichiometric Burn Efficiency
  • Air / Fuel Ratio
  • Gasoline
  • Diesel
  • Octane rating
**Power and Propulsion**

- Cetane rating
- Hydrocarbon emission
- Flame types
- Thermodynamic efficiencies
- Ignition requirements
- Combustion chamber and head design

**Ignition**
- Common ignition sources
- Combustion abnormalities
- Spark plug design considerations
- Ignition timing

**Emissions & Controls**
- Chemistry of emissions
- Emission controls
- Catalytic converter operation
- Exhaust gas recirculation (EGR)
- Valve overlap control
- Introduction to variable camshaft timing (VCT)

**Thermodynamics**
- Definition and comparison of common internal combustion cycles
- Otto cycle; Diesel cycle; Dual cycle
- Atkinson cycle

**Energy Conversion Kinematics and Mechanisms**
- Cylinder arrangement
- Piston design considerations
- Piston ring application
- Connecting rod design considerations
- Crankshaft design
- Balancing

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**The Basics of Internal Combustion Engines e-Seminar**

**10 Hours**

**I.D.# PD130944ON**

A similar course is available as a classroom seminar—**The Basics of Internal Combustion Engines**—see course info above.

Convenient, portable, and with core content from the instructor-led seminar (content and description similar to the preceding classroom counterpart), this more than ten hour e-seminar option offers an alternative way to receive the same instruction as the live classroom learning without the expense of travel and time away from the workplace. The course offers ten video modules accompanied by a handbook.

View the complete course description and a video demo at training.sae.org/eseminars/ic_engines

**What You Will Receive:**

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf’s, subject to DRM)
- Online Pre- & Post-test (self-test, immediate results)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

**Instructor:** William Mark McVea

**Fee:** $565 1.0 CEUs

**SAE SI ENGINE CERTIFICATE PROGRAM**

Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

Designed to familiarize you with key spark ignition engine components and technologies and how they function as a system, completing this certificate delivers a fairly deep level of engine expertise and, at the same time, an SAE credential. Complete the SI Engine Certificate and earn seven or eight graduate credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems and Kettering’s 40-credit M.S. in Mechanical Engineering. Visit training.sae.org/collegescredit. View the list of required and elective courses and additional information on enrolling in this SAE certificate program—at training.sae.org/certificate/siengine

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**Instructor:** William Mark McVea

**Fee:** $1305 1.3 CEUs

**Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote**
Turbocharging Internal Combustion Engines

3 Days
I.D.# C0314

The need to control emissions and maintain fuel economy is driving the use of advanced turbocharging technology in both diesel and gasoline engines. As the use of diesel engines in passenger car gasoline and diesel engines increases, a greater focus on advanced turbocharging technology is emerging in an effort to reap the benefits obtained from turbocharging and engine downsizing.

This seminar covers the basic concepts of turbocharging of gasoline and diesel engines (light and heavy duty), including turbocharger matching and charge air and EGR cooling, as well as associated controls. The limitations and future possibilities of today’s systems will be covered, as well as details on how emerging technologies will impact engine/vehicle performance. The seminar’s primary focus is on the turbocharger-engine interface (subjects such as matching, benefits, limitations, and new technologies) 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.

**Participants are expected to bring a laptop computer, with Excel, to the seminar for class exercises.

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. Individuals who need more background should consider attending the SAE seminars Diesel Engine Technology (ID# 93014, page 133) or The Basics of Internal Combustion Engines (ID# C0103, page 157).

Topical Outline

DAY ONE

- Engine-Turbocharger Basics
  - Overview
  - Impact of charge density
  - Pumping loop and thermodynamics effects
  - Gas exchange/air flow and performance characteristics -- Engine; Turbocharger; Engine/turbocharger interaction
- Turbocharger Design Features
  - Overview
  - Compressor side components and features
  - Turbine side components and features
  - Other significant turbocharger design requirements
  - Charge and EGR cooler features
  - Durability - thermal stress, materials, high and low cycle fatigue
  - Cooling, bearings, lubrication and sealing
  - Noise considerations
- Free-floating, Wastegate, Variable Area or Variable Geometry Turbochargers and Controls
- Compressor and Turbine Aerodynamics
  - Aerodynamic design features
  - Figures of merit for aero performance
  - Performance maps and their impact on engine characteristics
  - Methodology to evaluate the performance of compressors and turbines

DAY TWO

- Engine Air and EGR Flow Requirements
  - Power density and efficiency considerations
  - Emissions control considerations
- Turbocharger Matching
  - Matching principles with and without EGR
  - Single and multi-stage turbo matching
- Turbocharger Selection Based on Engine System Requirement
- Transient Response Considerations
- Basic Spreadsheet Tools for Engine and Turbocharger Parametric Explorations
  - Hands-on exercises for turbocharger and engine performance calculations
  - Hands-on parametric studies using simple calculation tools

DAY THREE

- Impact of Turbocharging on Gasoline and Diesel Engine Performance and Emissions
- Charge (Air and EGR) Cooling Systems
**POWER AND PROPULSION**

- Advanced Concepts in Turbocharging including Design Features of Advanced Concepts
  - Advanced versions of variable geometry turbocharging
  - High temperature and high strength materials
  - Two-stage turbocharging, series, parallel and sequential
  - Exhaust gas recirculation systems to minimize impact on efficiency
  - Turbocompounding
  - Electrically (and hydraulically) assisted turbocharging
  - Impact on emissions control in diesel and gasoline engines
  - Cold start emissions issues, catalyst temperature for diesel and gasoline
  - Turbocharger response issues

**Turbocharging for Fuel Economy and Emissions Web Seminar and Web Seminar Recording**

4 Hours  
**Web Seminar : I.D.# WB1018**  
**Web Seminar Recording: I.D.# PD331018ON**

Turbocharging is already a key part of heavy duty diesel engine technology. However, the need to meet emissions regulations is rapidly driving the use of turbo diesel and turbo gasoline engines for passenger vehicles. Turbocharged diesel engines improve the fuel economy of baseline gasoline engine powered passenger vehicles by 30-50%. Turbocharging is critical for diesel engine performance and for emissions control through a well-designed exhaust gas recirculation (EGR) system. In gasoline engines, turbocharging enables downsizing which improves fuel economy by 5-20%.

This Web Seminar will explore turbocharging for gasoline and diesel (heavy and light duty) engines, including the fundamentals of turbocharging, design features, performance measures, and matching and selection criteria. It will discuss the interaction between turbocharging and engine systems and the impact on performance, fuel economy and emissions. Developments in turbocharging technology such as variable geometry mechanisms, two-stage and sequential (series & parallel) turbocharging, EGR including low pressure loop, high pressure loop and mixed mode systems and novel turbocharging systems will be described using figures and data.

**Learning Objectives**

By connecting with this Web Seminar, you will be able to:
- Identify the basics of how a turbocharger works, how to measure the appropriateness of a turbocharger, and how to select and match a turbocharger to the needs of your powertrain
- Estimate the impact of turbocharging on performance and emissions
- Anticipate potential issues such as packaging, noise, driveability, reliability, and durability
- List the latest developments in turbocharging technology, their impact on engine performance and emissions, and the use of turbocharging world-wide

**Who Should Attend**

This course will be beneficial to powertrain development engineers, component development engineers, engineering managers, product planners, service engineers, and those developing product strategy. Heavy duty diesel engine development engineers may find the course helpful by increasing their knowledge of turbocharging and EGR systems.

**Topical Outline**

**Session 1**
- Introduction to Turbocharging
  - Fundamentals, Functionality, and Basic Design Features of Turbochargers
  - Impact of Turbochargers on Engine Performance, Emissions, and Fuel Economy
  - Performance Maps, Selection Criteria, Comparison and Matching of Turbochargers to Engine and Powertrain Needs

**Session 2**
- Advanced Issues and Technology
  - Turbocharger Noise, Reliability, and Durability Considerations
  - Advanced Technology Developments Including Variable Geometry, EGR Systems, and Multi-Stage Turbocharging
  - Worldwide Growth in Application of Turbocharging

**Instructor:** S. M. Shahed and Arjun D. Tuteja  
**Fee:** $415 .4 CEUs

**Variable Valve Actuation: Design and Performance Impact on Advanced Powertrains**

2 Days  
**I.D.# C1332**

Engine valvetrain systems have become more capable and increasingly more compact in the quest to improve efficiency. The developments parallel the advancements in other key engine components such as fuel injection or spark systems, turbocharging, aftertreatment, base engine and controls. While the gasoline sector has seen a steady rise in the adoption of Variable Valve Ac-
POWER AND PROPULSION

Variable Valve Actuation (VVA), Diesel systems have lagged behind and only a few systems have seen production. The level of VVA activity however in the Diesel sector is beginning to increase as tighter regulations of CO2 emissions approach. Valve control plays a strong role in a number of key areas: turbocharger systems, allowing for better optimization matching across wide engine operating flows; enabling advanced combustion strategies where control over the charge mass and temperature are important; and cold start, where valve timing can be extremely effective for engine warm up compared with other strategies that rely on additional fueling.

This seminar will cover the range of Variable Valve Actuation technologies present in the market, their operation principles, and their effect on engine performance. Both gasoline and Diesel applications will be covered including how they impact the in-cylinder combustion as well as the aftertreatment. Participants will have the opportunity to perform hands-on exercises to examine the effects of the engine valve profiles on performance and are asked to bring a laptop computer, with Excel, to the seminar for class exercises.

Learning Objectives
By attending this seminar, you will be able to:
- Describe and differentiate the variable valve actuation technologies present in the automotive industry
- Describe the defining features of each of these technologies, their requirements for engine design layouts, required actuators, lube oil, and need for control and ECU interface
- Apply basic tools to gage the thermodynamic impact effected by varying the valve profiles: impact on pumping efficiency, resulting charge mass trapped in cylinder, estimated bulk and adiabatic flame temperatures
- Articulate the contribution of valve timing and control over the engine performance and aftertreatment in modern engines in the context of today’s emissions standards
- Describe the limitations of current technologies towards more efficient and cleaner engines and the future role of valve actuation and its integration aspects with other advanced powertrain components

Who Should Attend
This seminar is designed for engineers, managers, and other technical personnel from OEMs and support industries concerned with the design and development of optimized diesel and spark ignition engine systems, including calibration, performance, fuel economy and emissions for passenger car, light truck and heavy duty engines. It will be particularly interesting to Diesel engineers who will likely adopt some of the technologies developed in the gasoline sector for further improvements in emissions control and gains in fuel economy. It will be also of interest to combustion researchers as VVA will play a strong enabling role to exploring advanced combustion strategies.

Prerequisites
Some background in thermodynamics, IC engine performance and emissions will be helpful. Individuals who need more background should consider attending the SAE seminar The Basics of Internal Combustion Engines (I.D.# C0103). See the course description on page 157.

Topical Outline

DAY ONE
- Motivation and Objectives
  - Near and long term landscape
  - Fuel Economy, performance and emission standards
  - Key engine technologies
  - Overview of VVA landscape
- VVA Timeline
  - Efficiency improvements and synergies with other technologies
  - Industry trends and benchmarking
- Basic Engine Definitions
  - Work, fuel consumption, efficiency, exhaust gas recirculation (EGR)
  - Class exercise: engine performance calculator sheet
  - Thermodynamics and chemistry
  - Class exercise: EGR and valve timing effects on combustion
- Variable Valve Actuation Designs
  - Valvetrain overview: lift, timing, valve overlap
  - Cam phasing, cam switching, continuous variable lift
  - Lost motion systems including cylinder cut-off
  - Camless systems, electro-hydraulic, fully electro-magnetic
  - Case study: continuously variable valve system design
- VVA Case Studies and Impact on Gasoline Engine Performance
  - Continuously variable valve system on gasoline engine
  - Atkinson cycle with a hybrid plugin powertrain
  - Miller Cycle

DAY TWO
- VVA Case Studies and Impact on Diesel Engine Performance
  - Loss motion system to enable LTC on a MD Diesel engine
  - Electro-hydraulic system on HD Diesel engine
- Engine Brake Systems
  - System description and competitive advantages
  - Class exercise: hydraulic layout of brake system
- Transient Performance
  - Response
  - Engine warm-up strategies
  - Gas exchange interactions (turbochargers)
- Modeling and Controls
  - Physical modeling of air system
  - Integration of multiple actuator systems
  - Enhancing combustion stability
Fuels and Energy Sources

Alternative Fuels: Impact on SI and CI Fuel Systems, Distribution and Storage

2 Days
I.D.# C0729

Microbial contamination and material compatibility present significant issues for alternative fuels, causing costly operational problems for suppliers, distributors and end-users. Fouling, corrosion, sulphide spoilage and increased water content can lead to filter plugging, blocking of fuel lines and injectors and consequently cause excessive wear and failure of engines and systems components. This course is a primer for those professionals who desire to learn how new fuel and fuel blends could potentially impact the operation and reliability of engines powered by oxygenated gasoline, desulfurized diesel fuel and biodiesel fuel blends. Attendees will learn the basics about fuel chemistries, material compatibility and how the increased susceptibility to water and microorganisms can affect equipment operation and reliability.

Learning Objectives

By attending this seminar, you will be able to:

• Explain the events that have shaped our current fuel policies
• Compare the differences between petroleum and biomass fuel chemistries
• Detect fuel and potential system material compatibility issues
• Describe how fuel systems could potentially be at greater risk for problems due to the presence of microorganisms
• Detect and remediate problems associated with microbial contamination of fuels
• Improve the overall operational reliability of power systems that utilize diesel and biodiesel fuels

Who Should Attend

This seminar is appropriate for fuel systems design engineers, fuel quality managers in refinery, pipeline and terminal operations, engine fuel quality managers, and maintenance technicians.

Topical Outline

DAY ONE

• Fuels
  • Brief overview of fuel history -- introduction of fuels for spark ignition and compression ignition engines; Events and policy that shaped fuels in the United States
  • Overview of Fuel Chemistries
    • Petroleum fuels -- Feedstocks and production
    • Biomass fuels -- Feedstocks and production
    • Unique chemical differences
  • Material Compatibility
    • How is material compatibility defined?
    • Metals vs. non-metals
    • Factors that contribute to the corrosion of metals and non-metals
    • Examples of material compatibility issues
• Microorganisms
  • Brief overview of the operational and economic impact of microorganisms to the gasoline, diesel and biodiesel industry
  • Brief description of microorganisms related to fuels
  • Requirements for microorganisms to survive in a fuel storage and distribution system
• Diesel Fuel Storage and Distribution
  • Entry and movement of microorganisms throughout the diesel fuel storage and distribution network
• Detection of Microorganisms
  • Types of detection equipment and procedures
  • Practicum

DAY TWO

• Remediation of Microorganisms
  • Microbial pesticides approved for use in fuels
  • USEPA regulations governing the sale of microbial pesticides
  • Characteristics of an efficacious microbial pesticide
  • Methods for treating storage and distribution systems
• Surveillance and Testing
  • Benefits of a routine surveillance program
  • Developing a surveillance program

Instructor: Ed English & Howard Chesneau
Fee $1365 1.3 CEUs
3 ways to get a no-obligation price quote to bring a course to your company • Call SAE Corporate Learning at 1-724-772-8529 • Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org

Decreasing Fuel Consumption and Exhaust Gas Emissions in the Transportation Industry

3 Days
I.D.# C1405

The transportation industry is changing quickly. While the technologies in transportation vehicles have become much friendlier to the environmental, the overall long-term impact remains a focal point in political and public discussions. The importance of striking a balance between global transportation and environmental protection and the need for technologies to further reduce fuel consumption and exhaust gas reductions will remain a global priority. Beginning in the earliest phases of research and development, manufacturers and suppliers in the ground vehicle, aerospace, and shipping industries must be decisive in defining future strategies that promote sustainability while also maintaining profitability.

This three-day seminar will provide participants a comprehensive overview of the technical trends currently being utilized across the globe to meet strict legislative requirements. The instructor will guide participants through various technologies, including detailed discussions on combustion, engines, fuels, aerodynamics, and corresponding strategies that are available and utilized in various regions across the globe. The instructor will present achievable solutions from the legislative, technical, and financial perspectives while also maintaining the balance with global environmental protection.

Participants will receive a copy of Onboard Diagnostics and Measurement in the Automotive Industry, Shipbuilding, and Aircraft Construction written by the instructor, Michael Palocz-Andresen.

Learning Objectives
By attending this seminar, you will be able to:
• Calculate the basic levels of fuel consumption and exhaust gas emissions in transportation
• Estimate the environmental and climate impact of combustion processes in ground, aerospace, and shipping vehicles
• Evaluate current technologies in use in Germany, Hungary, China, Japan, Egypt, and the USA
• Apply basic information to sustainable principles in construction, aerodynamics, propulsion, engine, electronic, computer and navigation technologies
• Explain alternative propulsion technologies such as electric drive, fuel cell, hybrid, and various other systems
• Evaluate the effectiveness of combining fossil fuels with renewable energy resources
• Evaluate predictions for future transportation models

Who Should Attend
This seminar is intended for individuals involved with vehicle manufacturing in the ground, aerospace, and shipping industries that are interested in global technologies currently being used to improve sustainability.

Topical Outline
DAY ONE
• Basics of Fuel Consumption and Exhaust Gas Emissions
• History of transportation
• Comparison of fuel consumption and emissions
• Units and international conversions
• Engineering Technology in Transportation
• Construction and engine technology
• Electronic and computer technology in vehicles, airplanes and ships

DAY TWO
• Combustion and Exhaust Gas Emission Processes
• Hardware systems for containing, transporting, and using fuels
• Exhaust gas after treatment technology
• Modern Communication and Navigation Technology
• Future inspection and maintenance
• Measuring technology; sensors, actuators, OBD and FAMEC system

DAY THREE
• Climate and Environment Legislation and Role of Limiting Values for Manufacturing, Maintaining and Recycling
• International legislation
• Tasks and possibilities in the next 25 years
• Free Discussions and Examination
• Group discussions
• Written examination

Instructor: Michael Palocz-Andresen
Fee $825 2.0 CEUs

Fundamentals of Automotive Fuel Delivery Systems

2 Days
I.D.# C0303

The key to a vehicle’s overall operation is the superior, quality design of its major moving subsystems. Automotive gasoline and diesel fuel delivery systems in particular must be virtually malfunction free for all components for the entire vehicle prescribed service life. Fuel systems must be robust and precise enough to store and deliver the appropriate amount of fuel to power the engine. These stringent requirements necessitate a
basic understanding of the subsystem working principles, functionalities and interrelated components.

This course provides a basic yet thorough examination of technical issues involved in automotive gasoline and diesel fuel delivery. Participants will acquire a fundamental understanding of the current technology and requirement guidelines and apply some of the principles through an in-class project and exercises. Examples of frequently encountered technical issues of fuel delivery systems shall also be discussed. The course is designed to encourage discussion, insights, and possible solutions into the engineering problems encountered in the gasoline and diesel fuel delivery systems and components.

Learning Objectives
By attending this seminar, you will be able to:
- Organize, differentiate and interpret the fundamental concepts, features and applications of fuel delivery systems
- Describe general gasoline and diesel fuel delivery system functionality
- Compare and differentiate individual components comprising the subsystem
- Identify interconnections of system components
- Apply general gasoline and diesel fuel system requirement guidelines

Who Should Attend
You should attend if you are an engineer or engineering manager involved in design, research, testing or implementation of automotive fuel delivery systems. Engine designers, suppliers of fuels and fuel delivery system components, and polymer engineers may benefit as well.

Topical Outline
- Introduction
  - Overview
  - General expectations
- Fundamental Fuel Delivery Systems
  - SI engine fuel delivery systems -- Gasoline; Alternative fuel
  - GDI engine fuel delivery systems -- for stratified; homogeneous; mixed combustion mode
  - Diesel engine fuel delivery systems -- Conventional unit injector system; Electronic controlled intensifier systems; High pressure common rail systems
  - Fuel Cell -- Solid oxide fuel cell; Proton exchange fuel cell
  - Advanced fuel delivery system concept -- Variable valve lifting; Cylinder deactivation
- Fuel Types & Properties
- Fuel Delivery Subsystem Working Principles
  - Delivery modules -- Return systems; Returnless; Mechanical returnless fuel delivery system (MRFS); Electronic returnless fuel delivery system (ERFS)
  - Fuel pump assemblies -- PFI pumps; GDI high pressure pumps; and diesel high pressure common rail (HPCR) pumps
  - Injector assemblies -- PFI injectors; GDI injectors; HEUI injectors; unit injectors; Diesel HPCR injectors and their electronic driving mechanism
  - Injection types -- Multi-point injection (MPI); Sequential multi-point injection (SMPI); Direct injection (DI); Common rail diesel injection (single injection event; Multiple injection events; Rate shaping); Homogeneous charge compression injection (HCCI) for gasoline and diesel
  - Fuel pressure regulation -- mechanical and electronic
  - Onboard refilling vapor recovery system (ORVR) and vapor management
  - Fuel level indication mechanism -- contact; non contact
  - Fuel filtration -- Pump/module inlet filtration; Inline filtration; Integrated filtration system; lifetime filters; filtration efficiency; beta value; and dirt capacity
  - Fuel delivery metering -- High pressure end; Inlet metering
- Fuel Delivery System OEM and Government Regulatory General Requirements
  - Functionality requirements
  - FTP highway and urban cycles
  - Durability requirements
  - Safety requirements
  - Permeation requirements
  - Contamination life requirements
  - Static charge and abatement techniques
- Fuel Delivery System and Components Evaluation and Testing Methods
  - Fuel tank; Fuel lines
  - Delivery module
  - Pump
  - Injector
  - Regulator
  - ORVR valve
  - Fuel level gauge; Fuel filter
  - Vapor canister
  - Fuel delivery driver module
  - Leak testing
  - Electrical static discharge testing
  - Permeation testing
- Summary

Instructor: Dr. Xiaojian Tao
Fee $1275 1.3 CEUs
Fossil and Renewable Energy Production, Storage, Transfer, and Use in the Mobility Industry

2 Days
I.D.# C1406

One of the major challenges facing the mobility industry is maintaining a consistent supply of fuels. Even while fossil fuel resources are limited on earth and not renewable, the gap between energy production and energy consumption is continuously growing. Exploration and extraction of new sources for oil production is costly, technically challenging, and in locations such as deep-ocean and Arctic reserves, can be politically and socially sensitive. A sustainable energy strategy must consider a decrease in the availability of fossil fuels and needs to include renewable fuel options. A number of technical advances have been made, including hybrid propulsion technologies and increased fuel efficiency standards to decrease the overall reliance on fossil fuels. This two-day seminar will provide seminar attendees an overview of fossil and renewable fuels and their respective production technologies, transportation, storage, and applications. The instructor will guide attendees through the various methods of fossil and renewable fuels production and the technologies for its use in transportation vehicles. The instructor will then provide an international perspective on transportation and storage of energy and its associated costs, from both the financial and environmental perspective. Active participation in this seminar will provide a comprehensive introduction to the technologies, science, and economics that may help in providing global solutions for a sustainable transportation industry.

Participants will receive a copy of the book titled Onboard Diagnostics and Measurement in the Automotive Industry, Shipbuilding, and Aircraft Construction written by the instructor, Michael Palocz-Andresen.

Learning Objectives

By attending this seminar, you will be able to:

• Describe measuring technology, remote sensing, data transfer, and fleet management
• Evaluate predictions for sustainable energy and fuel supply in future transportation

Who Should Attend

This seminar is intended for individuals involved with vehicle manufacturing in the ground, aerospace, and shipping industries that are interested in global technologies currently being used to improve sustainability.

Topical Outline

DAY ONE

• Basics of Energy Consideration, Units and Calculation Methods
  • History of fossil energy production and energy use
  • Global tendencies of fossil fuel use
• Renewable Energy Production
  • Wind energy, off-shore technology; efficiency; costs
  • Sun energy, heat and electric energy production, efficiency; costs
• Fuel Production Processing for the Transportation Industry
  • Gas to liquid, biomass to liquid, coal to liquid
  • Hydrogen, fuel cell applications, other fuels

DAY TWO

• Engineering Technology for Fuels in Transportation
  • Store, transport and measuring systems of fuels in automobiles, airplanes, and ships
  • Cost situation, predictions
• Environmental and Climate Aspects
  • Rescue technology, inspection and maintenance
  • The German way to Energy Change
  • Tasks and possibilities over the next 25 years
• Closing
  • Group discussions
  • Written examination

Instructor: Michael Palocz-Andresen
Fee $625 1.3 CEUs

Improving Fuel Efficiency with Engine Oils

2 Days
I.D.# C0914

Improving vehicular fuel efficiency is of paramount importance to the global economy. Governmental regulations, climate change and associated health concerns, as well as the drive towards energy independence, have created a technical need to achieve greater fuel efficiency. While vehicle manufacturers are focusing efforts on improved combustion strategies, smaller displacement engines, weight reduction, low friction surfaces,
etc., the research involved in developing fuel efficient engine oils has been less publicized. This seminar will highlight the role of lubricants in improving fuel efficiency and provide strategies for selecting the best oil for a given application.

The course begins with 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. 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, as well as detailed aspects of oil formulations which have significant effects on reduction in mechanical friction, such as base oil selection, viscosity grade choice and impact of friction modifiers, will be covered. The performance characteristics of fresh oil versus used oil and lubrication of coated surfaces will also 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.

**Topical Outline**

**DAY ONE**

- Reducing Fuel Consumption
  - Regulations - N. American, Europe and Asia
  - GHG emissions and climate change
  - Petroleum based fuels - availability
  - Biofuels - availability and global trends
- Fundamentals of Engine Friction
  - Gasoline engine; Diesel engine
- Methodology - Part 1: How to Measure Engine Friction
  - Examples of bench tests
  - Examples of engine tests

- Methodology - Part 2: How to Measure Fuel Consumption in Real Life Conditions
  - Gasoline vehicles; Diesel trucks

**DAY TWO**

- Fuel Economy Derived Lubricant Specifications
  - N. America - API specifications
  - United Europe - OEM specifications
  - Japan - OEM specifications
- Lubrication Fundamentals
  - Lubrication regimes
  - Stribeck curve
- Lubricant Components - Effects on Fuel Consumption
  - Base oils
  - Viscosity grades
  - Friction modifiers
- Fuel Economy Retention
  - Impact of used oil on fuel consumption vs. engine wear protection
- Lubrication of Low Friction Surfaces
  - Coatings
  - Engineered surfaces
- Impact of Diesel Emission Control Devices on Overall Fuel Consumption

**Instructor:** Ewa Bardasz  
**Fee:** $1275 1.3 CEUs

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**Liquid Atomization, Sprays, and Fuel Injection**

3 Days  
I.D.# 98019

Liquid fuel atomization and spray formation is the heart of the majority of stationary and mobile power generation machines that we rely on. This seminar focuses on the process of liquid atomization and spray formation and how it relates to fuel injection systems and emission of pollutants in modern engines. The seminar begins with background coverage of terminology, the purposes of liquid atomization and spray formation, and different designs of atomizers and nozzles employed in various industries. The focus is then directed to gasoline and diesel fuel injections, injector designs, and performance requirements for optimum engine operation with lowest possible emission of harmful pollutants. Based on the idea that knowledge of technical practices and advances in one area (i.e. diesel fuel injection) is beneficial to engineers in other areas (gasoline direct injection, rocket engines), this seminar takes an interdisciplinary approach. Attendees will understand the technology and logic behind different injector designs, and gain the knowledge to judge, adapt and transfer technology advances from one discipline to another.
Learning Objectives

• By attending this seminar, you will be able to: Explain important terminology commonly used in atomization and sprays
• Describe important processes in atomization and spray formation
• Articulate the effects of injection system design and operating conditions on engine performance, combustion, and emission of pollutants
• Describe different injector designs and the rationale for the use of each
• Define the role the injection system plays in combustion and emission and how it is used to provide guidance in design of low-emission combustion systems
• Implement appropriate design concepts and logic in the design of critical components such as intake valves and induction systems
• Evaluate future trends and technology developments in fuel injection

Who Should Attend

Automotive and aerospace engineers, technical and project managers, researchers and academicians will benefit by attending this seminar. Automotive engineers working on the design of combustion engine components, reduction of harmful pollutants emissions, software development and application for modeling of thermal-fluid, combustions and emissions and engineers and managers directly involved in fuel injection systems will also benefit. Aerospace engineers involved in the design of gas turbine or rocket engines’ combustion chambers will benefit as well.

Topical Outline

DAY ONE
• Description of the Atomization Process
• Disintegration of the Liquid Jets
  • Rayleigh criterion (no viscosity)
  • Weber’s criterion (effects of viscosity)
  • Ohnesorge criterion for atomization (Ohnesorge Number)
  • Rayleigh, first and second wind-induced breakup and atomization regimes
  • Influence of some parameters -- jet velocity profile; nozzle length-to-diameter ratio; ambient pressure
  • Disintegration of liquid sheets
  • Drop breakup in air flow, turbulent flow, and viscous flow
• Types of Atomizers: Pressure, Air-Assist, Air-Blast, Effervescent, Electrostatic, Ultrasonic, Diesel Injector and Gasoline-Fueled Injectors
• Drop Size Distribution and Measurements
  • Graphical and mathematical representation of drop size distribution
  • Averaged diameter and representative diameters
  • Measurement techniques -- patternation; drop size measurements and spray characterization
• Mechanical methods -- drop collection on slides; molten-wax and frozen-drop approach; cascade impactors; electrical; charged-wire and hot-wire methods; optical methods; imaging - photography and hography; single-particle light scattering (Phase Doppler Particle Analyzer, etc.); diffraction size analyzer
• Drop evaporation

DAY TWO
• Diesel Fuel Spray, Injector and Injection System
  • Fuel injection system -- pumps: in-line injection, distributor-type injection, single-barrel injection, and unit injector & unit pumps; injector designs: nozzle holder, nozzles, others
  • Overall spray structure
  • Liquid fuel atomization
  • Spray angle
  • Intact core length
  • Spray evaporation
  • Ignition delay
  • Mixing-controlled combustion
  • HC emission mechanisms in diesel engines and its relation to fuel injection
  • Soot formation and fuel sprays
  • Advanced topics (details of split injection, common-rail injection, interacting-sprays injection, ultra-high pressure fuel injection, effects on performance and emissions, and others)

DAY THREE
• Gasoline Port Fuel Injectors and Injection System
  • Multipoint port injection system -- classes of gasoline port injectors: low pressure, medium pressure, high pressure, air-assisted, swirl, heated vaporizing, ultrasonic, and electrostatic; key requirements of gasoline port injectors; deposit considerations
  • Single-point throttle body injection system
  • Feedback system
  • Effects of injection parameters on engine performance and emission: injection timing, spray targeting, spray momentum, mean drop size, pulse-to-pulse variability, and others
  • Flow of Fuel and Air in Intake Manifolds
  • Details of Gasoline Direct Injection (GDI) and its Effects on Engine Performance and Emission of Pollutants
  • Fuel-air mixing processes
  • Spray Modeling and Demonstration of Computer Software for Spray Calculation in Engines
  • Summary and Conclusion

Instructor: Bruce Chehroudi
Fee $1545 2.0 CEUs
Modern Fluids for Crankcase Engines: An Overview

2 Days
I.D.# C0704

Lubricating fluids are the lifeblood of modern engines, performing numerous vital functions from reducing system friction, temperature, and fuel consumption to minimizing tailpipe emissions. This comprehensive seminar covers the latest developments in lubricating fluids technologies and explores the relationships between lubricating fluids and emissions, after-treatment devices, bio-fuels, and fuel economy. Fundamentals of crankcase lubrication, including the properties and performance requirements of global base stocks and lubricants will be covered. The seminar will further explore the need for lubricating systems to possess thermal and oxidative stability sufficient to withstand the rigors of low-heat-rejection, high performance diesel engines or other modern engines equipped with various emission control devices. Case studies will be utilized to demonstrate the existence of overlapping phenomena aimed at extending oil life and protecting key mechanical components.

Learning Objectives

By attending this seminar, you will be able to:
• Describe how various classes of additives commonly used in crankcase lubricants impact:
  • wear of bearings, pistons, and piston rings
  • friction and fuel consumption
  • corrosion
  • piston cleanliness
  • swelling of seals
  • hydraulic media in fuel systems, such as hydraulically-actuated electronically-controlled unit injector system (HEUI).
• Recognize the limitations and technical trends in new base stocks and additive technologies
• Compare performance characteristics of lubricants designed for passenger cars manufactured in N. America, Europe or Japan
• Identify key lubricant requirements for protecting heavy duty diesel engines
• Select and optimize fluids for various light duty and heavy duty after-treatment applications
• Recognize differences between API, ACEA, and ILSAC lubricant categories

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 crankcase fluids in extending useful life of the overall systems, minimizing emissions and reducing fuel consumption will find the seminar beneficial.

Topical Outline

DAY ONE

• Introduction to Engine Lubricant Formulations
  • What are motor oils?
  • Standardized tests of new oils (SAE J300)
  • Used oils testing
• Lubrication Fundamentals
  • Functions of a lubricant
  • Friction
  • Lubrication regimes (Steinbeck Curve)
  • Wear modes
  • Viscosity
• Base Oils
  • Classes of crude oils
  • Conventional refining processes
  • Base oil categories
  • Affect of base oils on performance of engine oils
• Additives
  • Composition of motor oils - historical perspective
  • Lubricant additives industry
  • Engine oil additives -- Dispersants and dispersant VI improvers; Detergents and overbased detergents; Oxidation inhibitors; Wear inhibitors; Rust inhibitors; Friction reducers; Viscosity improvers; Factors promoting wear and deposits formation; Dispersion of particles in diesel and gasoline engine oils

DAY TWO

• Global Lubricant Specifications
  • Classification of motor oil by performance category
  • API service categories
  • Development of a new diesel engine oil category: PC10
  • Motor oil classifications- API doughnut
  • ACEA European oil specifications for gasoline and diesel engines
• Extended Service Intervals (ESI)
  • Maintenance intervals and engine life
  • Effect on lubricant formulations
• Fuel Economy
  • Diesel vs. gasoline engines test procedures
  • Lubricant role in friction reduction
• Global Trends in Emission Specifications and Exhaust Control Systems
  • Gasoline engines
  • Diesel engines
  • Fuel quality concerns
• Examples of Lubricant Interactions with Exhaust Systems
  • Three-way catalysts
  • Diesel particulate filters

Instructor: Ewa Bardasz
Fee $1335 1.3 CEUs
Motor Fuel: Technology, Performance, Testing, and Specifications

3 Days
I.D.# 98003

Fuel composition has had to change with the advent of more stringent emission regulations. Reformulated gasoline (RFG), for example, is vastly different from gasoline of even ten years ago. Tightening regulations on diesel emissions will dramatically change both diesel fuel and engine design. This three-day seminar will review the fundamentals of motor fuels, combustion and motor power generation. The primary content of the course provides a basic introduction to the technology, performance, evaluation, and specifications of current gasoline, diesel, and turbine fuels. The first day of the course begins with a brief review of the evolution of motor fuel through 100 years of performance and specification.

Learning Objectives

By attending this seminar, you will be able to:
• Describe how fuel compositional variables affect engine performance
• Interpret test data to determine if fuel meets required specifications and regulations
• Determine the purpose and mode of action of performance additives
• List the important processes in motor fuel
• Communicate effectively with others working with motor fuels
• Have a working knowledge of motor fuel composition, properties, and performance -- a necessity for engine designers, and fuel and additive formulators.

Who Should Attend

This course is intended for engine design engineers who need a basic understanding of the fundamental performance properties of motor fuels and additives. The course is also intended for formulators who need to understand the relationships of fuel performance and composition to properly design fuels and additives to meet current and future needs. Engine testing personnel; petroleum company employees; Federal, State, and Local Regulatory personnel, laboratory supervisors; and fuel marketing personnel would also benefit.

Topical Outline

DAY ONE
• Introduction and History of Motor Fuels
• Overview of Motor Gasoline
  • Gasoline composition, chemistry, production, blending
  • Spark ignition engine and effect of fuel quality on performance
  • Gasoline volatility and combustion
• Influence of composition on storage stability and engine deposit formation

DAY TWO
• Oxygenated Blend Components and Emissions
• Gasoline Specifications
• Overview of Diesel Fuel
  • Diesel composition, chemistry, production, blending
  • Diesel engine and effect of fuel quality on performance
  • Fuel characteristics influencing combustion and emissions
  • Low temperature and other fuel characteristics
• Fuel additives

DAY THREE
• Alternative Fuels, Future Trends, and Directions
• Diesel Specifications
• Gaseous Fuels for Engines
  • Natural gas combustion, performance, and emissions
  • LPG combustion, performance, and emissions
  • Alternative fuels, future trends, and directions
• Racing Fuels
  • General considerations
  • Hydrocarbon fuels; Alcohol fuels; Special fuels
• Future Trends in Fuels
  • Alternative fuels
  • Future trends and directions

Instructor: Kenneth Kipers
Fee $1715 2.0 CEUs

Using Computational Fluid Dynamics for Engineering Product Development

2 Days
I.D.# C0909

Over the last three decades Computational Fluid Dynamics (CFD) has developed into a sophisticated tool for analyzing fluid flow and other thermal sciences related phenomena. Most educational courses on this topic focus on the fundamentals of CFD, but sound knowledge of the fundamentals is not enough to make effective use of CFD in practical engineering product development. This seminar provides significant practical considerations in using CFD for product development and is designed to help engineers extract best benefits from CFD while avoiding potential pitfalls.

The seminar begins by discussing the applicability, benefits, and drawbacks of CFD in engineering product development. Ways of leveraging CFD, while avoiding pitfalls at various stages of the product development process, as well as various aspects of managing and implementing practical CFD projects, will be explained. Advanced aspects of CFD management and imple-
mentation such as methods development and multiphysics will also be covered. The resource requirements and costs of CFD are then detailed along with a discussion and exercises on performing return of CFD investment calculations. Commercially available codes will also be compared and contrasted. Hands-on exercises and case studies are used throughout the seminar to put practical emphasis on topics taught in the lectures.

**Learning Objectives**

By attending this seminar, you will be able to:
- Explain benefits and limitations of CFD in engineering product development
- Determine where to use CFD in various stages of the product development process
- Use CFD and experimental testing to compliment each other in the product development process
- Determine when to and when not to use CFD
- Plan, manage, and implement CFD simulation projects
- Evaluate CFD results for correctness and accuracy
- Leverage CFD with numerical simulations of other physics
- Calculate and plan the resources needed for implementing CFD
- Perform return on investment calculations for investments in CFD
- Make informed choices of commercial CFD software
- Determine when to and how to effectively use external CFD services
- How CFD and testing compliment each other
- How to choose between CFD and testing
- When and when not to use CFD
- Hands-On Exercise 2 - This exercise goes through a complete design optimization cycle, where a specific engineering product design is optimized using CFD
- CFD Project Management and Implementation
  - Need identification and goal determination
  - CAD data handling and extraction
  - Preprocessing, solving, post-processing and reporting
  - Evaluating correctness and accuracy of CFD results
  - Meaningful comparison of CFD results with experimental test data
  - Archiving CFD simulation data

**DAY TWO**
- Advanced Aspects of CFD Implementation
  - Various stages of CFD acceptance and usage
  - CFD methods development and R&D
  - Leveraging CFD with other numerical simulations
- Multi-physics
- CFD process compression
- Resources Needed for CFD Implementation
  - Hardware
  - Software
  - Personnel - roles of specialists and non-specialists
- Costs and Returns of CFD
  - CFD costs; Typical time needed for CFD implementation
  - CFD return on investment
  - Case studies and exercises
- Overview of Commercial CFD Software
  - Commercial CFD software tools currently available
  - Comparison of commercial CFD software tools
  - How to choose commercial CFD software
- External CFD Services
  - Types of external CFD services
  - When to use external CFD services
  - How to choose an external CFD services vendor
- External Resources for CFD Information

**Who Should Attend**

All engineering product development personnel involved in applications of fluid flow and thermal sciences will benefit from this course. These include product development and evaluation engineers, design engineers, engineering analysts, supervisors, managers, CAE strategists, and researchers. New entrants to the field of CFD will be able to use this course to identify and adopt the best CFD implementation and management choices and methods for their organizations from the get-go. Existing and experienced personnel in the CFD field will be able to use this course to improve upon their current CFD implementation methods and practices to realize greater benefits from CFD.

**Topical Outline**

**DAY ONE**

- Review of CFD
  - Overview of basic physics, mathematics, and numerics
  - Applications of CFD in automotive, off-highway and aerospace engineering
  - Typical CFD project work-flow
  - Benefits and limitations of CFD
  - Hands-On Exercise - Understanding the Benefits and Limitations of CFD
  - Leveraging CFD in the Product Development Process
    - Use of CFD at various product development stages
    - System and component level CFD simulations
  - How CFD and testing compliment each other
  - How to choose between CFD and testing
  - When and when not to use CFD
  - Hands-On Exercise 2 - This exercise goes through a complete design optimization cycle, where a specific engineering product design is optimized using CFD
  - CFD Project Management and Implementation
    - Need identification and goal determination
    - CAD data handling and extraction
    - Preprocessing, solving, post-processing and reporting
    - Evaluating correctness and accuracy of CFD results
    - Meaningful comparison of CFD results with experimental test data
    - Archiving CFD simulation data

**Fee $1265 1.3  CEUs**

**Instructor:** Sandeep Sovani
RELATED TRAINING SOLUTIONS

Some of our courses apply to more than one technology category. Consider these related courses described in other sections of this resource guide.

Emissions-Related OBD Systems: A Design Overview
This one day seminar is designed to provide an overview of the fundamental design objectives and the features needed to achieve those objectives for generic on-board diagnostics.
Read more about this course on page 30

Hybrid and Electric Vehicles: Current Production, Future Strategies
This two-hour web seminar will highlight the passenger, light-duty, and heavy-duty hybrid and electric vehicles that are currently in production, offered for sale, or planned for near-term production.
Read more about this course on page 37

Hybrid Vehicle Systems Integration
This seminar will address: how to establish essential vehicle requirements; development considerations for various vehicle systems and production/certification requirements. A strong focus will be placed on understanding the balances and tradeoffs associated with a hybrid electric system.
Read more about this course on page 38

Introduction to Hybrid and Electric Vehicle Battery Systems
Driven by the need for lower emissions, better fuel economy and higher efficiency, hybrid vehicles are appearing in many different configurations on today’s roadways. This seminar will introduce participants to the concepts of hybrid vehicles, their missions and the role of batteries in fulfilling those requirements.
Read more about this course on page 39

Plug-in Hybrids: Opportunities and Challenges
What are the advantages and challenges for vehicle manufacturers, public utilities, energy and environmental concerns, and end-users? What is the current state of plug-in hybrid development? This Web Seminar explores these questions and more.
Read more about this course on page 40
PRODUCT ENGINEERING DEVELOPMENT TOOLS & METHODS

Includes design, engineering practices, test methods, problem solving, and data analysis.

Accelerated Concept to Product (ACP) Process for Design Optimization Web Seminar

4 Hours
I.D.# WB1402

Today’s transportation industries are facing multi-disciplinary challenges. The product design and development process challenges often contradict each other, for example cost, weight, quality and performance. A central challenge is the need for cost and mass reduction to compete in the global market, while continuing to meet all new and existing requirements for quality and performance. Accelerated Concept to Product (ACP) Process is a performance-driven, holistic, product design development method intended to create a balance between structure and strength, synchronizing the individual facets of the product development process. It takes advantage of design, material and manufacturing experience using multiple CAD, CAE and CAO tools to reduce product design and development time and costs, as well as to reduce product mass and improve product performance.

This two-session web seminar will offer information for those who would like to start with the design of initial product structure from a general design space, a shape, or ideas available, or knowledge of design space and constraints. The instructor will show how you can use and locate the first initial load path (material) using topology optimization and special CAD tools. You will also learn how to generate your first initial pre-concept structure, with general shape of all necessary and required structures, based on your Load Path. As an illustration, the course will go through vehicle body in white (BIW) pre-concept development.

This web seminar is complementary to the Accelerated Concept to Product (ACP) Process using a 3G Design Approach Web Seminar, but is not a mandatory prerequisite. It details how to develop pre-concept designs with topology optimization and size the components based on the material alone. The 3G course uses the design that is generated in this course, or any current design concept, and applies a holistic 3G design approach for the product system and details designs for sub-systems.

Learning Objectives
By participating in this web seminar, you will be able to:
- Explore Accelerated Concept to Product (ACP) Process in today’s product design environment
- Apply holistic key enablers for efficient design and weight reduction in the ACP-Concept process
- Use Multidisciplinary Design (MD) Topology Optimization to solve design problems incorporating a number of disciplines and assess the material load path based on multidisciplinary loading assumptions
- Generate and design the initial geometry of a design concept based on the topology optimization skeleton and early manufacturing requirements
- Identify a Load Path Mapping (LPM) process

Who Should Attend
Chief engineers, product and design managers, principal engineers, program managers and lead design/CAE engineers will benefit most from this advanced course. A solid understanding of mechanical engineering concepts, as well as an understanding of CAD, CAE and design is required. Knowledge of Optimization software tools and capabilities is a plus.
As instructors: Akbar Farahani

Fee $415 .4 CEUs

SAE PRODUCT ENGINEERING TOOLS AND METHODS CERTIFICATE PROGRAM
Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

This program focuses on the study, development, management and implementation of product engineering principles, methodologies and techniques—powerful productivity enhancers that facilitate the reduction of product development time and cost.

training.sae.org/certificate/engineering_tools.

Accelerated Concept to Product (ACP) Process using a 3G Design Approach Web Seminar

6 Hours

WB1403

Today’s transportation industries are facing multi-disciplinary challenges. The product design and development process challenges often contradict each other, for example cost, weight, quality and performance. A central challenge is the need for cost and mass reduction to compete in the global market, while continuing to meet all new and existing requirements for quality and performance. Accelerated Concept to Product (ACP) Process is a performance-driven, holistic, product design development method intended to create a balance between structure and strength, synchronizing the individual facets of the product development process. It takes advantage of design, material and manufacturing experience using multiple CAD, CAE and CAO tools to reduce product design and development time and costs, as well as to reduce product mass and improve product performance.

This three-session web seminar will offer information on how to design a concept model from a clean sheet using a holistic 3G design approach (ACP-3G), where material types and its properties (Grades and Gauges), Geometry (shape), and manufacturing process can work together for the optimum weight and performance. The instructor will show how to use a systemic design process approach addressing the concept design for system structure for general design shape (section and size it based on manufacturing constraints). How to then design structural components in detail using sub-system design optimization and traditional design approaches will be covered. The process will use leading CAE, Optimization and CAD design tools for illustration. ACP-3G will show the design of structures with the most efficient resources (Design and CAE head counts) and optimum shape and material (Grade and Gauges) for the minimum cost for manufacturing. The course will also go through vehicle body-in-white (BIW) design process. It will identify the sizes and shape of the major components of a vehicle (Low Fidelity 3G) and finally, high-fidelity design of the components for manufacturing in both a sub-system and full system.

This web seminar is complementary to the Accelerated Concept to Product (ACP) Process for Design Optimization Web Seminar, but it is not a mandatory prerequisite. Both courses will begin with a foundational discussion of the ACP Process and design methodology. While the complementary course takes the material load path into consideration during topology optimization, this course explores a completely holistic design approach. The approach is based on existing or current design concept geometry, in which the material types and its properties (Grade
and Gauges), Geometry (shape) and manufacturing processes all work together for the optimum weight and performance.

Learning Objectives
By participating in this web seminar, you will be able to:
• Explore Accelerated Concept to Product (ACP) Process in today\’s product design environment
• Apply holistic key enablers for efficient design and weight reduction in the ACP-Concept process
• Define 3G design optimization of a structure that incorporates the optimal Geometry (shape) and material (Grade and Gauges), at the lowest cost for manufacturing
• Define and incorporate an efficient Load Management System (LMS)
• Describe and complete Full System MD (Multidisciplinary) 3G, Low Fidelity 3G (LF3G) optimization
• Describe decoupling process and identify the optimal design sub-system concept based on 3G
• Optimization for manufacturing requirements and cost constraints (Mass, Performance and Cost)

Who Should Attend
Chief engineers, product and design managers, program managers and lead design/CAE engineers will benefit most from this advanced course. A solid understanding of mechanical engineering concepts, as well as an understanding of CAD, CAE and design is required. Knowledge of Optimization software tools and capabilities is a plus.

Topical Outline
SESSION 1
• Accelerated Concept to Product Design Process Methodology - Overview
• Case Study
• Low Fidelity 3G (LF3G) Optimization Process
  • Load Path Management (LPM) evaluation under multi-disciplinary loading condition
  • Design targets setting and calibrations
  • Design space, design variables, constraints and objectives (Performance and Mass) based on load paths, Geometry, Grade and Gauge (3G) and manufacturing constraints
  • LF3G FE model parameterization, LF3G design and monitoring processes
  • 3G Optimization communication (CAD/CAE, Optimization and the solver software)
  • Load path optimization results study, Load Path Mapping (LPM) based on multidisciplinary loadings (static, dynamic and impact)
  • Load path driven design and sub-systems functions
  • LF3G Process outputs; new improved load paths, overall components section sizes (geometry) and grades and gauges for Decoupling and Sub-System Optimization

SESSION 2
• Decoupling Process 3G Sub-System Optimization
  • Sub-systems for detailed component design
  • Sub-system boundaries, loadings and constraints based on the full system
  • Design components based on the manufacturing process
  • Sub-system and full system comparison study
  • Sub-System 3G optimization process (same as LF3G Process)
  • Objectives, performance, design variables and manufacturing constraints (cost) in the 3G optimization process

SESSION 3
• Integration of 3G Sub-System Optimization, Full system 1G/2G Optimization and Final
  • Design Evaluation
  • 3G Sub-system Optimization and manufacturing feasibility
  • Final Design Evaluation based on performance, mass and cost (manufacturing, tooling and equipment)
  • The optimized sub-system into new design for full system evaluation
  • 1G/2G optimization for system correction
  • DFMA and full system evaluation for all attributes
  • Design sensitivity study
  • BOM, Joining Process, Assembly Process and Manufacturability confirmation
  • Final design evaluation

Instructor: Akbar Farahani
Fee $535 .6 CEUs

Accelerated Test Methods for Ground and Aerospace Vehicle Development
2 Days
I.D.# C0316

A similar course is available online, on demand – Accelerated Test Methods for Ground and Aerospace Vehicle Development e-Seminar – see course info below.

Engineers and managers involved with product development are constantly challenged to reduce time to market, minimize warranty costs, and increase product quality. With less and less time for testing, the need for effective accelerated test procedures has never been greater. 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 ground and 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.

**Topical Outline**

- Statistical model for reliability testing
  - Fundamentals of a statistical reliability test
  - Effects of automotive supply chain on sample size and duration
  - Common pitfalls
  - Examine and solve two or three real life statistical data set problems
- Key Accelerated Tests, Terms, and Methods
  - Definitions: Information Goal, Basic Method, Limitations
  - Full System Life Test (FSLT); Step Stress
  - Accelerated Reliability Highly Accelerated Life Test (HALT)
  - Failure Mode Verification Test (FMVT) — Development; Warranty; Life Prediction
- Test Acceleration vs. Program Acceleration
  - Advantages of accelerating a full validation program compared to an individual test
  - Examples of time/cost saved on individual test acceleration
  - Examples of time/cost saved on program acceleration
- Hybrid Acceleration Methods
  - Using information goals of individual test methods to combine and leverage tests
  - Hands-on team exercise: combine test methods to solve a particular information need
  - Decision and selection process
    - How to choose which method
    - Considering position in supply chain
    - Considering business model and product type
    - Considering development phase
    - Considering component, subsystem, and system level testing
    - Hands on team exercise: selecting optimal testing solution for several scenarios

**Accelerated Test Methods for Ground and Aerospace Vehicle Development e-Seminar**

10 Hours
I.D.# PD130624ON

A similar course is available as a classroom seminar—Accelerated Test Methods for Ground and Aerospace Vehicle Development – see course info above.

This course offers more than 10 hours of instruction divided into fourteen modules; a coordinated handbook; and a copy of the instructor’s book, Accelerated Testing and Validation Management, which includes numerous hands-on exercises and a CD with analytical spreadsheets. Convenient, portable, and with core content from the instructor-led seminar (view description for classroom seminar jabove), the e-seminar program option offers new and alternative ways to receive the same instruction as the live classroom learning without the expense of travel and time away from the workplace.

View the complete course description and a video demo at training.sae.org/eseminars/atm.

**What You Will Receive:**

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf’s, subject to DRM)
- Online Pre-test & Post-test (self-test, immediate results)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

**Instructor:** Alexander (Alex) J. Porter

**Fee:**
- $595 1.0 CEU

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Advanced GD&T Competencies: Composite Positioning Web Seminar and Web Seminar RePlay

1.5 Hours
Web Seminar: I.D.# WB1321
Web Seminar RePlay: I.D.# PD331321ON

While the basics of position are covered in a standard Geometric Dimensioning & Tolerancing (GD&T) course, and sometimes a lone example of composite position is given, those discussions often overlook the variations allowed that enable more accurate control based on part function. This advanced Web Seminar will clarify the proper use of “double-decker” position controls in GD&T. There are two distinct types: composite position (one symbol) and two single-segment position controls (two symbols). These are commonly used to locate patterns of features (bolt circles, etc.), but they are rarely taught in any depth. In this course, participants will learn the difference in showing one vs. two position symbols and the importance of the datum references in understanding each meaning, per the ASME Y14.5-2009 standard. Many samples will be shown of the proper tolerancing of patterns of holes and pins that use each method. Examples and exercises will be provided to allow participants to practice several calculations. Learning these advanced techniques will permit better communication of part and assembly requirements between designers and manufacturers.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Explain composite positioning tolerancing
• Explain two single-segment tolerancing
• Apply the appropriate callout based on functional requirements
• Describe gages for each and calculate gage sizes

Who Should Attend
This advanced-level course is intended for designers, product engineers, manufacturing engineers, manufacturing personnel, and quality/gaging inspectors with a basic knowledge of GD&T concepts. It is a companion to the Advanced GD&T Competencies: Profile of a Surface And Advanced GD&T Competencies: Datum Usage Web Seminars - pages 159 and 160.

Prerequisites
For those new to GD&T, the Fundamentals of Geometric Dimensioning & Tolerancing Web Seminar is a recommended prerequisite. See course description on page 173

Topical Outline
• Brief review of position and bonus tolerance
• Explanation of composite tolerancing
• The need to control orientation vs. location
• Adding secondary and tertiary datums to the lower tolerance
• Two single-segment position tolerancing
• Functional gaging and CMM gaging perspectives

Instructor: John-Paul Belanger
Fee $210 .15 CEUs

Advanced GD&T Competencies: Datum Usage Web Seminar and Web Seminar RePlay

1.5 Hours
Web Seminar: I.D.# WB1319
Web Seminar RePlay: I.D.# PD331319ON

Standard Geometric Dimensioning & Tolerancing courses cover the basics of datums but can overlook the variations that enable usage in complex ways. This advanced Web Seminar details the proper use of datums, showing their full potential to make your drawings as effective as possible. Most people who use GD&T are familiar with traditional datums derived from flat surfaces, and have adequate knowledge of the principle of establishing 3-2-1 contact points. Participants learn to select, identify, simulate, and describe datums and datum features for special uses such as irregular shapes, flexible parts, and datum references that use the maximum material modifier. Web Seminar also covers several new modifiers and options given in the ASME Y14.5-2009 standard. Learning these advanced techniques will allow designers to better communicate certain requirements.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Explain the difference between a datum and a datum feature
• Select appropriate datums for irregularly shaped parts such as body or interior panels
• Properly simulate given datums
• Explain effects of a modified datum on a geometric tolerance
• Interpret new datum tools such as translation and custom degrees of freedom

Who Should Attend
This advanced-level course is intended for designers, product engineers, manufacturing engineers, manufacturing personnel, and quality/gaging inspectors with a basic knowledge of GD&T concepts. It is a companion to the Advanced GD&T Competencies: Composite Positioning and Advanced GD&T Competencies: Profile of a Surface Web Seminars. See course descriptions on pages 159 and 160.
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

Prerequisites
For those new to GD&T, the Fundamentals of Geometric Dimensioning & Tolerancing Web Seminar is a recommended prerequisite. See the course description on page 173.

Topical Outline
• Brief review of traditional datum usage
• Selecting datums: surface vs. feature of size
• Use of the MMB modifier (formerly MMC)
• Using a pattern as a single datum
• The new translation modifier
• Applying the “M” modifier to a surface
• Customized degrees of freedom
• Irregular feature of size datums
• Moveable datum targets

Instructor: John-Paul Belanger
Fee $210 .15 CEUs

Advanced GD&T Competencies: Profile of a Surface Web Seminar and Web Seminar RePlay
1.5 Hours
Web Seminar I.D.# WB1320
Web Seminar RePlay: I.D.# PD3313200N

Basic Geometric Dimensioning & Tolerancing courses cover profile but often ignore the variations allowed with these symbols that enable usage in complex ways. This advanced Web Seminar clarifies the proper use of the profile tolerances in GD&T and uncover the nuances of these two symbols. Profile of a surface is arguably the most powerful GD&T symbol, so its full potential is explored. It can be used to control size, form, orientation, and location and its relationship to datums can be varied. Learning these advanced techniques allow designers to better communicate certain requirements. The examples given in the course will also illustrate several of the new options for profile that were introduced in the ASME Y14.5-2009 standard.

Instructor: John-Paul Belanger
Fee $210 .15 CEUs

Who Should Attend
This advanced-level course is intended for designers, product engineers, manufacturing engineers, manufacturing personnel, and quality/gaging inspectors with a basic knowledge of GD&T concepts. It is a companion to the Advanced GD&T Competencies: Datum Usage and Advanced GD&T Competencies: Composite Positioning Web Seminars. See course descriptions on page 159 and 160.

Prerequisites
For those new to GD&T, the Fundamentals of Geometric Dimensioning & Tolerancing Web Seminar is a recommended prerequisite. See course description on page 173

Topical Outline
• Review of profile of a surface and profile of a line
• Using profile without datums
• All around and all over
• Locating a profile zone with tolerated dimensions
• Using the MMB modifier with profile
• Composite profile
• The “U” modifier
• Nonuniform tolerancing

Instructor: John-Paul Belanger
Fee $210 .15 CEUs

ANOVA for Design of Experiments
1 Day
I.D.# C0714

This seminar is suggested for product or process experts who have a need to utilize more detailed information concerning Design of Experiments analysis. It primarily addresses the subject of ANOVA, analysis of variance, which is a statistically based, objective decision-making tool. This is an advanced seminar that covers the fundamentals required to analyze orthogonal experiments, interpret, and recommend further action based on the analysis. Emphasis is placed on the analysis phase of the DOE process. The seminar covers DOE basic review, simple and complex ANOVA situations, process capability estimation, and a review of available computer software for experimental design and analysis.

Learning Objectives
By attending this seminar, you will be able to:
• perform ANOVA for DOE analysis
• interpret ANOVA results
• estimate process capability from ANOVA information

Instructor: John-Paul Belanger
Fee $210 .15 CEUs
**Who Should Attend**

This seminar is designed for product and process design engineers, manufacturing engineers, quality engineers (control, assurance, or supplier), testing and development engineers, and technical managers who are interested in more comprehensive experimental analyses and information. Although, more statistical in nature, this seminar does not require a statistical education or background to comprehend the contents; only fundamental mathematical skills are necessary. This seminar is also very helpful in providing a statistical foundation for those seeking certification in quality engineering.

It is strongly recommended that the registrant attend a Basic Design of Experiments course or have experience with fractional factorial experiments based on orthogonal arrays before attending the ANOVA for Design of Experiments course.

**Topical Outline**

- **Training Objectives**
- **Design of Experiments Process Flowchart**
- **Planning and Conducting Phase Review**
- **Analyzing and Interpreting Results**
  - observation method review
  - column effects method review
  - raw data ANOVA -- one-way; two-way; multi-way with orthogonal arrays
  - variation ANOVA
  - attribute data ANOVA
  - interpreting experimental results
  - plotting
  - prediction of mean and confidence interval
  - confirmation experiment
  - process capability estimates
- **Software Review and Comparison**

**Design for Manufacture and Assembly (DFM/DFA)**

*2 Days*

<table>
<thead>
<tr>
<th>Instructor:</th>
<th>Phillip J. Ross</th>
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<td>Fee</td>
<td>$725 .7 CEUs</td>
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This seminar provides a functional understanding of the principles involved in conducting a Design for Manufacture/Design for Assembly study. DFM/DFA can support both manual and automated processes resulting in significant cost savings through simpler designs with fewer components. Related topics include workstation layouts, ergonomic considerations and errorproofing. Actual examples from the automotive industry are used to support the lecture and participants complete actual design efficiency using the DFM/DFA worksheet.

**Learning Objectives**

By attending this seminar, you will be able to:

- Recognize and list the benefits of the DFM/DFA method in creating product designs which support manufacturing processes leading to short and long term product cost savings
- Outline a Robust Manufacturing Plan that optimizes and simplifies product design without sacrificing quality
- Objectively determine which designs would be suitable as DFM/DFA candidates
- Perform the essential stages of a Design for Manufacture process including the analysis required to overcome typical manufacturing difficulties encountered in product design
- Construct an actual DFM/DFA worksheet and calculate design efficiency

**Who Should Attend**

Product Engineers, Designers and Managers, Manufacturing and Tooling Engineers, and Project Managers who desire to understand DFM/DFA as a product design tool to increase manufacturability of product assemblies. The course is best suited for individuals in the manufacturing industry and is beneficial to OEMs and Tier suppliers.

**Topical Outline**

**DAY ONE**

- **Introduction to DFM/DFA and DFM/DFA objectives**
  - DFM, DFA and Product Life Cycle
  - Six Steps of the DFM/DFA Life Cycle Model
  - DFM and DFA advantages and challenges in a Product Development environment
- **Design Considerations**
  - Creating the DFM/DFA Environment
  - Guidelines for selecting DFM candidates
  - Integrating FMEA and DFM/DFA
  - Material Selection process
  - Project Cost Estimation
  - DFM Worksheet, Tables and Terms Defined
  - Minimizing part count using the Minimum Part Criteria
  - Finalizing the Critical Design Characteristics
  - DFM introductory project

**DAY TWO**

- **Design Considerations (cont)**
  - Operator Interface Considerations - Handling, Insertion, and Fastening issues
  - Calculating initial design efficiencies
  - Prioritizing Design Improvement efforts using the Worksheet codes
  - Finalizing DFM project
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

- Process Considerations
  - Workplace Layout
  - Methods of Assembly
  - Lean Production Metrics
  - Errorproofing
  - Introduction to DFM Concurrent Costing
  - Total cost savings through DFM and DFA

Who Should Attend
You should attend if you are a product designer, product engineer, or manufacturing engineer. Individuals involved in a new or ongoing product development process will benefit by learning how to help synchronize and optimize fabrication and assembly activities. This course is most effective when attended by product development teams. However, this is not a requirement for attendance.

Topical Outline
- Welcome and Introduction
- What is DFM+A
  - The history of DFM+A
  - The various “Design fors”
  - Why companies are using DFM+A
  - DFM+A success stories
  - DFM+A benefits
  - Key factors in ensuring DFM+A success
- DFA Good Design Principles
  - The Boothroyd Dewhurst Design for Manual Assembly Method
  - Using the manual handling and insertion tables
  - Determining theoretical minimum part count
  - Filling in the BDI DFA worksheet
  - Computing the DFA Index
- DFA Baseline Analysis Exercise (Pneumatic Piston)
- Redesign Project (Pneumatic Piston Assembly)
  - Developing design concepts
  - Identifying conservative and “stretch” designs
  - Selecting the best DFA concept
  - Analysis of redesign
  - Presentation of team results
- General Approach to Manufacturing Cost Estimation
  - Manufacturing cost drivers
  - Estimating piece cost
  - Cost calculation exercise
- BDI Design for Manufacture (DFM) Cost Estimation
  - Injection molding cost algorithms
  - Sample calculation
  - Exercise (analyzing part from pneumatic piston)
- Brief Design for Service (DFS) Overview
- DFM+A Workshop Checklist
- Institutionalizing DFM+A in Your Organization
  - How DFM+A fits in with other strategies
  - Lessons learned from other companies
  - Ideal workplace implementation plan

Instructor: Angelo Mago
Fee $1225 1.3 CEUs

Design for Manufacturing & Assembly
1 Day
I.D.# 95032

2 Days
I.D.# 92047

Design for Manufacturing and Assembly (DFM+A), pioneered by Boothroyd and Dewhurst, has been used by many companies around the world to develop creative product designs that use optimal manufacturing and assembly processes. Correctly applied, DFM+A analysis leads to significant reductions in production cost, without compromising product time-to-market goals, functionality, quality, serviceability, or other attributes. This seminar will include information on how DFM+A fits in with QFD, Concurrent Engineering, Robust Engineering, and other disciplines.

Each participant will receive and use the hard-bound authoritative reference textbook *Product Design for Manufacture and Assembly*, written by Geoffrey Boothroyd, Peter Dewhurst and Winston Knight.

You are also asked to bring a calculator capable of making simple calculations.

Learning Objectives
Upon successful completion of this course, you will be able to:
- Perform Design for Assembly (DFA) Analysis using the BDI Manual (Worksheet) Method
- Perform DFM Analysis (manufacturing cost estimation)
- Apply Design for Service (DFS) Principles
- Reduce your company’s production costs by analyzing and eliminating the factors that greatly affect the time, cost, and quality of manufacturing, assembly, and service processes
- Utilize effective analysis, brainstorming, and trade-off techniques for redesigning assemblies and subassemblies

Instructor: Kevin Zielinski
Fee (95032) $895 .7 CEUs
Fee (92047) $1445 1.3 CEUs

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• Fill out the online quote request at www.sae.org/corplearning • Email us at Corplearn@sae.org
Design of Experiments (DOE) for Engineers

2 Days
I.D.# C0406

A similar course is available as a live online Web Seminar – Design of Experiments (DOE) for Engineers Web Seminar – see course description below.

Design of Experiments (DOE) is a methodology that can be effective for general problem-solving, as well as for improving or optimizing product design and manufacturing processes. Specific applications of DOE include identifying proper design dimensions and tolerances, achieving robust designs, generating predictive math models that describe physical system behavior, and determining ideal manufacturing settings. This seminar utilizes hands-on activities to help you learn the criteria for running a DOE, the requirements and pre-work necessary prior to DOE execution, and how to select the appropriate designed experiment type to run. You will experience setting up, running, and analyzing the results of simple-to-intermediate complexity, Full Factorial, Partial Factorial, and Response Surface experiments utilizing manual methods as well as a hands-on computer tool that facilitates experimental design and data analysis. You will also receive an overview of Robust DOE, including the Taguchi DOE Method.

Participants will be given information on how to receive, install and configure a fully-functional 30-day trial version of Minitab™ for their use in class, and/or for their personal evaluation. While some computers will be available, attendees are encouraged to bring a laptop computer and/or a calculator to the seminar to provide additional hands-on time.

Learning Objectives

By attending this seminar, you will be able to:
• Decide whether to run a DOE to solve a problem or optimize a system
• Set-Up a Full Factorial DOE Test Matrix, in both Randomized and Blocked forms
• Analyze and Interpret Full Factorial DOE Results using ANOVA, (when relevant) Regression, and Graphical methods Set-Up a Fractional (Partial) Factorial DOE, using the Confounding Principle
• Analyze and Interpret the results of a Fractional Factorial DOE
• Recognize the main principles and benefits of Robust Design DOE
• Decide when a Response Surface DOE should be run
• Select the appropriate Response Surface Design (either Plackett-Burman, Box-Behnken, Central Composite, or D-Optimal)
• Interpret Response Surface Outputs
• Utilize the MiniTab™ Software tool to analyze data

Who Should Attend

This seminar will benefit engineers, designers and quality professionals in research, design, development, testing and manufacturing who are interested or active in one or more of the applications listed above. Individuals should have an engineering degree or equivalent coursework in math, statistics and computers.

Topical Outline

• Icebreaker: Team Problem Solving Exercise Using Engineering Judgment
• What is DOE?
  • Types of Designed Experiments
  • Application Examples
  • Where DOE Fits in with Other Tools/Methods
• DOE Requirements: Before You Can Run an Experiment
  • Writing Problem and Objective Statements
  • Ensuring DOE is the Correct Tool
  • Selecting Response Variable(s) and Experimental Factors
  • Actual vs. Surrogate Responses
  • Attention to Experiment Logistics
  • Test Set-up and Data Collection Planning
  • Selecting and Evaluating a Gage
• Full Factorial Experiments
  • Introduction to Cube Plots for 3- or 4-factor 2-level Experiments
  • Experiment Set-Up
  • Factor Levels, Repetitions, and “Right-Sizing” the Experiment
  • Experiment Terms to Estimate (Main Effects and Interactions)
  • High-Level Significance Evaluation
• DOE Statistical Analysis
  • ANOVA Principles for Simple Full Factorial Experiments — Statistics Basics; Significance Test Methods; Effect of Non-Random Experiments; Estimating Significance Test “Power”; Confidence Intervals; Estimating Random Error
  • Analysis Plots — Normal and Half-Normal Plots; Main Effect and Interaction Plots
  • Regression Analysis of Simple Full Factorial Experiments
  • Using MiniTab™ for Full Factorial DOE Experiments
• Fractional (Partial) Factorial Experiments
  • The Confounding Principle — How it Works; What Information We Lose with Confounding (and why we might not care!)
  • Selecting and Using Generators (Identities) to Set Up Confounding Strings
  • Determining Which Factor Combinations to Run
  • Analyzing Fractional Factorial Experiment Data
  • Using MiniTab™ for Fractional Factorial Experiments
• Robust Design Experiments (Overview)
• What is Robustness?
• Control and Noise Factors
• Classical and Taguchi Robust DOE Set-Up
• Robustness Metrics
• Analytical and Graphical Output Interpretation
• Response Surface Modeling
  • What Response Surface Models do BEST
  • Available Response Surface DOEs (Plackett-Burman, Box-Behnken, etc.) — Ideal Situation(s) to Use Each Response Surface DOE Type; Cube Plot Set-up of Each Response Surface DOE
  • Analyzing Response Surface Experiment Data
  • Methods for Finding Optimum Factor Values
  • Using MiniTab™ for response Surface Experiments
• Miscellaneous Notes and Wrap-up

Instructor: Kevin Zielinski
Fee $1345 1.3 CEUs

SAE PRODUCT ENGINEERING TOOLS AND METHODS CERTIFICATE PROGRAM
Watch for the certificate icon to indicate course titles that are part of an SAE multi-course certificate program.

This program focuses on the study, development, management and implementation of product engineering principles, methodologies and techniques. When used properly, these tools and methods become powerful productivity enhancers and facilitate the reduction of product development time and cost. Complete this certificate and earn up to seven graduate credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems and Kettering’s 40-credit M.S. in Mechanical Engineering. Visit training.sae.org/collegecredit for more information. For the complete list of required and elective courses and additional information on enrolling in this SAE certificate program, visit training.sae.org/certificate/engineering_tools.

Design of Experiments (DOE) for Engineers Web Seminar
12 Hours
I.D.# WB0932

A similar course is available as a classroom seminar – Design of Experiments (DOE) for Engineers—see course description above.

Design of Experiments (DOE) is a methodology effective for general problem-solving, as well as for improving or optimizing product design and manufacturing processes. Specific applications of DOE include, but are not limited to, identifying root causes to quality or production problems, identifying optimized design and process settings, achieving robust designs, and generating predictive math models that describe physical system behavior. This competency-based Web Seminar utilizes a blend of reading, discussion and hands-on to help you learn the requirements and pre-work necessary prior to DOE execution, how to select the appropriate designed experiment to run, DOE execution, and analysis of DOE results. You will experience setting up, running, and analyzing simple-to-intermediate complexity Full Factorial and Partial Factorial experiments both by hand and using computer software. You will also set-up and analyze Robust/Taguchi and Response Surface experiments utilizing computer software. Each participant will receive a 30 day Minitab™ product trial copy for use in the Web Seminar. Due to the nature of the Web Seminar format, each participant will be expected to dedicate approximately one hour to complete “homework” and/or short reading assignments in preparation for each session.

Learning Objectives
• Determine when DOE is the correct tool to solve a given problem or issue
• Select the appropriate DOE experiment type (DOE Goal) for a given application
• Set up simple Full Factorial DOEs by hand, using cube plots
• Set up and analyze any Full Factorial DOE using Minitab™
• Identify appropriate partial factorial design(s) based on one’s application
• Set-up and analyze Partial Factorial DOEs, simple Robust Design (Taguchi) DOEs, and simple Response Surface DOEs using Minitab™
• Recognize the structured process steps recommended when executing a DOE project

Who Should Attend
This Web Seminar will benefit engineers involved in product design and/or optimization; process design and/or optimization; quality improvement efforts such as defect elimination, warranty avoidance or similar initiatives; and technicians, analysts and
Managers who support engineers in these efforts. This course has no specific course prerequisites. However, participants are expected to have some math background, that includes elementary statistics. Since the course includes demonstration and hands-on use of Minitab™, participants should have some familiarity with Windows-based personal computer applications.

**Topical Outline**

**Session 1**
- Introduction
- What is DOE (with Initial Data Collection Exercise)
- Full Factorial Experiments using Cube Plots
  - Identifying main effect and interaction terms
  - Determining effects for all terms
- Estimating How Much Experiment Data is Enough
- Assignment for Session 2: Review of Web-Based Demo of Minitab™ - Full Factorial DOE Set-up and Analysis; and Reading, Overview of DOE Statistics

**Session 2**
- Set up and Analysis of a Full Factorial Experiment using Minitab™
- Minitab™’s DOE Results (High Level Overview of Minitab™ Outputs)
- Review of Methods for Determining ‘Significance’
- ANOVA and Regression Overview
- Assignment for Session 3: Hands-on Exercise in the use of Minitab™ using Simulator to Generate Data, and Reading on the Structured DOE Process

**Session 3**
- Review of Exercise Assigned at the End of the Session 2
- Review and Additional Information on DOE Statistics and Interpretation of DOE Output
- Best Practice: The Problem Solving Process
- Best Practice: The Structured DOE Process
- Assignment for Session 4: Reading on Overview of Confounding and Partial Experiments

**Session 4**
- The Confounding Principle and Partial Factorial Experiments
- How Confounded Occurs in a DOE, including Identity Usage and Resolution
- Setting up Partial Factorial Experiments using Minitab™
- Assignment for Session 5: Partial Factorial Exercise using Minitab™ and a Simulator to Generate Data for the DOE; Reading on Robust/Taguchi DOE

**Session 5**
- Review of Exercise Assigned at the End of the Session 4
- When Robust/Taguchi DOE is Appropriate
- How Robust/Taguchi DOE is Different
  - Two-Step Optimization Concept
  - Control vs. Noise
- Importance of Control-by-Noise Interactions
- Signal-to-Noise (S/N) and Loss Statistics
- Some Taguchi DOE Success Stories (incl. Set-up and Analysis in Minitab™)
- Demonstration of Minitab™ for Setting Up a Taguchi DOE
- Assignment for Session 6: Robust/DOE Exercise using Minitab™ and a Simulator to Generate Data for the DOE, Reading on Overview of Response Surface Methodology

**Session 6**
- Review of Exercise Assigned at the End of the Session 5
- When Response Surface DOE is Appropriate
- How Response Surface DOE is Different
  - Box-Behnken Concepts (with Demonstration of Minitab™ Set-up)
  - Central-Composite Concepts (with Demonstration of Minitab™ Set-up)
- Class Exercise: Response Surface Set-up and Analysis
- High-level Overview of Other Designs/Application: Plackett-Burman and Mixture
- FAQ Review
- Summary

**Instructor:** Kevin Zielinski
**Fee:** $810 1.2 CEUs

**Design Review Workshop**

**1.5 Days**
**I.D.# C1306**

In today’s highly competitive and liability minded environment, Design Reviews (DR) are a must for all major mobility industries such as Automotive, DOD, Aerospace, Agriculture, Recreation, Marine and Rail. While Design Reviews are becoming increasingly important in product liability litigation, they also serve as an effective way to transfer organizational best practices for specific concerns and issues.

This hands-on workshop describes how formal Design Reviews can be used in conjunction with other new product development methods to improve product designs by uncovering potential problems before they are discovered at a later stage of development or application when the costs of correction are much higher. A range of effective techniques for organizing and conducting Design Reviews will be presented. Participants will receive specific guidance and tools to assist them in tailoring Design Reviews to reflect their own organization’s requirements. Topics are applicable to a broad range of new product development programs, ranging from components to complete systems, for both OEMs and suppliers.
LEARN THEN DO -
In this workshop the attendee not only learns the essential elements of a robust Design Review process but also has the opportunity to apply these principles in the conduct of a mock Design Review. Participants will also experience some of the frequently encountered real-world issues that distract from accomplishing good results. During these “reviews” the attendee will experience each of the roles in a typical Design Review--leader, facilitator, recorder, and participant. An after-action review will be performed following each DR session to discuss positive outcomes and identify opportunities for improvement.

Learning Objectives
By attending this seminar, you will be able to:
• Describe the relationship of the process to concurrent engineering and knowledge management
• Establish the requirements for a successful Design Review process
• Describe the types and timing of reviews
• Organize a typical Design Review
• Conduct a review and get positive results

Who Should Attend
The workshop is designed for individuals who are involved in the development of new products and who seek to improve that process. Product development team members including, but not limited to, directors, manager, project and program managers, design, development, process, product, quality, and application engineers will find the course valuable. It is aimed primarily at engineers and managers who will be facilitating or leading such reviews, but will also benefit manufacturing, marketing and purchasing personnel.

Topical Outline
DAY ONE
Design Review Process
• Why Design Reviews Should be Part of a Product Development Process
  • Market and quality drivers
  • Schedule and cost drivers
  • Litigation considerations
• Outline of the Design Review Process
  • Design reviews as part of an overall risk management process
  • What design reviews are and are not
• Types and Timing of Reviews
  • Concept reviews
  • Preliminary reviews
  • Critical reviews
  • Production readiness reviews
  • Other types of reviews

• Scope of Design Reviews
  • Design review vs gate (or phase) review
  • Formal and informal reviews
  • Key ingredients for a successful review
  • Implementing a DR process
DAY TWO (ends at 12:30)
Design Review Hands-on Workshop
• Organizing an Effective Design Review
  • Roles during the DR
  • Selecting participants
  • Preparing for the DR
  • Assignments leading to a DR
  • Duration of a review
• Conducting a Design Review
  • Conflict Management
  • Closure and follow-up
  • Using check lists to build organizational knowledge
  • Handling problem participants

Instructor: Angelo Mago
Fee $1265 1.0 CEUs

Design Reviews for Effective Product Development
1 Day
I.D. # C0004
Design reviews are required for ISO 9001:2000 compliance and compatible automotive and aerospace specifications. They are becoming increasingly important in product liability litigation and are accepted as a cost-effective best practice and an effective application of knowledge management, valuable for accelerating the maturity of new products.

This seminar describes how formal design reviews can improve products by uncovering potential problems before they are discovered at a later stage of development or application, when the costs of correction are much higher. A broad range of effective techniques for organizing and conducting design reviews will be presented. Specific guidance and tools to assist attendees in structuring design reviews tailored to their own company, specification, or contract requirements will also be provided. Material covered will be applicable to all types of development programs, ranging from components to complete vehicles, and for both OEMs and suppliers.

Learning Objectives
By attending this seminar, you will be able to:
• Describe the relationship of the process to concurrent engineering and knowledge management
• Establish the requirements for a successful design review process
• Describe the types and timing of reviews
• Organize a typical design review
• Conduct a review and get positive results

Who Should Attend
The seminar is designed for individuals who are involved in the development of new products and who seek to improve that process. Product development team members including, but not limited to, directors, managers, project and program managers, design, development, process, product, quality, and application engineers will find the course valuable. It is aimed primarily at engineers and managers who would be facilitating or leading such reviews, but will also benefit manufacturing, marketing and purchasing personnel.

Topical Outline
• Why Design Reviews are Widely Used Today
  • Market drivers
  • Quality drivers
  • Schedule and cost drivers
  • Litigation considerations
• What Design Reviews Are and Are Not
• Current Specification Requirements
  • ISO 9001
  • QS9000
  • AS9000
• Outline of the Design Review Process
  • Relation of design reviews to: concurrent engineering; integrated product development teams; knowledge management
• Types and Timing of Reviews
  • Concept reviews
  • Preliminary reviews
  • Critical reviews
  • Production readiness reviews
  • Other types of reviews
• Scope of Design Reviews
• Formal and Informal Reviews
• The Key Ingredients for a Successful Review
• How to Organize an Effective Design Review
  • Participants
  • Invitations
  • Preparation for a review
  • Duration of a review
  • Physical arrangements
• How to Conduct a Design Review
  • Importance of a positive tone
  • Some proven procedures, check lists, comment sheets
  • Handling problem participants
• Closure and Follow-up
• Reports
• Implementation
• Review of Experiences of Participants

Instructor:  Angelo Mago
Fee $765 .7 CEUs

DRBFM & PFMEA Workshop Focused on Connecting Customer Expectations to Design & Process Requirements
2 Days
I.D.# C1361

This two-day training will explain all phases of the DRBFM and PFMEA methodology and provide details on how to accomplish the specific steps. With the Design Review Based on Failure Modes (DRBFM) and Design Review Based on Test Results (DRB-TR) Process Guidebook that is bundled with the course, the instructor will provide specific information on each step. Formats, examples, notes and homework slides will be used to illustrate the defined steps of the SAE J2886 DRBFM Recommended Practice and the AIAG DRBFM Reference Guide. Similarities in content between DRBFM and FMEA will be discussed; however the focus will be on conducting DRBFM methodology.

This DRBFM training will provide roles and responsibilities of management, design engineers, manufacturing engineers, DRBFM and technical experts. Those interested in DRBFM will benefit from understanding the rationale behind this methodology and learn to guide teams through the paradigm shifts and mind-set that are needed. Those interested will learn how DRBFM supports the activity of the engineer, company objectives and customer expectations.

Process Failure Modes and Effects Analysis (PFMEA) is a methodology that is intended to identify risk within a process and define controls and actions to mitigate the risk. A well done PFMEA improves quality, reliability and safety of a process. This course is designed to assist companies in addressing common problems with the application of Process Failure Modes and Effects Analysis (PFMEA) as defined in the new SAE J1739 FMEA Standard. The course will focus on both the methodology (structured PFMEA Process Flow) and provide a road map to address company culture and engineering “mind set.” The defined structure and road map will provide an understanding of how to link the Process Flow Diagram (PFD), Process Failure Modes and Effects Analysis (PFMEA) and the Process Control Plan (PCP).
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

Along with addressing the common problems and providing a detailed PFMEA structure, this course defines roles and responsibilities of management, engineers, and facilitators in the new J1739 standard. The course provides examples and formats to help both those familiar with performing PFMEA and new to the PFMEA methodology. The course provides opportunity for participants to develop their own PFD, PFMEA, and PCP by following along with the course and getting feedback from the course instructor (if desired).

Learning Objectives
After completing this program, you will be able to:
• Outline the fundamental steps of DRBFM methodology, including:
  • An understanding of the DRBFM Culture
  • DRBFM Plan and analysis requirements
  • Necessary preparation feeding DRBFM analysis
  • The two phases of DRBFM analysis
  • Documentation of design, validation and manufacturing actions
  • Feedback loop into engineering knowledge documents
• Explain the intent and format of the DRBFM worksheets
• Predict what it takes to gain and maintain proficiency and consistent application of the methodology
• Locate answers to most DRBFM questions
• Identify new PFMEA requirements that must be fulfilled by management
• Align ideas within the logical framework of the PFMEA worksheet
• Correctly use Process Flow Diagrams (PFD)
• Apply new risk assessment evaluation criteria to the PFMEA
• Apply the PFMEA as a tool in Process Development
• Identify current problems implementing PFMEA
• Illustrate the logical framework of the PFMEA Process Map and worksheets
• Know the definition & purpose of Process Failure Mode and Effects Analysis (PFMEA)
• Perform all steps in the PFMEA process
• Use the PFMEA as a tool in Process Development
• Define the linkage between PFD, PFMEA, and PCP
• Identify “hidden factories” steps and material handling in PFDs
• Discuss the linkage of DFMEA and PFMEA
• Correctly complete Process Control Plans (PCP)

Who Should Attend
Engineers, supplier quality engineers, validation and test engineers, and facilitators, trainers and consultants in all industries. This seminar will benefit new engineers, advanced and senior engineers and managers who must participate in or manage FMEA’s and DRBFM.

Topical Outline
DAY ONE
• Introduction and course objectives
  • DRBFM Process Competitive Assessment - Toyota Process
• Step One: Preparation Documents
  • Preparation Documents Exercise and Review
  • Participants can bring either DFMEA or DRBFM foundation documents of a current project (boundary diagram, functions and specifications, changes and current issues) for review during this session
• Step Two: Change Point Analysis
  • How to complete DRBFM analysis
  • Forum One: Change Point Detail and Functions - System, Sub-system and component
• Change Point Analysis - continued
  • Forum One: Document Change Point Analysis (each student): Concerns; Causes; Effects; Importance; Design Countermeasures; Actions to gain knowledge - Defined by engineer
• Step Three: Design Review and Step Four: Action Results
  • Including an introduction to Design Review Based on Test Results
• How to Audit your DRBFM and Wrap up
DAY TWO
• Introduction to PFMEA and Course Objectives
• Step One: Planning
• Step Two: Preparation (PFD)
• Step Two: Preparation (PFD) - continued
• Step Three and Four: PFMEA Analysis
  • Functions from PFD: Failure modes; Effects; Classification; Causes; Controls; Actions; Risk Analysis (S-O-D)
• Step Five: Actions Taken
  • Actions Taken
  • Revised Risk Analysis (Occurrence & Detection)
• Step Five: Process Control Plan Development (PCP)
  • Linkage with PFD and PFMEA
  • Define the four sections of PCP
  • Product and Process Information
  • Characteristics: Product and Process & Classification
  • Methods
  • Reaction Plan
• How to Audit PFD, PFMEA and PCP and wrap up

Instructor: Bill Haughey
Fee $1300 1.3 CEUs
Finite Element Analysis (FEA) for Design Engineers Web Seminar

12 Hours
I.D.# WB1241

The Finite Element Analysis (FEA) has been widely implemented by automotive companies and is used by design engineers as a tool during the product development process. Design engineers analyze their own designs while they are still in the form of easily modifiable CAD models to allow for quick turnaround times and to ensure prompt implementation of analysis results in the design process. While FEA software is readily available, successful use of FEA as a design tool still requires an understanding of FEA basics, familiarity with FEA process and commonly used modeling techniques, as well as an appreciation of inherent errors and their effect on the quality of results. When used properly, the FEA becomes a tremendous productivity tool, helping design engineers reduce product development time and cost. Misapplication of FEA however, may lead to erroneous design decisions, which are very expensive to correct later in the design process.

This six-session Web Seminar provides design engineers with the skills necessary for proper use of FEA in the design process and to ensure that this powerful tool is implemented in the most efficient and productive way. Participants will study different types of analyses typically performed, discuss common misconceptions and traps in the FEA, and review implementation of Management of FEA in the design environment. The Web Seminar format will allow for some customization so problems of particular interest to participants and an exchange of FEA experiences may be discussed during the live sessions. Hands-on exercises focusing on the analysis of FEA errors and proper modeling techniques will be assigned.

The eBook, Engineering Analysis with SolidWorks® Simulation by Paul Kurowski, will also be included in the course materials. In-class, hands-on exercises and between-session assignments will provide an opportunity to put what is learned into practice.

Learning Objectives

By connecting with this Web Seminar, you will be able to:

• Select preferable modeling approaches
• Analyze errors inherent to FEA results
• Identify FEA advantages and shortcomings
• Avoid mistakes and pitfalls in FEA
• Produce reliable results on time
• Request FEA analysis and use FEA results
• Provide effective FEA project management
• Ensure quality and cost-effectiveness of FEA projects

Who Should Attend

This course addresses the needs of design engineers who are not specialized analysts but need to use the Finite Element Analysis to analyze new product during the design process. Also non-specialist FEA users, R&D engineers and managers, project engineers, and product engineers will benefit from its coverage of different FEA formulations, tools for error analysis, common errors, traps and misconceptions, and an introduction to FEA project management.

Topical Outline

Session 1
• Fundamental Concepts in the FEA
• Finite Element Analysis Process
• Origins and Types of FEA Errors
• Finite Element Mesh
• In-class Exercises

Session 2
• Control of Discretization Error - Convergence Process
• Verification and Validation of FEA Results
• In-class Exercises
• Homework Assignment

Session 3
• Control of Modeling Error
• Types of Finite Elements
• Types of Boundary Conditions
• Useful Modeling Techniques
• In-class Exercises
• Homework Assignment

Session 4
• Modal Analysis
• Buckling Analysis
• In-class Exercises
• Homework Assignment

Session 5
• Nonlinear Geometry Analysis
• Nonlinear Material Analysis
• Contact Stress Analysis
• 2-3 in-class exercises
• Homework Assignment

Session 6
• Steady State Thermal Analysis
• Transient Thermal Analysis
• FEA Implementation
• FEA Project Management
• FEA Traps and Misconceptions
• Quiz in preparation to post-course learning assessment

Instructor: Paul Kurowski
Fee $845 1.2 CEUs
FMEA for Robust Design: What, Why, When and How Web Seminar

12 Hours  
I.D.# WB1422

Failure Modes and Effects Analysis (FMEA) is an integral part of product design activity applicable to any type of product or service. It is a quantitative and qualitative step-by-step approach for identifying and analyzing all actual and potential points of failure in a design, product or service. A successful team-based FMEA activity can use their collective experience with similar products to dramatically improve not only product performance but also reduce manufacturing issues at both a component and system and processing level. This web seminar introduces the five basic types of FMEAs with emphasis on constructing a Design FMEA. Each column of the FMEA form is clearly explained using a typical FMEA example. This example can be a provided sample or a company sample provided candidate. The course covers various methods for clearly identifying product function at three levels, and associating distinct failure modes, effects and causes related to each function level. Special attention is given to Severity, Occurrence, and Detection and how to develop effective Risk Priority (RPN) strategies and Recommended Actions for significant RPNs.

All material is in conjunction with current industry standards.

**Learning Objectives**

Upon completion, the participant should have developed a completed FMEA and, thus, be able to understand and apply the following:

- Relating Product Development, Voice of the Customer (VOC) and the FMEA
- Why and when to use System and Design FMEAs
- The FMEA as a risk management technique
- The five types of FMEAs
- Organizing effective FMEA development teams and meetings
- The steps to generating a quality FMEA, including a column by column review of the Design FMEA form
- Basics of Root Cause Analysis
- Design Control techniques, Detection Strategy, Risk Priority strategies and Risk Ranking tables
- Assignment of recommended actions

**Who Should Attend**

The course is designed for individuals who are involved in the development of new products and who seek to improve that process. Product development team members including, but not limited to, project and program managers, design and development, process, product, quality, and application engineers will find the course valuable. It is aimed primarily at these managers and engineers who will be facilitating or leading such FMEA activities. Directors, marketing and purchasing personnel will also benefit by understanding why the FMEA process is important to developing a safe and effective product.

**Topical Outline**

Session 1
- FMEA Introduction
- Background and History
- The FMEA Standards - MIL-STD_1629, SAE J1739, AIAG
- Relationship of Design and Process FMEA in a design & manufacturing environment

Session 2
- Five Types of FMEAs

Session 3
- FMEA and Risk Management
- Defining Risk Management
- FMEA and Robust Design
- FMEA as part of Design to Cost
- FMEA as Product Liability Protection

Session 4
- Managing the FMEA Process
- Assembling the FMEA Team
- Facilitator Role during the FMEA Process
- Capturing the 6 Levels of Voice of the Customer (VOC)
- The FMEA Database and FMEA Templating
- Tips for standardizing concise expression of failure modes, effects and causes

Session 5
- Column By Column Review of the FMEA - Part 1
  - Header
- Item/Function - Primary, Secondary and Customer Satisfaction
- Failure Mode
- Effects and Severity
- Causes and Occurrence
- Controls and Detection

Session 6
- Column By Column Review of the FMEA - Part 2
  - Calculating and Assessing RPN
  - Risk Tables and RPN assignment strategies
  - Recommended Actions
  - Responsibility and Target Dates
  - Verification

**Instructor:** Angelo E. Mago

**Fee:** $810  
1.2 CEUs
**Fundamentals of and Improvements in Commercial Vehicle Aerodynamic Drag**

2 Days  
I.D.# C0919

Now, more than ever before, the design and operation of commercial vehicles is influenced by the need to address emissions regulations and government-mandated fuel economy standards. With continued concerns among commercial vehicle owners and operators about rising fuel prices and the impact on operating costs, OEMs and aftermarket developers are actively pursuing technologies that reduce aerodynamic drag and increase vehicle efficiencies. Integrating drag-reducing technology and add-on devices into a commercial vehicle requires an understanding of aerodynamic principles. In addition, understanding the trade-offs in support of vehicle function and operational requirements plays a key role in the integration process. This two-day seminar will detail the fundamentals of aerodynamic drag, basic shape parameters, and airflow patterns that occur through and around commercial vehicles. In addition, drag reducing concepts, technology and devices currently in use and estimating fuel economy benefits will also be discussed. The examination of various tools and methods (wind tunnels, on-road testing, airflow visualization, CFD) for designing and evaluating drag reduction concepts will be beneficial for attendees, particularly engineers and developers. Finally, scale model testing, drag and pressure measurement methods, data interpretation, and the influence of crosswinds and interpretation of surface pressures will provide attendees a comprehensive learning experience on the topic of commercial vehicle aerodynamics. Attendees will receive a copy of SAE J1252- Wind Tunnel Test Procedure for Trucks and Buses.

**Learning Objectives**

By attending this seminar, you will be able to:

- Describe the fundamental principles of commercial vehicle aerodynamic drag, with specific application to heavy duty trucks
- Identify the major sources of aerodynamic drag and related vehicle shape parameters
- Identify best practices of good design for reducing drag
- Explain the integration trade-offs related to vehicle function and operating requirements
- Implement appropriate methods to develop/verify drag reduction proposals
- Apply wind tunnel and/or on-road methods for assessing vehicle fuel economy benefits
- Describe the basics of flow visualization and instrumentation needed to measure and understand airflows and to interpret aerodynamic data

**Who Should Attend**

This seminar will be beneficial to engineers, product designers, developers, owner/operators, and others that are relatively new to vehicle aerodynamics or are associated with projects or purchasing decisions where vehicle aerodynamics plays an important role in improving fuel economy. Other individuals wanting to improve their understanding of drag reduction principles will appreciate the balance between theory and application and find this course very helpful.

**Topical Outline**

**DAY ONE**

- The Motivation for Improving Commercial Vehicle Fuel Economy
  - EPA regulatory announcement
  - NHTSA factors and considerations for (proposed) vehicle economy standard
  - NAS report on technologies to reducing fuel consumption
  - EPA SmartWay certification program
  - Vehicle classification and duty cycles
  - Aerodynamic drag and fuel consumption rules of thumb
  - Certification metrics for regulation and aerodynamic assessment
- Basic Concepts of Fluid Mechanics
  - Fluid statics and static pressure
  - Real & ideal flow
  - Viscous effects - laminar & turbulent boundary layers
  - Reynolds number
  - Dimensional analysis and similitude
- Fluid Dynamics and the Bernoulli Equation
  - Aerodynamics and the Laws of Physics
  - Bernoulli’s equation
  - Streamlines
  - Pressure coefficient
  - Wind pressure
  - Internal flow
  - Applications & flow visualization videos

**DAY TWO**

- Commercial Vehicle Aerodynamics
  - SAE J1252
  - SUV drag components
  - Typical drag coefficients (CD)
  - Studies on intercity buses and coaches

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**Product Engineering/Development Tools & Methods**

Catalog Key  
Certificate  
Online, on demand  
Live, online  
Certification  
ACTAR approved
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

- NASA Dryden on-road truck studies
- Aerodynamics of combination vehicles and straight trucks
- Guidelines for reducing drag
- Operational considerations
- Wind average drag coefficient
- Additional information
- Additional Information on Vehicle Aerodynamic Commercial vehicle industry developments
- More on the aerodynamics of tractors and trailers
- Operational, FMCSA & safety considerations
- Pneumatic aerodynamics for HD vehicle drag reduction

- Experimental Methods
  - Wind tunnels
  - SAE J1321 Type II fuel consumption procedure
  - Scale model testing & ground simulation alternatives
  - Effect of Reynolds number - Critical Reynolds number
  - Flow visualization
  - Additional information

- Computational Fluid Dynamics (CFD) for Product Development
  - Introductory comments on CFD methodology
  - An application of CFD to commercial vehicles from DOE
  - Verifying results - an example
  - Calibrating CAE tools for product design
  - Role of CFD in the product design process - some strengths & weaknesses

Learning Objectives
By attending this seminar, you will be able to:
- Describe the purpose and uses of SPC
- Select the best measurement system to use for a specific application
- Identify an appropriate process control sampling strategy
- Determine the basic type of control chart to use
- Collect data and construct basic control charts
- Interpret control chart results

Who Should Attend
Quality managers, engineers, and technicians, project engineers, manufacturing engineers, technical specialists and anyone with responsibility for product or process control who want to apply SPC in the workplace should attend this seminar. Individuals seeking to attain the Certified Quality Engineering status within the American Society for Quality will find this course particularly helpful.

Topical Outline
DAY ONE
- Introduction
- Viewpoints and Determinants of Quality
- SPC: Part of a Product Quality System
- SPC philosophy: prevention versus detection
  - Process control system
  - Causes of variation: common and special
  - Reactions to causes of variation
  - Requirements and specifications
  - Control charts: SPC tools
  - Benefits of SPC
  - SPC implementation process
- Quality Characteristic Determination
  - Everything is a process
  - Process flowchart and functions
  - Quality characteristics generation -- intermediate/final; variable/attribute
  - Critical characteristics determination -- final customer requirements; subsequent process requirements
  - Process example
- Quantification (measurement) of Quality
  - Types of characteristics -- variable; attribute
  - Methods of measurement and measurement systems
  - Measurement system capability
- Sampling Strategy
  - Sample size
  - Sample frequency
  - Sample structure
- Quality Planning Workshop
- Basic Control Chart Types
  - Variable: X and R charts -- AIAG example; workshops

Instructor: Jack Williams
Fee $1335 1.3 CEUs

Fundamentals of Statistical Process Control
2 Days
I.D.# C0553

As competition for market share increases, so does the need to monitor processes and quality to ensure top-notch products. This hands-on seminar will provide you with the skills to apply and maintain statistical process control to assist your organization in the improvement of various processes to achieve higher percentage yield or higher quality products or services. Quality characteristics (process outputs to track), measurement systems, sampling strategies, types of control charts, construction of control charts, and control chart interpretation will be covered. The determination of the key process parameters and controlling them to provide consistent results will improve quality and lower costs, in particular, scrap and rework costs. Statistical theory and depth are kept to a minimum while you learn how to utilize the tools. Attendees will receive a copy of the Statistical Process Control Manual (SPC-3, 2nd Edition) by the Automotive Industries Action Group.
DAY TWO
• Basic Control Chart Types (continued)
  • workshops
  • process capability indices (Cp & Cpk)
• Attribute
  • np chart - number defective -- AIAG example; workshops
  • c chart - number of defects -- AIAG example; workshops
• Basic Chart Interpretation
  • Basic decision rules
  • Process responses -- jumps, steps, shifts; trends; cycles
• Documented process changes

Instructor: Phillip J. Ross
Fee $1265 1.3 CEUs

Fundamentals of Geometric Dimensioning & Tolerancing (GD&T) Web Seminar and Web Seminar RePlay
16 Hours
Web Seminar: I.D.# WB0933
Web Seminar RePlay: PD330933ON

A similar course is available as a live classroom seminar – Geometric Dimensioning & Tolerancing – see course description below.

Geometric dimensioning and tolerancing (GD&T) is used as a symbolic way of showing specific tolerances on drawings. GD&T is a valuable tool that effectively communicates the design intent to manufacturing and inspection. It is governed by the technical standard ASME Y14.5M-2009. This course introduces participants to the GD&T system, providing a working knowledge of the correct interpretation and application of each symbol, general rules, the datum system, and ‘bonus’ tolerance and highlighting some of the changes in the updated Y14.5 standard. The material is reinforced with many practice exercises.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
• Explain the benefits of geometric tolerancing
• Identify datum features and determine their order of precedence
• Identify and interpret each of the characteristic symbols
• Describe the material condition modifiers and how ‘bonus’ tolerance occurs
• Correctly interpret GD&T feature control frames, and explain the impact on manufacturing and inspection

Who Should Attend
This course is ideal for anyone who has a need to apply or interpret geometric tolerances on a product print. Product engineers, manufacturing engineers, CAD designers, quality inspectors, and other engineering and manufacturing personnel will all benefit from a better understanding of design requirements; improved communication with customers and suppliers; and improving designs by taking advantage of bonus tolerance and other GD&T benefits. Participants should have an understanding of basic blueprint reading.

Topical Outline
Session 1
• Why Use GD&T?
  • Review of traditional dimensioning
  • Benefits of GD&T
  • Technical standards
  • Definitions
  • Basic dimensions
  • How to read the feature control frame

Session 2
• Rules and the Form Symbols
  • Rule #1: Size controls form
  • Rule #2: Assume RFS
  • Flatness
  • Surface straightness
  • Circularity
  • Cylindricity

Session 3
• Bonus Tolerance
  • GD&T applied to a feature of size
  • Bonus and the MMC modifier
  • Virtual condition
  • Gaging and inspection of GD&T

Session 4
• Datums
  • Datum vs. datum feature
  • The datum reference frame
  • Primary, secondary, and tertiary datums

Session 5
• Profile and Orientation
  • General definition of profile
  • Profile of a line
  • Profile of a surface
  • Use of datums with profile
  • Perpendicularity; Angularity
  • Parallelism

Session 6
• Position Tolerance I
  • True position; Position tolerance RFS
  • Using MMC or LMC
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

- The “boundary” concept
- The pitch diameter rule

Session 7
- Position Tolerance II
  - Projected tolerance zone
  - Inspecting parts for position
  - Calculating tolerance values
  - Composite position tolerance

Session 8
- Symmetry and Coaxial Controls
  - Concentricity
  - Symmetry
  - Circular runout
  - Total runout

Instructor: John-Paul Belanger
Fee $965 1.6 CEUs

Geometric Dimensioning & Tolerancing (GD&T)
3 Days
I.D.# C0133

A similar course is available as a live online Web Seminar – Fundamentals of Geometric Dimensioning & Tolerancing Web Seminar – see course description above.

This in-depth course covers the GD&T system per ASME Y14.5-2009, including why it reduces costs, how to interpret the symbols, and how to apply these tolerances correctly. Participants will learn the basic definitions and rules, the importance of datums, the meaning of each tolerance, and sample ways of gaging geometric tolerances. The class is mainly lecture, with many practice exercises. Participants are encouraged to bring sample parts and/or prints (with or without GD&T already applied) to class for questions. Time is reserved for discussing the application of GD&T to your parts/prints.

Learning Objectives
By attending this seminar, you will be able to:
- Describe the tolerance zones defined by each symbol
- Determine when to use Rule #1 to control form and when other controls are appropriate
- Recognize correct syntax for feature control frames
- Relate common gaging and inspection methods to geometric tolerance zones and feature control frames
- Correctly apply and interpret the MMC modifier and other modifiers
- Assess various datum schemes against product functionality and manufacturing and inspection performance
- Recognize the need for product-specific GD&T guidelines and list the steps required to create them
- List the changes in the 2009 standard from previous editions

Who Should Attend
This course is ideal for anyone who has a need to apply or interpret geometric tolerances on a product print. Product engineers, manufacturing engineers, CAD designers, quality inspectors, and other engineering and manufacturing personnel will all benefit from becoming fluent in GD&T.

Topical Outline
- Drawings and Dimensioning
  - Importance of engineering drawings
  - Fundamental dimensioning rules
  - Review of coordinate dimensioning and tolerancing
  - Benefits of using GD&T
  - History of GD&T
  - Quality issues - how GD&T fits into other standards
  - GD&T standard: ASME Y14.5-2009
- Introduction to GD&T Symbols and Terms
  - Definitions
  - Material conditions — MMC, LMC, RFS
  - Radius and controlled radius
  - Reading a feature control frame
- Rules and Concepts of GD&T
  - Rule #1- Size controls form
  - Inspecting a part for size limits
  - Rule #2 - Implied RFS
  - Virtual condition
  - Bonus tolerance
  - Gaging GD&T-fixtures; special gages; CMMs
- Form Tolerances
  - Flatness applied to a surface
  - Straightness applied to a surface
  - Circularity
  - Cylindricity
  - Straightness and flatness applied to a feature of size
  - Per-unit form control
- Datums
  - Purpose of datums in GD&T
  - Single planar datum
  - The datum reference frame
  - Datum targets
  - Feature-of-size datums
  - Compound datums
  - How to select datums for a part
  - Simulating datums on gage fixtures and CMMs
- Profile Tolerances
  - General definition of profile
  - Profile of a line
  - Profile of a surface
Introduction to Design Review Based on Failure Modes (DRBFM) Web Seminar and Web Seminar RePlay

6 Hours
6 Web Seminar: I.D.# c
Web Seminar RePlay: I.D.# PD331047ON

Design Review Based on Failure Modes (DRBFM) is a methodology focused on change management and continuous improvement. It centers on early prevention and engineering knowledge, eliminating time spent debating ranking systems, waiting for lead engineers to document and list their concerns, identifying what types of concerns are open for discussion and resolution, and brainstorming without any actionable closure.

This Web Seminar will explain all phases of the DRBFM methodology and provide details on how to accomplish the specific steps. With the Design Review Based on Failure Modes (DRBFM) and Design Review Based on Test Results (DRBTR) Process Guidebook that is bundled with the course, the instructor will provide specific information on each step. Formats, examples, notes and homework slides will be used to illustrate the defined steps of the new SAE J2886 DRBFM Recommended Practice. Similarities in content between DRBFM and FMEA will be discussed, however the focus will be on conducting DRBFM methodology.

This DRBFM web seminar will provide roles and responsibilities of management, design engineers, manufacturing engineers, facilitators and technical experts. Those interested in DRBFM will benefit from understanding the rationale behind this methodology and learn to guide teams through the paradigm shifts and mind set that are needed.

Learning Objectives
By connecting with this web seminar, you will be able to:
• Outline the fundamental steps of DRBFM methodology, including:
  • DRBFM Plan and analysis requirements
  • Necessary preparation feeding DRBFM analysis
  • The two phases of DRBFM analysis
  • Documentation of design, validation and manufacturing actions
  • Feedback loop into engineering knowledge documents
  • Explain the intent and format of the DRBFM worksheets
  • Predict what it takes to gain and maintain proficiency and consistent application of the methodology
  • Find answers to most DRBFM questions

Who Should Attend
Product engineers, manufacturing engineers, quality engineers, supplier quality engineers, validation and test engineers, and facilitators, trainers and consultants in all industries. This Web Seminar will benefit beginning engineers, advanced and senior engineers and managers who must participate in FMEA’s and DRBFM.

Topical Outline
Session 1
• DRBFM Procedure, Forms, Planning and Preparation
  • Process Guide and Workbook Overview
  • Scope and Purpose
### Introduction to Failure Mode and Effects Analysis for Product and Process

**2 Days**  
**I.D.# C1201**

Failure Mode and Effects Analysis (FMEA) is a systematic method for preventing failure through the discovery and mitigation of potential failure modes and their cause mechanisms. Actions are developed in a team environment and address each high severity, occurrence or detection ranking indicated by the analysis. Completed FMEA actions result in improved product performance, reduced warranty and increased product quality. This course assists team members to apply severity, occurrence and detection rankings consistently and efficiently and explores, in detail, the linkage of the Design FMEA and the Process FMEA through special characteristics development and product and process design collaboration. The relationships between FMEA and other popular tools, including Fault Tree Analysis (FTA), Design Verification Plan and Report (DVP&R) and Control Plans is discussed. Participants can expect dynamic “hands-on” activities with in-class Design and Process FMEA creation, facilitation skill development and risk analysis best practices. Instruction and clarification will be provided for relevant portions of the SAE J1739 standard, Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA), a copy of which will be included with the course materials.

**Learning Objectives**

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

- List the benefits, requirements, and objectives of an FMEA
- Demonstrate the steps used in developing an FMEA
- Follow the methodology to efficiently create an FMEA
- Describe other tools used in, or related to the FMEA
- Identify corrective actions resulting from proper FMEA development
- Identify and classify the levels of risk requiring corrective action
- Show the links between Design and Process FMEA
- Demonstrate the FMEA’s role in developing Special Characteristics and Design and Process Controls
- Summarize the objectives of the SAE standard J1739

**Who Should Attend**

This seminar is designed for engineers involved with manufacturing, product design, reliability, testing, quality, development, logistics/support, product assurance/design assurance, materials, and their management or anyone responsible for the design and development of manufacturing, assembly or service processes in the completion of a Design or Process FMEA.

**Topical Outline**

**DAY ONE**

- Pretest - Set baseline of knowledge and determine Voice of the Customer (participants) wants needs and desires
- FMEA Process Overview
  - Introductions and course objectives
  - What is risk?
  - The history and purpose of FMEA
  - SAE J1739 introduction
  - FMEA - where it fits in the product development process
  - System/Subsystem/component Design FMEA
  - Manufacturing and Assembly Process FMEA
  - Machinery and Equipment FMEA (Logistics Support)
- FMEA Development Methodology
  - Design FMEA development methodology - the three path model
  - Failure Mode Avoidance FMA /FPA Failure Prevention Analysis
Introduction to PFMEA (Process Failure Modes and Effects Analysis)

1 Day
I.D.# C1360

Process Failure Modes and Effects Analysis (PFMEA) is a methodology that is intended to identify risk within a process and define controls and actions to mitigate the risk. A well done PFMEA improves quality, reliability and safety of a process. This course is designed to assist companies in addressing common problems with the application of Process Failure Modes and Effects Analysis (PFMEA) as defined in the new SAE J1739 FMEA Standard. The course will focus on both the methodology (structured PFMEA Process Flow) and provide a road map to address company culture and engineering “mind set.” The defined structure and road map will provide an understanding of how to link the Process Flow Diagram (PFD), Process Failure Modes and Effects Analysis (PFMEA) and the Process Control Plan (PCP). The course addresses common problems such as: inadequate preparation defining detailed process operation steps in the Process Flow Diagram (PFD) and therefore not addressing all steps in the process (Hidden Factory), lack of understanding of product characteristics (output) and process characteristics (input) within the process flow, false starts and rework of PFMEA due to a lack of understanding of process functions, failing to address all process operations in the PFMEA (including outputs and inputs), too much time spent debating ranking systems (potential problems hidden in the Risk Priority Number), a lack of emphasis on prevention controls or early detection of product defects, the lack of understanding of how to complete the Process Control Plan (PCP), and what information is common throughout the PFD, PFMEA and PCP.

Along with addressing the common problems and providing a detailed PFMEA structure, this course defines roles and responsibilities of management, engineers, and facilitators in the new J1739 standard. The course provides examples and formats to address all process operations in the PFMEA (including outputs and inputs). The course addresses common problems such as: inadequately preparing defining detailed process operation steps in the Process Flow Diagram (PFD) and therefore not addressing all steps in the process (Hidden Factory), lack of understanding of product characteristics (output) and process characteristics (input) within the process flow, false starts and rework of PFMEA due to a lack of understanding of process functions, failing to address all process operations in the PFMEA (including outputs and inputs), too much time spent debating ranking systems (potential problems hidden in the Risk Priority Number), a lack of emphasis on prevention controls or early detection of product defects, the lack of understanding of how to complete the Process Control Plan (PCP), and what information is common throughout the PFD, PFMEA and PCP.

Learning Objectives

After completing this program, you will be able to:

- Identify new PFMEA requirements that must be fulfilled by management
- Align ideas within the logical framework of the PFMEA worksheet
- Correctly use Process Flow Diagrams (PFD)
- Apply new risk assessment evaluation criteria to the PFMEA
- Apply the PFMEA as a tool in Process Development

Instructor: Lee D. Dawson

Fee $1345 1.3 CEUs
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

- Identify current problems implementing PFMEA
- Illustrate the logical framework of the PFMEA Process Map and worksheets
- Know the definition & purpose of Process Failure Mode and Effects Analysis (PFMEA)
- Perform all steps in the PFMEA process
- Use the PFMEA as a tool in Process Development
- Define the linkage between PFD, PFMEA, and PCP
- Identify “hidden factories” steps and material handling in PFDs
- Discuss the linkage of DFMEA and PFMEA
- Correctly complete Process Control Plans (PCP)

Who Should Attend
Manufacturing engineers, product engineers, quality engineers, supplier quality engineers, validation and test engineers, and FMEA facilitators, trainers and consultants may be interested in the program content. New engineers, advanced and senior engineers who must participate in FMEA, as well as those that manage FMEA activity, will also gain valuable insights.

Topical Outline
- Introduction to PFMEA and Course Objectives
- Step One: Planning
- Step Two: Preparation (PFD)
- Step Two: Preparation (PFD)...continued
- Step Three and Four: PFMEA Analysis
- Functions from PFD: Failure modes; Effects; Classification; Causes; Controls; Actions; Risk Analysis (S-O-D)
- Step Five: Actions Taken
- Actions Taken
- Revised Risk Analysis (Occurrence & Detection)
- Step Five: Process Control Plan Development (PCP)
- Linkage with PFD and PFMEA
- Define the four sections of PCP
- Product and Process Information
- Characteristics: Product and Process & Classification
- Methods
- Reaction Plan
- How to Audit PFD, PFMEA and PCP and wrap up

Instructor: Bill Haughey
Fee $755 .7 CEUs

Model Based Engineering Process Workshop

2 Days
I.D.# C1316

The promise of the systems engineering process (commonly referred to as the “V” model or model based design) includes improved productivity, reduced life cycle time, and an increase in design reliability and has led to the widely accepted use of modeling tools within the automotive industry. This workshop provides a step-by-step illustration of how to establish the proper process mechanisms to create, verify, and validate an ECU requirement and establish the foundation for using model based engineering as part of the product development process. This two day seminar presents an in-depth exploration of the model based engineering process. Through the use of examples and exercises and centered on a generic driver seat module specification, the instructor will guide participants through the model based engineering process including requirements capture, design, development, test, and validation exercises. The instructor will define the various elements involved in a model based engineering process and provide a comparison between the processes used in traditional engineering development and the processes that are adopted in model based engineering.

Learning Objectives
By attending this seminar, participants will be able to:
- Evaluate the advantages of the model based engineering process
- Identify and evaluate the model based engineering process flow
- Describe the process of creating a function model
- Describe the process of validating a function model
- Describe the process of using the function model as a requirement
- Evaluate and explain the structure and process of creating an ECU function model for requirements

Who Should Attend
This workshop is created for the people who perform the tasks of create model as part of design requirement documentation, using model as code generation and vehicle architecture development.

Topical Outline
DAY ONE
- Model Based Engineering Process Overview
  - What is the model based engineering process
  - Comparison of the model based engineering process and traditional engineering processes
- Model Based Requirements Capture Process
  - Capturing model based requirements
  - Examples of “good” model based requirements

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PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

- ECU Model Development
  - What is an ECU model?
  - Requirements for ECU model development

DAY TWO
- Process for the Model Development
  - Model Design
  - Model Development
  - Model Validation/Testing
  - Model Review
  - Model Release
- Examples
  - Seat Manual Operation Function
  - Seat Memory Operation Function
  - Seat Function Integration (Manual, Memory, Personality)
- Step by Step approach to Model Validation
  - Why is a model test plan needed?
  - Constructing a model test bench
  - Approaches to model validation
- Final Release Process
  - Archiving the model, test suites, and requirements for reuse on future programs
- Overview of Model Based Software Development Process
  - What is the model based software development process?
  - Comparison to traditional software development?
- Workshop Review

Instructor: Yibing Dong
Fee $551 1.3 CEUs

Reverse Engineering: Technology of Reinvention

2 Days  
I.D.# C0559

During the past decade reverse engineering has become a common and acceptable practice utilized by many original equipment manufacturers and suppliers. This course focuses on the application of modern technologies used to decode the design details and manufacturing processes of an existing part in the absence of the original design data. It emphasizes the real-life practice of reverse engineering in the aerospace industry from both scientific and legal points of view. Attendees will learn the applicability and limitations of reverse engineering through case studies and hands-on exercises.

Various measurement instruments, ranging from traditional micrometers to computer-aided laser probes, will be compared for their merits and shortcomings. The statistics of dimensional measurements and the acceptable tolerance of variations, with emphasis on industrial standards in real-life practice will be discussed. Material identification, manufacturing process verification and the system compatibility of the subject part to be reverse engineered will be covered in substantial detail. In addition, the materials specifications will be exemplified as useful supporting documents for substantiation data.

Note: Participants should bring a calculator for in-class exercises.

Learning Objectives

By attending this seminar, you will be able to:
- Define the critical elements of reverse engineering
- List the measurements and analyses required to duplicate/reproduce an OEM part by reverse engineering
- Recognize if an OEM part can be duplicated/reproduced by reverse engineering
- Judge if a “duplicated” part will meet the design functionality of the OEM part
- Evaluate the feasibility of a reverse engineering proposal/project
- Describe and implement a process to duplicate/reproduce a part by reverse engineering

Who Should Attend

This seminar is designed to assist individuals in various industries including, but not limited to, automotive, aerospace, off-highway, motorsports and parts brokerage firms. Corporate senior executives, engineering managers, engineers, technicians, government inspectors, sales managers, salespersons, lawyers and legal counselors will find the course relevant and informative.

Topical Outline

DAY ONE
- Introduction
  - Historical background
  - Reverse engineering vs. machine design
  - Three basic requirements: form, fit and function
- Geometrical Form
  - Dimensional measurement
  - Precision instruments of measurement
  - Tolerance
  - Virtual exercise of geometrical modeling
- Material and Process Identification
  - Chemical composition identification
  - Manufacturing process verification
  - Materials specification substantiation
  - Machining process identification
- Data Process and Analysis
  - Statistical analysis
  - Statistical exercise
  - Case study of statistical confidence
  - Reliability
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

DAY TWO
• Demonstration and Exercise
  • Demonstration of scanning
  • Hands-on exercise of reverse engineering
  • Case study
• Regulations and Certifications
  • Government regulations
  • Industrial standards Certification requirements
• Fit and Function
  • System compatibility
  • Critical performance
  • Vendor substantiation
  • Safety and damage tolerance
• Acceptance and Legality
  • Evolving industry trends
  • Moral and legal issues
  • Examples - legal precedents

Instructor: Wego Wang
Fee $1225 1.3 CEUs

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Robust Design
2 Days
I.D.# C1231

Engineers are taught to create designs that meet customer specifications. When creating these designs, the focus is usually on the nominal values rather than variation. Robustness refers to creating designs that are insensitive to variability in the inputs. Much of the literature on robustness is dedicated to experimental techniques, particularly Taguchi techniques, which advocate using experiments with replications to estimate variation. This course presents mathematical formulas based on derivatives to determine system variation based on input variation and knowledge of the engineering function. If the function is unknown, experimental techniques are presented to efficiently estimate a function.

The concept of designing for both nominal values and variability is expanded to multiple outputs and designing to minimizing costs. Traditionally, if the output variation is too large to meet requirements, the tolerances (variation) of the inputs are reduced. Using the approach presented in this course, the equations presented can be used to identify the contribution of each of the inputs to the output variation. The variation of the components with the largest contribution can be reduced which will reduce output variation. At the same time, the variation of the components contributing the least to the variation of the output can be increased which will reduce costs. A system of equations can be created that will allow an optimization routine to create a design optimized for total cost including the cost of poor quality and component cost.

Participants should bring a laptop computer for in-class exercises.

Learning Objectives
By attending this seminar, you will be able to:
• Create designs that have a minimal sensitivity to input variation
• Reduce design costs
• Determine which design parameters have the largest impact on variation
• Optimize designs with multiple outputs

Who Should Attend
This course is relevant to design and manufacturing engineers, researchers and those interested in cost reduction. This methodology can link manufacturing to engineering design and help design engineering solve manufacturing problems.

Topical Outline
DAY ONE
• Basics of Variation - unique problems facing engineers; small sample sizes and the inability to obtain random samples; techniques for overcoming these problems
Companies realize that they need to do more with less which means we need to use the most efficient and effective methods. This seminar blends the philosophy of Taguchi with the simple graphical methods of Box, Hunter, & Hunter to give a powerful set of DOE tools.

Wide use of Design of Experiments or DOE methods has been hindered by complications in planning a DOE to handle interactions and by analysis complexity of ANOVA. A Preferred Columns Method simplifies planning so engineers can assign factors to an array in minutes. Graphical methods allow quality professionals to distinguish large (active) factors from small terms and portray these findings to broad audiences. By simplifying DOE’s, road blocks are removed so that more people can begin using these highly productive methods.

**Learning Objectives**

By attending this seminar, you will be able to:

- Explain Taguchi’s Quality Philosophy of Closeness to Target
- Plan efficient factorial experiments using the Preferred Columns Method
- Compare data sets with dual or multiple stem and leaf plots
- Analyze the data using simple graphical methods such as dot plots and probability plots

**Who Should Attend**

This seminar will be most beneficial to engineers and quality professionals who work in product design, manufacturing, testing, reliability, quality, process, or development.

**Topical Outline**

- Taguchi Loss Function
- Comparison of Two Means
- Dual stem & leaf plots
- Exceedances test
- Graphical T-test for differences
- One-Factor Experiments
- Multiple stem & leaf plots
- Graphical F-test for multiple comparisons
- Two-Factor Experiments
- Response plots to see effects and interactions
- Graphical F-tests to compare averages
- Full Factorials
- Math model behind factorial experiments
- Independent factors vs. interactions
- Randomizing the runs
- Planning Fractional Factorials Measurement system that uses continuous data
- How to select factors for a DOE
- Confounding patterns and resolution
- Preferred Columns Method to set up a fractional factorial
- Data sheets
- Customizing for a 4-level factor
- Analyzing Fractional Factorials
- Column effects table
- Quantifying the noise of repeats
- Dot plots with error distributions
- Interaction plots
- Prediction model
- Cube plot
- Probability plot of column effects

**Instructor:** Jerry L. Roslund  
Fee $1285  1.3 CEUs
Statistical Methods for Quality Engineering

3 Days
I.D.# C0554

Based on your test data or process data, do you ever wonder if:
- An improved product really performs better?
- A substitute material really processes the same?
- A cheaper material really performs satisfactorily?
- What confidence do you have in the final decision that you make?

This seminar will help individuals responsible for product or process development and testing to statistically assess the variation of the product or process performance and make effective decisions with confidence. Technical personnel are consistently making changes to product and process designs and the resultant performance changes need a statistical basis for moving ahead to the cost assessment and release phases. Various continuous and discrete probability functions will be covered with the normal distribution receiving the most emphasis. Other distributions including Weibull, Exponential, Binomial, Poisson, Hypergeometric, and nonparametric comparisons will be covered. Various confidence intervals and tests of comparison, including Z test, Student’s t tests, Chi-Square test, F test, and ANOVA for the normal distribution for these probability functions are covered. Attendees will work along with the instructor on many examples throughout the seminar and should bring a scientific or statistical calculator to class for the various activities.

Learning Objectives

By attending this seminar, you will be able to:
- Select the proper distribution model
- Determine valid sample sizes
- Design valid tests of comparison
- Make effective decisions at stated confidence levels

Who Should Attend

This course applies to anyone making product or process assessment or changes and will help them to make effective decisions concerning those situations. Product design managers and engineers, process design managers and engineers, and quality managers and engineers will particularly benefit from this course. Individuals seeking to attain the Certified Quality Engineering status within the American Society for Quality will find this course particularly helpful.

Topical Outline

DAY ONE
- Introduction
  - Training objectives
  - Statistical resources
- Concept of variation
- Common development questions
- Histograms
- Descriptive statistics
- Distribution Models
  - Continuous
  - Discrete
  - Applications
- Model Selection
  - Empirical distribution functions
  - Cumulative distribution functions
  - Normal probability paper
  - Small sample sizes and median ranks
  - Tests for normality

DAY TWO
- Parametric Evaluations and Tests
  - Normal and log-normal data -- Z confidence intervals and tests; t confidence intervals and tests; Chi-Square confidence intervals and tests; K factor confidence intervals; F tests;

DAY THREE
- Parametric Evaluations and Tests (continued) -- analysis of variance
- Weibull distribution, confidence intervals and tests
- Exponential distribution tests
- Poisson distribution applications
- Binomial distribution applications
- Hypergeometric applications
- Nonparametric Tests
  - Sign tests, Run tests, and Rank tests

Instructor: Phillip J. Ross
Fee $1545 2.0 CEUs

Statistical Tolerance Design

1 Day
I.D.# 88033

This seminar will include a review of statistical theory and present statistical methods, which are used to better select and/or analyze Tolerance Stack-ups. The Probability (RMS) Method, the Monte Carlo Simulation Technique and tolerance optimization techniques will be discussed along with guidelines on which method(s) to use in given situations. Attendees will also view a demonstration of a microcomputer Monte Carlo Simulation program that analyzes the effects of form and assembly variation on the quality of a finished product. This seminar will provide an overview of Design of Experiments (DOE) methods, which enable effective analysis of critical product dimensions and tolerances. Note: Participants should bring a scientific calculator for several in-class exercises.
Learning Objectives
By attending in this seminar, you will be able to:
• Apply worst case, root-mean-square, and Monte Carlo simulation methods for the allocation of analysis of simple-to-intermediate complexity tolerancing schemes
• Use the “Risk of Misassembly” approach for tolerance allocation, and the “Main Effect” approach for determining dimensional variables tolerance which exhibit the greatest impact on build variation
• Understand and be exposed to various computer tools which can greatly improve their statistical tolerancing efforts, given the intricacies of GD&T, plus-minus tolerancing, and various datum schemes

Who Should Attend
This seminar is intended for engineers and educators who would like to have a good working knowledge of applying statistics to product design in order to better predict and improve product quality.

Topical Outline
• Review of Tolerancing Methods, Tolerance Stack-Ups and the Relationship between Tolerancing and Quality. A High-Level Overview of Geometric Dimensioning & Tolerancing (GD&T) and Process Capability Measurement is Provided
• Tolerance Synthesis (Allocation) Versus Tolerance Analysis
• Overview of the Worst Case (non-statistical) Tolerancing Method for Comparison with Statistical Tolerancing Results
• Probability & Statistics Concepts Required for Statistical Tolerancing Methods
• Tolerance Allocation Based on “Risk of Misassembly”
• Statistical Tolerancing Using the Root-Mean-Square (RMS) Method
  • With bilateral tolerances
  • With unilateral and/or asymmetrical tolerances
  • In 2-D and 3-D applications
  • Participant exercises
• Statistical Tolerancing Using Monte Carlo Simulation
  • Performing Monte Carlo Analysis by hand
  • Demonstrations of computer software for Monte Carlo Simulation and analysis (VSA-2D, VSA-3D and others, if time permits)
• Analyzing Part Tolerances using Main Effect and Sensitivity Analysis Methods — Methods for Determining the Contribution of Process Variables to Overall Process Variation. A Brief Description of Partial and Full-Factorial Analysis is Also Provided
• Overview of Design of Experiments (DOE) and Tolerance Optimization Techniques — Their Benefits in Effective Tolerancing of Parts and Assemblies
• Tolerance Management Program Guidelines — For the Benefit of Participants Interested in Establishing a Comprehensive Quality Assurance Program in Their Organization

Instructor: Kevin Zielinski
Fee $805 .7 CEUs

Tolerance Stack-Up Analysis
2 Days
I.D.# C0022

A similar course is available as a live, online web seminar. Tolerance Stack-Up Fundamentals – see course description below.

This course is designed to help product design personnel create 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, beginning with coordinate tolerances and moving on to geometric tolerances.

The course will eliminate confusion over how to include the bonus and shift in a tolerance stack: for example, when using tolerance of position with the MMC modifier. 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. Results can be quickly and easily checked, and revisions can be made with ease. Students receive extensive practice at creating stacks, and should bring a calculator or laptop computer equipped with MS Excel for the numerous student exercises.

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
PRODUCT ENGINEERING/DEVELOPMENT TOOLS & METHODS

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.

Topical Outline
- Introduction to Tolerance Stacks
- Review of GD&T and the Y14.5 Standard
- Review of Virtual Condition and Resultant Condition concepts
- Introduction to Tolerance Stack-up Analysis Procedure for parts (part stacks) using coordinate dimensions and tolerances
- Introduction to Tolerance Stack-Up Analysis Procedure for assemblies (assembly stacks) using coordinate dimensions and tolerances (100% interchangeability)
- Tolerance Stack-up Analysis for runout and concentricity
- Tolerance Stack-up Analysis for surface profile: bilateral and unilateral
- Tolerance Stack-up Analysis for tolerance of position: RFS
- Tolerance Stack-up Analysis for tolerance of position: MMC-bonus
- Tolerance Stack-up Analysis for tolerance of position: MMC-shift
- Tolerance Stack-up Analysis for form and orientation controls: surface and feature of size
- Use of Statistical Methods in Stack-up Analysis: Root-Sum-Square and its Derivatives
*Indicates hands-on practice exercises immediately follow lecture

Instructor: John-Paul Belanger
Fee $1445 1.3 CEUs

Tolerance Stack-up Fundamentals Web Seminar and Web Seminar RePlay
6 Hours
Web Seminar: I.D.# C0842
Web Seminar RePlay: I.D.# PD3308420N

A similar course is offered as a classroom seminar - Tolerance Stack-Up Analysis – see course description above

Analysis of tolerance stacks varies widely. This Web Seminar introduces the basic tools to create a common methodology for tolerance stack-ups, and ensure seamless documentation. Participants will create 1-D tolerance stacks for parts and assemblies that use geometric dimensioning and tolerancing using a tolerance stack spreadsheet. This simple, manual spreadsheet method produces an easily interpreted and checked documentation trail, and is easily adaptable to common electronic spreadsheet programs. Multiple examples will be provided to assist engineers in applying tolerance stack-up fundamentals to Y14.5 issues.

Learning Objectives
By connecting with this Web Seminar, you will be able to:
- Perform and develop a tolerance stack-up analysis
- Correctly enter geometric feature control frame data into a tolerance stack
- Apply a common step-by-step methodology to tolerance stack analysis

Who Should Attend
Engineers familiar with concepts and practices contained within Y14.5 and who are looking for a fundamental step-by-step process for getting geometric dimensioning and tolerancing (GD&T) into a tolerance stack will benefit from this course. A basic understanding of GD&T symbols and concepts is required.

Topical Outline
Session 1
- Introduction and review
- Introduction and tolerancing review
- Tolerancing strategies
- Review of GD&T
Session 2
- Stack fundamentals
- How to identify the stack path
- The two-column stack spreadsheet
- Entering dimensions into the spreadsheet
- Examples with coordinate dimensions
Session 3
- Factoring GD&T into a Stack
- Location and runout tolerances
- Profile tolerances
- Form and orientation tolerances
Session 4
- Bonus and shift tolerance in a stack
- Overview of bonus and shift tolerance
- Part vs. assembly stacks

Instructor: John-Paul Belanger
Fee $620 .8 CEUs
Vibration Analysis using FEA: A Hands-on Workshop

2 Days
I.D.# C0830

FEA has been used by engineers as a design tool in new product development since the early 1990's. Until recently, most FEA applications have been limited to static analysis due to the cost and complexity of advanced types of analyses. Progress in the commercial FEA software and in computing hardware has now made it practical to use advanced types as an every day design tool of design engineers. In addition, competitive pressures and quality requirements demand a more in-depth understanding of product behavior under real life loading conditions.

This seminar introduces one of the advanced types of FEA: vibration analysis. By considering time dependent loads and inertial effects, vibration analysis allows for a more in-depth product simulation thus reducing product development cost and time. The course reviews basic concepts of vibration analysis and illustrates how they are implemented in FEA to simulate product behavior. The most common types of vibration analysis such as modal, time response, frequency response and random vibrations are covered. Participants will have the opportunity to practice skills learned utilizing the commercial FEA software SolidWorks Simulation.

Learning Objectives
By attending this seminar, you will be able to:
• Evaluate the importance of dynamic effects in product simulation
• Analyze inertial and damping effects in structural response
• Use vibration analysis as a design tool
• Perform time response, frequency response and random vibration analyses
• Apply proper FEA modeling techniques to model system dynamics

Who Should Attend
The seminar will be of interest to any design engineer who already uses Finite Element Analysis (FEA) as a design tool and would like to explore if and how vibration analysis with FEA may benefit the design process. It builds on participants’ experience with static FEA and on knowledge of mechanical vibrations common to any mechanical engineer.

Topical Outline
DAY ONE
• Structure vs. Mechanism
• Fundamental Assumptions in the FEA
• Verification and Validation of FEA Results
• Modal Analysis
  • Convergence of frequencies
• Rigid body modes
• Properties of lower and higher modes
• Eigenvalues and eigenvectors
• Modal superposition method
• Modes separation
• Modeling techniques in modal analysis
• Time Response Analysis
  • Time depended load
  • Impulse load
  • Static vs. dynamic response
  • Time response of a single degree of freedom oscillator

DAY TWO
• Frequency Response Analysis
  • Steady state harmonic response
  • Force and base excitation
  • Resonance
  • Modal damping
  • Frequency response of two degrees of freedom oscillator
• Random Vibration
  • Acceleration power spectral density
  • Interpretation of random vibration results
• Linear vs. Non-linear Vibration Analysis
• Modeling Considerations in Vibration Analysis

Instructor: Paul Kurowski
Fee $1365 1.3 CEUs

Vibration Analysis Using Finite Element Analysis (FEA)

12 Hours
I.D.# WB1401

Finite Element Analysis (FEA) has been used by engineers as a design tool in new product development since the early 1990's. Until recently, most FEA applications have been limited to static analysis due to the cost and complexity of advanced types of analyses. Progress in the commercial FEA software and in computing hardware has now made it practical to use advanced types as an everyday design tool of design engineers. In addition, competitive pressures and quality requirements demand a more in-depth understanding of product behavior under real life loading conditions. This course will enable participants to expand the scope of FEA to vibration analysis to simulate product behavior under those conditions. This six-session web seminar introduces vibration analysis performed with Finite Element Analysis (FEA). By considering time-dependent loads and inertial and damping effects, vibration analysis allows for a more in-depth product simulation thus reducing product development cost and time. The course reviews basic concepts of vibration analysis and illustrates
how they are implemented in FEA to simulate product behavior. The most common types of vibration analysis such as modal, time response, and frequency response will be covered.

All topics are illustrated using FEA software, SolidWorks® Simulation, for which participants will be provided a student license and opportunity to practice skills learned. Acquired skills, however, will not be software specific and no prior exposure to FEA software is required.

Learning Objectives
By participating in this web seminar, you will be able to:
• Evaluate the importance of dynamic effects in product simulation
• Analyze inertial and damping effects in structural response
• Perform modal analysis, time response analysis and frequency response analysis
• Apply proper FEA modeling techniques to model system vibration
• Use vibration analysis as a design tool

Who Should Attend
The course will be of interest to design, R&D, project, and product engineers who already use Finite Element Analysis (FEA) as a design tool and would like to explore if and how vibration analysis with FEA may benefit the design process. It builds on participants’ experience with static FEA and on knowledge of mechanical vibrations common to any mechanical engineer.

Topical Outline
Session 1
• Structure vs. Mechanism
• Simulation Process with the FEA
• Verification and Validation of FEA Results
• Discrete and Distributed Systems
• Mode of Vibration
• Modal Analysis
• Eigenvalues and eigenvectors
• In-class Exercises/Homework Assignment

Session 2
• Modal Analysis
• Convergence of Frequencies
• Rigid Body Modes
• Properties of Lower and Higher Modes
• Modes of Vibration of Single Degree of Freedom Oscillator (1DOF) and Two Degrees of Freedom Oscillator (2DOF)
• In-class Exercises/Homework Assignment

Session 3
• Modal Analysis
• Modeling Techniques in Modal Analysis
• Modes Separation
• Modal Analysis as a Tool to Find “Weak Spots”

• Modal Analysis as a Diagnostic Tool
• In-class Exercises/Homework Assignment Session 4
• Modal Analysis with Pre-Stress
• Buckling Analysis
• Analogies between Modal Analysis and Buckling Analysis
• Modes of Vibration
• Modal Superposition Method
• In-class Exercises/Homework Assignment Session 5
• Time Response Analysis
• Load Excitation and Base Excitation
• Impulse Load
• Static vs. Dynamic Response
• Time Response of a 1DOF and 2DOF Systems Time Response of a Distributed System
• In-class Exercises/Homework Assignment Session 6
• Frequency Response Analysis
• Steady State Harmonic Response
• Force and Base Excitation
• Resonance
• Modal Damping
• Frequency Response of a 1DOF and 2DOF Systems
• Frequency Response of a Distributed System
• Linear vs. Non-linear Vibration Analysis
• Summary for Post-Course Learning Assessment

Instructor: Paul Kurowski
Fee $810 1.2 CEUs
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- Intro to Statistical Tolerance Stacks
- Solid Model Tolerancing (ASME Y14.41)
- System Approach to Component Tolerancing

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You will learn best practices in creating a compliance program for your products and markets, and how to use this program at all stages of product development and production.
Read more about this course on page 51

Fault Tree/Success Tree Analysis
Sharpen your skills with this no-nonsense program that will show you practical ways to implement popular tools in your product/process design, manufacturing, reliability assurance and safety operations.
Read more about this course on page 52

Root Cause Problem Solving: Methods and Tools
This proven 8-step approach to problem solving will help improve operational and financial performance by identifying causes and implementing solutions to significant or recurring problems.
Read more about this course on page 46

Introduction to Weibull Engineering Fast Track
Weibull Analysis is popular worldwide as the best method for predicting modeling variability and failure of designs, products, and systems. In this introductory short course, instructor Wes Fulton will provide a solid overview of Weibull Engineering capabilities.
Read more about this course on page 54

Military Tactical Vehicle Product Development - Concept to Production
Understanding the U.S. Department of Defense (DoD) requirements, processes, and product development lifecycle allows for more effective new product engineering and development within the DoD marketplace. The overall objective of this two day seminar is to establish a working knowledge of the military tactical vehicle product development process.
Read more about this course on page 55

Weibull-Log Normal Analysis Workshop
New and advanced Weibull techniques are a significant improvement over the original Weibull approach. This workshop, originally developed by Dr. Bob Abernethy, presents case studies in addition to the latest techniques in SuperSMITH® Weibull for risk forecasts with renewal and optimal component replacement.
Read more about this course on page 61
SAFETY AND ACCIDENT RECONSTRUCTION

Includes vehicle impact, accident reconstruction, occupant safety, and safety standards.

Applying Automotive EDR Data to Traffic Crash Reconstruction

3 Days  I.D.# C1210

EDR’s are not new, but are becoming more prevalent in part due to a new federal regulation. 49 CFR, Part 563, which affects vehicles produced after September 30, 2012, will result in a standardized and publicly available EDR in 90% of new vehicles. Accident Reconstructionists frequently have trouble reconciling EDR data with other data sources, and improvements in ABS technology result in fewer tire marks visible at the scene of crashes to allow calculation of pre-crash speeds without an EDR.

This course will provide the participant with the skills necessary to analyze EDR data that has already been imaged, apply it to crash reconstruction, and reconcile it with calculations using other data sources. The course will enable the participant to analyze any current and future EDR data set without regard to manufacturer. The class presents the generic analysis step by step, then groups EDR’s into manufacturer-specific families and their data limitations, and works case studies that highlight targeted key learning objectives. The student will also learn key points to satisfy court Frye and Daubert requirements for EDR data to be admissible, and suggest methods to present EDR data that will communicate the data understandably to attorneys and lay juries.

Learning Objectives

By attending this seminar, you will be able to:

• Describe EDR sensor operation, recording interval and duration, resolution, accuracy, and time latency and articulate the limitations of applying the data to crash analysis.

• Calculate min and max speeds prior to loss of control or braking, and at impact based on the last accurate EDR pre-crash speed data point.

• Evaluate EDR vs. actual ground speed for specific vehicle operational conditions and vehicle equipment modifications.

• Calculate speed at impact and closing speeds by combining EDR Delta V data with normally collected scene and vehicle data such as post crash travel distance, departure angle, drag factor, and vehicle weights. Apply data to inline rear end, head on, and angular collisions.

• Reconcile EDR data with other physical evidence and combine to narrow speed ranges.

• Use time-distance and overlay EDR data on scene maps/diagrams to show where critical driving inputs were made vs. inputs required to avoid collisions.

Who Should Attend

This course is a must for anyone involved in the investigation and analysis of passenger car and light truck crashes who needs to understand the types of event data that are available, the limitations of that data, and how to apply it to a collision reconstruction and reconcile it with data from other sources. In addition, this course can be valuable to insurance adjusters and claims managers, and attorneys handling automotive collisions. Engineers designing EDR’s to meet part 563 regulations may also benefit from understanding how the data they store will be used. New analysts requiring training, as well as experienced analysts who require information on changing technology and federal regulations will find this course relevant and timely.

Topical Outline

DAY ONE

• Overview
  • Case Study - vision of success
SAFETY AND ACCIDENT RECONSTRUCTION

- Overview - EDR data availability by manufacturer by model and model year
- 49 CFR Part 563 EDR regulation timing and contents
- EDR Data Analysis
  - Rules of recording and data limitations - Is this recording from my crash, and which of my multiple events is this recording(s) from?
  - Speed data accuracy
  - Speed at impact drills
  - Accelerator pedal release and brake application
  - Using Delta V to obtain closing speed and impact speed
  - Delta V data accuracy

DAY TWO
- GM EDR families - data availability and limitations, and case studies
  - Using Longitudinal Delta V to get speed at impact in angular collisions
  - Using speed data in critical speed yaw single vehicle crashes; transforming speed vs time into speed vs. distance to impact
  - Reconciling EDR data to scene evidence and evaluating uncertainty in inline collisions
  - Multiple events - which event is my recording from?
- Ford EDR families - data availability and limitations, and case studies
  - Ford PCM - evaluating when criminal or negligent behavior occurs, transforming speed vs time data to speed vs distance and overlaying on map to evaluate sight lines
  - Ford ACM - using Delta V in inline collisions and stability control system longitudinal acceleration data to determine real time drag factor

DAY THREE
- Chrysler EDR families - data availability and limitations, and case studies
  - Using acceleration data to calculate Delta V
  - Using yaw angle data to sub-topic
- Toyota EDR families - data availability and limitations, and case studies
  - Using RPM and Delta V to determine speed when actual speed is above data limitation
  - Data latency
- Honda, Mazda, and other manufacturer EDR families (to the extent they are known at the time of the class)
- EDR data admissibility technical foundation

Basic Hybrid and Electric Vehicle Safety Web Seminar and Web Seminar RePlay

2 Hours
Web Seminar: I.D.# C0904
Web Seminar RePlay: I.D.# PD330904ON

High-voltage, high-current energy storage systems and electrical circuits in many current and future alternative-propulsion powertrains present unique challenges to the automotive industry. Care must be taken to minimize risk to all who come into contact with the vehicle throughout its development and life cycle, including powertrain developers, assembly line workers, service technicians, vehicle occupants, and first responders. Significant risk to life and limb can arise from technical issues surrounding these vehicles.

This 120-minute Web Seminar reviews safety concerns and precautions related to high-voltage circuits present in hybrid, plug-in hybrid, electric, and fuel cell hybrid vehicles. HV circuits are discussed in general to provide an understanding of “where the risk lies”. The effects of electrical current on the human body are summarized and existing protective measures, along with the standards that govern such measures, are described. Specific issues related to vehicle development, service, and operation are explained, along with onboard fault detection systems used to protect individuals from electrical injury. A general understanding of electrical and mechanical engineering is helpful, but is not required.

Learning Objectives
By participating in this web seminar, you will be able to:
- Describe component functions and locations in a typical high-voltage powertrain as well as the onboard safety systems associated with such components
- Explain the general effects of electric current on the human body
- Know which national and international safety standards apply to high-voltage vehicle circuits
- Summarize HV safety working issues that may be present during a vehicle’s development, assembly, service, and operation
- Identify general issues associated with extrication of occupants from vehicles with high-voltage powertrains

Who Should Attend
Light and heavy duty engineers and technicians who work directly with high-voltage vehicle circuits in hybrid, plug-in hybrid electric, and/or fuel cell hybrid vehicles, as well as component suppliers, safety officers and/or personnel who plan to develop high-voltage safety programs or procedures, will benefit from this Web Seminar.

Instructor: Richard R. Ruth
Fee $1575 2.0 CEUs

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SAFETY AND ACCIDENT RECONSTRUCTION

Instructor: Jack Rosebro
Fee $260 .2 CEUs

Driver Distraction from Electronic Devices: Insights and Implications Web Seminar and Web Seminar RePlay

4 Hours
Web Seminar: I.D.# WB1140
Web Seminar RePlay: I.D.# PD331140ON

Although many have an idea of what the term “driver distraction” means, there is no common definition within the research community. Additionally, there are many studies that have investigated the topic, but with varying and sometimes conflicting results. What should be made of these discrepancies?

Topical Outline

Session 1
• Overview of Driver Distraction Problem
  • Statistics (crashes, injuries, fatalities, monetary burden)
  • Forms of Distraction
    • Cognitive
    • Visual
    • Auditory
    • Manual
  • Definition of Driver Distraction
  • Overview of Methods to Assess Driver Distraction

This four-hour Web Seminar will provide an overview of driver distraction (predominantly electronic devices): the problem; how to define it; the current state of research and how to critically evaluate that research to make informed decisions; and the effectiveness of state laws and fleet policies to reduce it. The conclusion of the course will summarize strategies, techniques, and technologies that have been shown to be effective in reducing distracted driving from electronic devices.

Learning Objectives
By connecting with this web seminar, you will be able to:
• Weigh the extent of the driver distraction problem
• Define driver distraction
• Critically examine the current state of driver distraction research
• Identify the strengths and limitations of various research approaches that assess driver distraction from electronic devices
• Recognize the difference between various forms of distraction (cognitive, auditory, visual, manual)
• Assess the effectiveness of policy efforts to reduce driver distraction from electronic devices
• Explain that all cell phone “tasks” do not have equal risk
• Determine effective strategies, techniques, and technologies for minimizing distracted driving

Who Should Attend
This course is intended for all those interested in being equipped to critically examine the current state of research in driver distraction. Although the course is aimed at driver distraction from electronic devices, the results pertain to driver distraction in general. Vehicle manufacturers, OEMs, and cell phone providers and manufacturers will be able to use the information presented in this Web Seminar to develop engineering solutions in this area. Government and driving advocate officials will be able to use the information presented in this Web Seminar to design and deliver informed policy decisions regarding driver distraction. Transportation safety researchers will learn about the latest research in this area as well as future research needs.

Topical Outline

• General high-voltage electrical safety issues in vehicles
  • Issues with energy storage systems
  • Issues with motor controllers
  • Issues with motor-generators
  • Issues with DC-DC converters
  • Relationship between high-voltage (HV) bus and 12V bus
  • Gasoline-electric hybrids (HEV)
• Electrical injury
  • Effects of electrical energy on the human body
  • Electrical resistance of the human body
  • “Let-go” current
  • Common electrical accidents
• Industry protection against electrical injury
  • Standards and regulations organizations
  • Personal protective equipment
• On-board vehicle protection against electrical injury
  • Insulation and insulation breakdown
  • Fusing and interlocks
  • Ground-fault protection systems
  • Discharge and isolation circuits
• Powertrain development issues
  • Working with prototype battery packs
  • Working in powertrain test cells
• Service and repair issues
  • Hazards associated with routine maintenance
  • Hazards associated with HV component diagnosis and repair
  • General industry safety procedures
• Vehicle occupant and first responder issues
  • Protective measures for vehicle occupants
  • Hazards associated with vehicle occupant
• Effects of electrical energy on the human body
• Electrical resistance of the human body
• “Let-go” current
• Common electrical accidents
• Standards and regulations organizations
• Personal protective equipment
• Insulation and insulation breakdown
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• Ground-fault protection systems
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• Working with prototype battery packs
• Working in powertrain test cells
• Hazards associated with routine maintenance
• Hazards associated with HV component diagnosis and repair
• General industry safety procedures
• Protective measures for vehicle occupants
• Hazards associated with vehicle occupant
SAFETY AND ACCIDENT RECONSTRUCTION

Session 2
• Possible Reasons for Discrepancies
  • Driver Choice
  • Self-regulation
  • Arousal
• Effectiveness of Policy Efforts to Reduce Driver Distraction from Electronic Devices
• Research Needs/Next Steps
• Minimizing Distracted Driving from Electronic Devices (what works, what shows promise, what doesn’t work)
• Summary

Instructor: Jeffrey Hickman
Fee $415  .4 CEUs

Injuries, Anatomy, Biomechanics & Federal Regulation

3 Days
I.D.# 85049

Safety continues to be one of the most important factors in motor vehicle design, manufacture and marketing. This seminar provides a comprehensive overview of these critical automotive safety considerations: injury and anatomy; human tolerance and biomechanics; occupant protection; testing; and federal legislation. The knowledge shared at this seminar will enable attendees to be more aware of safety considerations and to better understand and interact with safety experts.

Learning Objectives
By attending in this seminar, you will be able to:
• Recognize the significance of various injuries, how to rank order and quantitatively compare their severity, and how to access overall severity of multiple injuries.
• Assess the significance of various test results, know their basis and how to interpret them.
• Identify the biomechanical and legal basis of safety regulations and their changes (especially FMVSS 208 and 214).
• Describe the different measuring capabilities of various test dummies including Hybrid III test dummies.
• Contrast the difference between impact and deceleration injuries for various body regions and explain the “third collision,” which takes place within the vehicle.

Who Should Attend
This seminar is designed for all professionals - technical or managerial - who are involved either directly or indirectly with vehicle safety performance. An engineering undergraduate degree in any discipline would be beneficial.

Topical Outline
• Introduction & Background
• Next Generation Restraint Systems
• Injury Scales -- Abbreviated Injury Scale (AIS); Injury Severity Score (ISS); Trauma Score; Harm; Injury Priority Rating (IPR), Functional Capacity Index (FCI)
• Diagnostic Images of Injuries -- Plain Film X-rays, CT, MRI
• The Role of Alcohol
• Anatomy, Injuries and Tolerance Parameters (By Body Region) -- Head & Neck; Spine; Chest; Abdomen; Pelvis and Lower Extremities
• Test Devices: Basic Differences and Measuring Capabilities for Front and Side Impact Tests
• FMVSS 201, 208, 214 and NCAP and LINCAP -- Current & Proposed Injury Criteria and their Biomechanical Basis
• Regulatory Process -- Federal Rulemaking Process and NHTSA -- Legal Authorizations and Restrictions
• Assessing Pre-existing Conditions and Previous Injury
• Older Drivers - Special Needs

Instructor: Jeffrey A. Pike
Fee $1615 2.0 CEUs

Overview and Impact of the Automotive Functional Safety Standard ISO 26262 Web Seminar and Web Seminar RePlay

4.5 Hours
Web Seminar: I.D.# WB11134
Web Seminar RePlay: I.D.# PD3311340N

ISO 26262: Road Vehicle - Functional Safety is now becoming a condition of compliance for doing business in the automotive sector. The Scope states: “ISO 26262 is intended to be applied to safety-related systems that include one or more electrical and/or electronic (E/E) systems and that are installed in series production passenger cars with a maximum gross vehicle mass up to 3,500 kg...”

This course provides background for reading and applying the standard and explains its scope, the major differences from the general safety standard IEC 61508, and how the scope changes with the introduction of new systems. The vocabulary of the standard is used to enable participants to engage in the context of the standard and a selected list of acronyms is provided as reference. An overview of all parts of the standard is provided and its impact is explained, without lengthy examples requiring days of workshop attendance.
SAFETY AND ACCIDENT RECONSTRUCTION

Learning Objectives
By connecting with this web seminar, you will be able to use the standard to:
• Determine if and how the scope of ISO 26262 applies to your system or component
• Plan a Safety Case based on ISO 26262
• Prepare or reply to Development Interface Agreement compliant to ISO 26262
• Determine the safety goals and Automotive Safety Integrity Level (ASIL)
• Determine the HW requirements based on ASIL
• Determine the SW requirements based on ASIL

Who Should Attend
This Web Seminar would be especially valuable for engineers and managers that desire an overview of the standard’s content, without attending a multi-day workshop or following lengthy technical examples in order to become skilled practitioners. This includes those involved in product development for vehicle manufacturers or suppliers whose products contain electronics or software; engineering quality professionals including SPICE, CMMI, and internal process assessment; attorneys involved in Product Liability; and supplier quality engineers. Web Seminar participants should have an engineering degree. Knowledge of automotive product development and electronics or software is helpful. It is recommended that you have a copy of the ISO 26262 Standard, but it is not required. However, the standard is required for application after the course is completed.

Topical Outline
Session 1
• Motivation for Creating ISO 26262
  • Pre-standard work of France and Germany
  • U.S. involvement and resulting changes to the standard
  • National Academy of Science expectations
• Differences to IEC 61508, the General Safety Standard Previously Used
  • Comparison
  • Impact on Automotive Development
• Overview of the ISO 26262
  • Planning
  • System
Session 2
• Overview of the ISO 26262 (cont’d)
  • Hardware/Software
  • Operations
  • Supporting Processes
  • ASIL-oriented and Safety-oriented Analyses

Instructor: Joseph D. Miller
Fee $415 .45 CEUs

Safe Handling of High Voltage Battery Systems
1 Day
I.D.# C1019
Electric and hybrid vehicles are becoming more visible on today’s roadways and the automotive companies are working hard to make these vehicles as transparent as possible to enhance consumer acceptance. The battery system forms a key part of any of these vehicles and is probably the least understood. With practically no moving parts the battery systems show no visible or audible warning of any latent dangers. This seminar will introduce participants to the risks encountered in handling high voltage battery systems and their component parts. With the understanding of these risks, the seminar will then address how to raise risk awareness and then methods of dealing with those risks. The outcome of this seminar should be improved avoidance of personal injury, reduced risk of reputation loss and product liability actions and reduced risk of loss of property and time.

Students will have an opportunity to participate in a real world battery handling case study scenario in which they will identify solutions for potential risk situations.

Learning Objectives
By attending this seminar, you will be able to:
• Identify the handling risks of the battery system
• Respect the risks and work with them
• Develop a safety program to manage the risks

Who Should Attend
This seminar is primarily intended for vehicle and battery engineers, battery system integration engineers, battery testing engineers, safety systems engineers, electrical engineers and thermal management engineers recently assigned to their roles or returning to hybrid or electric vehicle programs. It will also be beneficial to those involved in the specification, design, development, testing and planning of hybrid vehicle programs. Prototype shop staff will find the safety protocol aspects helpful.

Prerequisites
SAE course Introduction to Hybrid and Electric Vehicle Battery Systems (C0626, page 39), is recommended as a prerequisite. Material presented will be practical in nature and is based on selected fundamentals of chemistry, materials science, electrical and mechanical engineering. An undergraduate degree in electrical, mechanical or chemical engineering will assist in gaining maximum benefit from the material presented. Experience or training in battery electrochemistry is helpful, but not essential.
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Topical Outline

- High Voltage Batteries
  - Electrochemical energy
  - Construction aspects and controls
  - DC vs AC
  - Lithium Ion aspects
- Risks of HV Batteries
  - Team exercise: identifying the risks
  - Risk drivers
  - Hazards classifications
  - Cell vs pack level
- Risk Management
  - Abuse prevention
  - Best practices, design measures, error proofing
  - Prevention & warnings
  - Claims vs. test data
  - Housekeeping
  - Containment
- High Voltage Issues in Engineering and Manufacturing Environments
  - Avoidance of internal dangers from handling
  - What can go wrong in different environments
  - MSDS
  - Special tools
  - Handling of ‘failed’ batteries or cells
  - Dealing with an incident - team exercise

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Become more proficient in the practice of vehicle crash/accident reconstruction by successfully completing this certificate program from SAE. Required courses guide you through crash reconstruction methods, vehicle dynamics, and event data recorder (EDR) technology. Then select three electives that suit your individual technical interest area. Completing the SAE Accident Reconstruction Certificate Program grants you eight credits towards the SAE/Kettering University 20-credit Certificate in Automotive Systems or Kettering’s 40-credit M.S. in Mechanical Engineering. Visit training.sae.org/collegecredit for more information. View the list of required and elective courses and more information on enrolling in this SAE certificate program--training.sae.org/certificate/accident_recon

Side Impact Occupant Safety and CAE

2 Days
I.D.# C0717

Side impact crashes account for approximately twenty-six percent of all motor vehicle fatal crashes, second only to frontal crashes, according to a report by the National Highway Transportation and Safety Administration (NHTSA). While car companies and suppliers continue to develop new technologies that make vehicles safer, NHTSA rolled out updated safety regulations (FMVSS 214) based on new research studies, making vehicle safety design more and more complex.

This seminar is designed to familiarize participants with the engineering principles behind vehicle and restraint designs for occupant safety. Students will learn the mechanics of side crashes and how vehicle structures, restraint systems, and interiors affect occupant safety. Students will also be exposed to system, subsystem, and component level CAE and testing tools used in the simulation of side impacts. Accident crash statistics, biomechanics, government regulations and public domain frontal safety tests will also be covered. A combination of hands-on activities, including computer simulations, discussion, and lecture are used throughout the course. A camera that takes slow-motion movies at up to 1,000 frames per second is employed to capture the miniature Side Impact Crash Demo Test kit on day one, which enables the registrants to thoroughly analyze the crash impact.

Learning Objectives

By attending this seminar, attendees will be able to:

- Explain side impact and how the vehicle structure, door trim and side airbags affect occupant responses
- Describe different dummy types and what injury metrics are used to evaluate occupant injuries
- Interpret FMVSS 214 regulations and public domain safety evaluations such as LINCAP and IIHS safety rating systems
- Describe system, sub-system and component level CAE and testing tools that are used to assist in design decisions
- Evaluate the relative effect of door intrusion and restraint system characteristics
- Select correct data filtering to process crash test data

Who Should Attend

This course is designed for engineers who are new to the field of occupant protection in side impacts as well as those individuals who require knowledge regarding IIHS side impact ratings and the FMVSS 214 regulation. This course will also be of interest to engineers who deal with side impact issues or are involved in designs of side impact related components, such as airbags, door trim, side.

Instructor: Erik J. Spek
Fee $785 .7 CEUs
SAFETY AND ACCIDENT RECONSTRUCTION

Topical Outline

DAY ONE
• Vehicle Crash Safety Introduction
  • Crash injury and fatality data from the U.S.
  • Distribution of different crash types
  • Active safety and passive safety
  • Trend of crash safety ratings
• Vehicle Side Impact Test Modes
  • Moving deformable barrier impact
  • Pole impact
• Biomechanics
  • Test Dummies and Injury Metrics
    • SID/HiIII; SID IIs & SID IIs-FRG
    • ES-2 & ES-2re
    • BioSID & WorldSID
• U.S. Regulatory Requirements
  • FMVSS 214, 201, 301
• U.S. Public Domain Tests and Performance Ratings
  • LINCAP; IIHS
• European Regulatory Requirements
• Euro-NCAP and Performance Ratings in Other Markets
• Test Data Processing
  • Filtering and SAE J211 guidelines
  • HIC, TTI
  • Numerical integration, differentiation, occupant relative travel
  • Hands-on in computer lab: test data processing
  • Hands-on Computer Exercises
    • Simulations Using Simplified Models
    • Crash Data Processing

DAY TWO
• Side Impact Mechanics
  • Vehicle structure
  • Door trim
  • Thoracic and pelvic bolsters
  • Inflatable devices for impact protection
• Restraint System for Side Impact
  • Thorax bag; Shoulder bag
  • Thorax-head combo bag; Thorax-pelvis combo bag
  • Seat mounted and door mounted side airbags
  • Inflatable curtain
  • Inflatable shoulder belt / lap belt
• Crash Sensors
  • G-based sensors; Pressure sensors
• Vehicle Crash Computer Modeling (CAE)
  • Vehicle CAE model
  • Occupant CAE model
  • Crash Barrier CAE models
• Component and Sub-system Crash Development Tools
  • Sled tests
  • Sub-system level FEA
  • Madymo for airbag development
• Vehicle Level Crash Development and Test Data Analysis
  • Barrier test
  • Crash vehicle re-build
  • Surrogate vehicle test
  • Full vehicle FEA analysis
  • Test data analysis
• Design Optimization and Robustness
  • DOE used in component test, HYGE sled and CAE
  • Optimization in CAE
  • Robust design using CAE
• Hands-on Project Using Miniature Test Kit
  • The effect of vehicle stiffness
  • The effect of door trim design, restraint system
• Summary

Instructor: Stephen Kang and Zhibing Deng
Fee $1365 1.3 CEUs

Vehicle Crash Reconstruction Methods

3 Days
I.D.# C1417

Automotive crash reconstruction is a process carried out with the specific purpose of estimating in both a qualitative and quantitative manner how a crash occurred. Reconstructions are based on data collected during the crash and physical evidence gathered during a crash investigation. To some extent, testimonial evidence is also used. Whether a crash is between two vehicles, a vehicle and pedestrian or a vehicle and a barrier, specific crash segments, classified as pre-impact, impact and post-impact motion often are reconstructed separately. Each of the segments is analyzed using established engineering, scientific and mathematical principles and based on the physical evidence. Not only must each method be well established, but it must be selected so its coverage corresponds to the conditions of the physical conditions. Three main factors - human, vehicle and environment are taken into account during a reconstruction.

This seminar is devoted to the exposition, use and limitations of the engineering, scientific and mathematical principles and methods used to reconstruct vehicle crashes. The primary objective is to help the attendees achieve a high level of understanding of these methods. The course covers a wide range of topics including vehicle acceleration/deceleration, impact mechanics, Event Data Recorder (EDR) and Engine Control Module (ECM) technology, tire mechanics, vehicle-pedestrian impacts and topics from vehicle dynamics. Most of the calculations can be carried out using commonly available spreadsheet technology.

VCRware, a commercially available software based in Microsoft Excel and written by the instructors, will be provided to the
SAFETY AND ACCIDENT RECONSTRUCTION

attendees for class exercise use during the seminar. Attendees should bring a Windows-based laptop equipped with Excel 2003 or later. Attendees will also receive a copy of the instructors’ book, Vehicle Accident Analysis and Reconstruction Methods, published by SAE International, 2011.

Learning Objectives
By attending this seminar, attendees will be able to:
• Describe the basic mechanics of collisions, including the differences between normal and tangential contact/interaction effects, restitution, energy loss, \( \Delta V \), PDOF, common velocity conditions and other topics.
• Articulate the differences between point mass and rigid body impact analysis and when each can be applied, and should not be applied.
• Recognize the critical differences between methods described in the field of Crash Reconstruction such as “Conservation of Linear Momentum” and “Planar Impact Mechanics”, the assumptions and limitations behind these methods and when and how they should, and should not, be used.
• Formulate and solve impact problems to reconstruct crashes with Event Data Recorder (EDR) and/or Engine Control Module (ECM) data and use spreadsheet optimization technology to turn a crash analysis into a reconstruction.
• Combine pedestrian and vehicle motion to reconstruct pedestrian collisions including situations where the point of impact is unknown.
• Use planar photogrammetry to determine unknown points and paths from photographs and site measurements.
• Describe tire forces and tire mechanics for braking/accelerating and steering including Antilock Braking System (ABS) operation.

Who Should Attend
This course is well-suited for persons just beginning to work in the area of crash reconstruction as well as persons already in the field who want to establish a more firm foundation in current crash reconstruction technology.

Topical Outline
DAY ONE
• Straight-Line Motion
  • Equations of motion of two-axle vehicles including pitch motion and load transfer due to braking acceleration
  • Values of the frictional drag coefficient, \( f \), (“drag factor”) of light vehicles and heavy trucks
• Point Mass Collisions (COLM, Conservation of Linear Momentum)
  • Basic concepts and simple applications of impact theory: impulse, momentum, velocity change, \( \Delta V \), energy loss, normal & tangential impulses (and the impulse ratio)
• Planar Impact Mechanics (PIM)
• Thorough coverage of the system equations and solution equations of impulse and momentum for the collision of two vehicles including rotational inertia and angular momentum which are essential for the analysis and reconstruction of crashes using EDR data
• Class exercises using VCRware software

DAY TWO
• Crush and Tangential Energy Loss
  • Introduction to the concepts of crush measurements (CRASH3) to compute collision energy loss and its relationship to crash vehicle \( \Delta V \)
• Event Data Recorder (EDR) Technology
  • Introduction to the general characteristics of EDRs: driver and vehicle state data (settings), time intervals, pre-crash data, crash acceleration & \( \Delta V \)
• Crash Reconstruction using EDR Data, Planar Impact Mechanics and Spreadsheet Optimization Techniques
  • Use of Planar Impact Mechanics for analysis & reconstruction of crashes
• Class exercises using VCRware software
• Frontal Vehicle-Pedestrian Collisions
  • Introduction to and derivation of the equations of the Han-Brach pedestrian impact model and other pedestrian impact models, both empirical models and mechanics models
• Class exercises using VCRware software

DAY THREE
• Planar Photogrammetry
  • Determination of road surface markings from photographs and site measurements
• Mechanics and Modeling of Tire Forces
• Description of longitudinal tire forces (braking/acceleration)
• Lateral tire forces (steering/cornering) and tire forces under combined braking and steering
• Friction ellipse
• Modeling of tire forces using the Bakker-Nyborg-Pacejka (BNP) equations and the modified Nicolas-Comstock equations
• Antilock braking principles
• Critical Speed from Tire Yaw Marks
• Description and measurement of yaw marks and reconstruction of vehicle speed at the beginning of yaw marks
• Articulated Vehicle Impact
• Concepts of impulse and momentum applied to crashes between articulated vehicles (such as tractor semitrailers) and other articulated vehicles, barriers or single vehicles
• Topics from Vehicle Dynamics
• Discussion of the bicycle model of a two-axle vehicle along with concepts of oversteer and understeer

Instructor: R. Matthew Brach and Raymond M. Brach
Fee $1755 2.0 CEUs

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Vehicle Frontal Crash Occupant Safety and CAE

2 Days
I.D.# CO621

Car companies and suppliers continue to develop new technologies that make vehicles safer and regulatory agencies continue to update safety regulations based on new research studies, making vehicle safety design more and more complex. This seminar covers the mechanics of frontal crashes and how vehicle structures, vehicle restraint systems, and vehicle interiors affect occupant safety. It also describes details of how CAE tools work in the simulation of frontal crashes. The goal of the course is to familiarize participants with engineering principles behind vehicle and restraint designs for occupant safety. Accident crash statistics, biomechanics, government regulations and public domain frontal safety tests will be reviewed briefly. Students will also be exposed to Madymo, one of the major occupant CAE tools. The basic inner workings of the tool, such as rigid body dynamics, joints, contact, airbag and seatbelt modeling, and modeling techniques will be shared with the class. The class also offers participants opportunities to do hands-on computer analysis as well as simplified hands-on crash tests, where students can learn first-hand how vehicle pulses and restraint design affect occupant response. A camera that takes slow-motion movies at up to 1,000 frames per second is employed to capture the miniature Side Impact Crash Demo Test kit, which enables the registrants to thoroughly analyze the crash impact.

Learning Objectives

By attending this seminar, you will be able to:
- Explain frontal crashes and how vehicle structure and restraint systems affect occupant responses
- Describe how restraint components function in crashes and protect occupants
- Carry out calculations of injury metrics using test or CAE results as input
- Describe the occupant CAE tool, Madymo, and how it works
- Explain assumptions and limitations of CAE models
- Evaluate the relative effect of crash pulse, and restraint system characteristics
- Analyze and evaluate crash pulses
- Describe FMVSS 208 and NCAP requirements and metrics
- Explain the use of different dummies and their limitations

Who Should Attend

This course is designed for engineers who are either new to the field of automotive safety or familiar with only certain aspects of automotive safety. It can help engineers, for example, who design a specific component in a vehicle to understand how it works in vehicle crashes, how its characteristics affect occupant response and how it relates to other components in the vehicle.

Topical Outline

DAY ONE
- Vehicle Crash Safety Introduction
  - U.S. crash injury and fatality data
  - Distribution of different crash types
  - Active and passive safety
- Vehicle Frontal Crash Modes
  - Frontal rigid, offset deformable and angular barriers
  - Out of position tests, driver and passenger
  - HYGE and Servo sled tests; Component tests
- Biomechanics - Human Anatomy and AIS Injury Scale
- Brief Overview of Frontal Test Dummies and Injury Metrics
- Frontal Crash Mechanics
  - Crash pulse, front loaded, rear loaded
  - Class Project using Excel: calculate vehicle velocity and crush from pulse; get maximum crush, time to zero velocity; pulse comparison, front-loaded and rear loaded pulses
  - Intrusions
  - Occupant to restraint gaps and restraint characteristics
  - Belted vs. unbelted occupant
  - Class project: determining occupant responses
  - Airbag quickness and stiffness
  - Belt slack, pretension, EMR
  - Driver vs. passenger
  - Typical crash event
  - 5th percentile female submaringing
- Crash Sensor - Airbag & Pretensioner Firing & Non-firing Conditions; Sensor Tests

DAY TWO
- Brief Review of U.S. and European Regulations and Public Domain Safety Ratings
- Numerical Data Processing
  - Filtering and SAE J211 guidelines
  - HIC, Nij, Cumdur, V*C calculations
  - Numerical integration, differentiation, occupant relative travel
- Vehicle Crash Computer Modeling (CAE)
  - Vehicle structure CAE, finite element method
  - Occupant CAE, rigid body dynamics
  - CAE assumptions and limitations
- DABLIT - Component Test for Driver Airbag
- DOE and Optimization
- Restraint System
  - Airbag, inflator, single & dual stage
  - Crash sensor, Restraint Control Module (RCM)
  - Seatbelt, D-rings
  - Retractors, torsion bars
  - Buckle and retractor pretensioners
  - Steering column stroke; Steering wheel lower and upper rims
  - Knee bolster
- Real World Crashes - Safety for the Aging Population; Crash Severity Distribution

Instructor: Stephen Kang

Fee $1315 1.3 CEUs

Catalog Key

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<th>Classroom</th>
<th>Live, online</th>
<th>Online, on demand</th>
<th>Certificate</th>
<th>ACTAR approved</th>
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SAFETY AND ACCIDENT RECONSTRUCTION

RELATED TRAINING SOLUTIONS
Some of our courses apply to more than one technology category. Consider these related courses described in other sections of this resource guide.

Acquiring and Analyzing Data from Sensors and In-Vehicle Networks
After reviewing the traditional approach of acquiring data directly from sensors, the course will focus on the newer approach of obtaining data from the in-vehicle network for both automotive and heavy duty vehicles. Attention is given to the complications of taking data from the in-vehicle network and how to overcome them.

Read more about this course on page 22

Developing In-Vehicle User Interfaces: Design Principles and Techniques
This course will provide a systematic design method to develop intuitive and safe vehicle interface solutions. Participants will learn user interaction design steps, tools, and the team synergies required to develop an interface from concept to the final product.

Read more about this course on page 29

Vehicle User Experience: Human Factors Principles and Techniques for Design, Research and Development
The automotive industry faces unprecedented growth in vehicle technologies and features that can dramatically affect the vehicle user experience. This course will provide an overview of principles and techniques for designing and developing vehicle interfaces which deliver optimal solutions while avoiding unintended consequences like driver distraction.

Read more about this course on page 35
Ahmadian, Mehdi
Mehdi Ahmadian, Ph.D. is a Professor of Mechanical Engineering at Virginia Tech, where he is also the Director of the Center for Vehicle Systems and Safety (CVeSS) and the Railway Technologies Laboratory (RTL). He is the founding director of CVeSS, RTL, Virginia Institute for Performance Engineering and Research, and the Advanced Vehicle Dynamics Laboratory. Dr. Ahmadian has authored more than 200 technical publications and has made more than 130 technical presentations in topics related to advanced technologies for ground vehicles. He holds six U.S. patents and has edited four technical volumes. He currently serves as editor for the International Journal of Vehicle Systems Dynamics, co-editor for Advances in Mechanical Engineering, and associate editor for the Journal Shock Vibration. Dr. Ahmadian is a member of SAE International and is the recipient of the 2008 Forest R. McFarland Award for outstanding contributions to the SAE International Engineering Meetings Board. He is also a Fellow of ASME and a Senior Member of AIAA. In the past, he has served as associate editor for the ASME Journal of Vibration and Acoustics and associate editor for the AIAA Journal. Dr. Ahmadian’s research interests include vehicle dynamics and control, advanced suspensions, biodynamics, ride engineering, tire dynamics, advanced materials for improving vehicle performance, and vehicle noise and vibration assessment. Dr. Ahmadian has over 25 years of industrial and academic experience, working in research, development, and engineering of various systems for ground vehicles, air vehicles, and water vessels for both civilian and military applications.

Aloi, Daniel N.
Daniel N. Aloi, Ph.D., is an Associate Professor of Engineering and the Interim Chair at the Electrical & Computer Engineering Department, Oakland University, Rochester, MI. He received his B.S., M.S. and Ph.D. degrees in electrical engineering from Ohio University in 1992, 1996 and 1999, respectively. He has been employed at Oakland University since January 2002. Dr. Aloi was a Sr. Project Engineer at OnStar, Inc. (2000 - 2001) and a Visiting Assistant Professor at Ohio University (1999 - 2000). His research areas include applied electromagnetics and various areas of the global positioning system (GPS) in the automotive and aviation industries. Dr. Aloi has attracted in excess of $2.0M dollars in external funding as PI, authored over 45 technical papers and obtained 5 patents. He is an Associate Editor for the IEEE Transactions on Aerospace and Electronic Systems in the area of navigation and for the SAE International Journal on Passenger Vehicles: Electrical and Electronic Systems. He has also served as a key technical advisor to the Federal Aviation Administration’s Satellite Program Office in regards to the Local Area Augmentation System, which is a proposed GPS-based landing for commercial aircraft.

Banish, Greg
Greg Banish is a mechanical engineer and motorsports enthusiast who works in Ford Motor Company’s gasoline engine calibration group. After studying for a bachelor’s degree in Mechanical Engineering at GMI Engineering & Management Institute (Kettering University), he wrote his thesis on vehicle instrumentation and measurement. Putting this education to practical use, he founded his own performance shop outside of Detroit and has served local enthusiasts, shops, automotive companies and OEMs. Greg later worked for SiemensVDO and General Motors as a calibration engineer on programs ranging from direct injection turbocharged engines to the Chevy Volt Hybrid control system. He is a member of SAE International and SEMA and has authored two books on aftermarket EFI calibration. With thousands aftermarket calibrations performed, he has worked with a wide variety of engines and control systems in addition to his OEM calibration work.

Barak, Pinhas
A professor of mechanical engineering, Dr. Pinhas Barak specializes in vehicle systems dynamics and suspension design, active and semi-active suspension systems, chassis and vehicle design systems, mechanical control systems, and vibrations. He recently established the Vehicular Dynamics Design Center at Kettering University. Dr. Barak is a member of SAE International, ASME, ASEEE and SIAM, with more than 25 years of industrial experience in automotive engineering. He also received the SAE International Outstanding Faculty Advisor Award in 1993. Dr. Barak received both a B.S.C. and an M.S.C. in mechanical engineering from the Technion Israel Institute of Technology and his Ph.D. in mechanical engineering from Wayne State University.

Bardasz, Ewa
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 2002 Award for Research on Automotive Lubricants, and 2009 SAE International 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.

**Bauer, Daniel P.**
Mr. Bauer, an ASME Certified Senior GD&T Professional who holds a Master of Science in Industrial Operations and is fluent in Spanish, serves as president and principal consultant with ITR. With experience supporting over 20 automotive component and vehicle programs in the past 10 years in the U.S., Europe, and China, he specializes in providing training and engineering services in the areas of design engineering, quality, performance improvement, and productivity. In the early '90s Mr. Bauer spent three years designing and implementing training and quality programs for six Ford Motor Company launches. Programs included electrical, fuel handling, and powertrain components, including the 600V6 Vortec Launch. Over the past three years he has worked to develop a comprehensive error proofing system for Chrysler Corp. He has worked with Chrysler to implement the system on several vehicle programs: the 1998 Dodge Durango, the 1999 Jeep Grand Cherokee, the 2000 Dakota Quad Cab, the 2001 Minivan, and the 2002 Ram Pickup. Most recently Mr. Bauer served as a visiting professor at Shanghai Jiao Tong Univ. where he conducted a certification program in Geometric Dimensioning and Tolerancing and Reading Engineering Drawings. The train-the-trainer program certified university professors and GM engineers who support the GM China training curriculum in both Shanghai and Beijing. He serves as an adjunct instructor and consultant for the Society of Manufacturing Engineers, DaimlerChrysler Quality Institute, General Motors Univ., General Physics Training Institute, and other post secondary institutions. He provides training and consulting services on topics including Failure Mode and Effects Analysis (FMEA), Control Plan Development, Problem Solving, Statistical Process Control (SPC), Capability Analysis, Blueprint Reading, Geometric Dimensioning and Tolerancing (GD&T), Project Management, and Error Proofing. Mr. Bauer has authored publications on Geometric Dimensioning and Tolerancing, Tolerance Stackup Analysis, Product Design Error Proofing, Failure Mode and Effects Analysis, Lean Plant Layout, Standardized Work, Blueprint Reading, Program Management, Advance Product Quality Planning, Control Plan Development, and Team Building. He has additionally worked with General Motors Distance Learning to pilot a series of interactive television broadcasts on Project Management. Mr. Bauer holds a B.A. from Eastern Michigan Univ. and an M.S. in Industrial Operations with distinction from Lawrence Technological Univ.

**Belanger, John-Paul**
John-Paul Belanger is president of Geometric Learning Systems, a consulting firm specializing in geometric dimensioning and tolerancing (GD&T) and stack analysis. For over fifteen 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, electronic, 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.

**Blair, Julian**
Julian Blair is the Calibration Process Lead of Engine Development, Calibration and Verification for General Motors. Named to this position in January 2013, Julian leads the Global Calibration Process Technical Resource Board with the charter of streamlining GM calibrations tools to enable the benefits of common process. Previously, Julian was a Calibration Specialist on V6 passenger car applications for a number of engine calibration areas namely; Torque Modeling and Control, Spark and Dilution Control, Electronic Throttle Control, and Fuel Control. He also held positions of Lead Engine Calibrator, Test Automation Engineer and Test Technology Engineer in the GM Engine Development Dynamometer Laboratory. Julian joined GM’s engineering team in 2001 after graduating from Tennessee State University with a Bachelor’s and Master’s degrees in Mechanical Engineering. He is also a licensed and registered Professional Engineer in the State of Michigan.

**Bolourchi, Farhad**
Dr. Bolourchi is currently a staff research engineer II with Nexteer Automotive Innovation Center where he designs algorithms for advanced chassis systems. Farhad helped develop Delphi’s first electric power steering system, for which he received the company’s highest technical award, the “Boss Kettering”. Dr. Bolourchi previously worked for Hughes Aircraft Company and gained valuable experience in both missile systems controls and automotive applications. He was also a part time faculty member at the University of California - Davis and Sacramento State University. Farhad received GM’s President Honors award in 1998, and was inducted to Delphi’s Hall of Fame in 1999. He has numerous publications and patents related to control systems and automotive applications. Dr. Bolourchi has a B.S. in Mechanical Engineering from Northeastern University, a M.S. in Mechanical Engineering and a Ph.D in Nonlinear Control Systems from the University of California - Davis.

**Borghese, Joe**
Joe Borghese is a Staff Engineer at Honeywell International in Torrance, CA. Joe has been involved in the design, development and test of compact heat exchangers for aerospace and industrial applications for over 25 yrs. As the thermal analysis group leader for 9 years he led efforts to develop several new compact fin surfaces for use in aerospace and automotive applications. He recently was responsible for the design of the oil coolers for the GENx engine (Boeing 787 and 747-800), the oil cooler for the Honeywell HGT1700 Auxiliary Power Unit and the Environmental Control System ram air heat exchangers for the Airbus A350. In the past Joe has led efforts to develop high temperature recuperators for industrial turbogenerators and automotive Exhaust Gas Recirculation coolers. Joe received his bachelor’s degree in Mechanical Engineering from the University of Illinois and a master’s degree from M.I.T.

**Buckman, Leonard**
Leonard Buckman is president of Buckman Consulting Services, Inc., a firm with OEM and brake supplier clients in North America, Japan and Europe. Previously, he worked at Ford Motor Company as a brake specialist, heading up all heavy truck brake system design actions necessary for the initial implementation of FMVSS 121; at Rockwell International, serving as Chief Brake Engineer, Director of Worldwide Brake Engineering & Product Planning, and Vice President of Brake and Axle Product Management; and at Meritor WABCO VCS as President and General Manager. Mr. Buckman has a unique perspective because of his experience as a brake specialist both at a major truck OEM and at major suppliers of worldwide brakes and brake systems. He was selected by the U.S. Secretary of Transportation to serve as the commercial vehicle brake specialist on the 1999 DOT Vehicle Safety Planning Group and has twice received the SAE Distinguished Speaker Award. Mr. Buckman is a registered Professional Engineer and holds a B.S. in engineering physics from Michigan Technological University. He also completed post-graduate work in engineering mechanics and mechanical engineering at Wayne State University and the University of Michigan, respectively.
Cattelan, Alexandra
Ms. Cattelan is currently the Chief Engineer of New Energy Systems at AVL. She has extensive experience in hybrid and electric vehicle and powertrain system design, development, validation and production and has been in automotive engineering for 20 years. Prior to her current position, Ms. Cattelan was the Assistant Chief Engineer for the Chevrolet Volt and Vehicle Performance Manager for the Midsize Hybrids at General Motors. She also has extensive experience in natural gas and propane vehicle engineering including responsibilities in system development, software and controls engineering, calibration and validation, as well as experience in vehicle manufacturing and environmental consulting. Ms. Cattelan holds a B.S. in Industrial Engineering and a M.S. in Mechanical Engineering, both from the University of Toronto, Canada.

Chau, K. T.
K. T. Chau received his B.Sc.(Eng.) degree with 1st Class Honors, M.Phil. degree and Ph.D. degree all in Electrical & Electronic Engineering from The University of Hong Kong. He joined the alma mater in 1995, and currently serves as Professor and Director of the International Research Center for Electric Vehicles. He is a Chartered Engineer and Fellow of the IET. At present, he serves as Co-Editor of the Journal of Asian Electric Vehicles. Professor Chau has published over 300 refereed technical papers, co-authored a monograph Modern Electric Vehicle Technology, and wrote two book chapters #147Electric Motor Drives for Battery, Hybrid and Fuel Cell Vehicles#148 and #147Hybrid Vehicles#148 in Electric Vehicles: Technology, Research and Development and Alternative Fuels for Transportation, respectively. Professor Chau has received many awards: including the Chang Jiang Chair Professorship by the China's Ministry of Education; the Environmental Excellence in Transportation Award for Education, Training and Public Awareness by the SAE International; the Award for Innovative Excellence in Teaching, Learning and Technology at the International Conference on College Teaching and Learning; and the University Teaching Fellow Award by The University of Hong Kong.

Chehroudi, Bruce
Dr. Chehroudi is Chief Scientist and Group Leader at Advanced Technology Consulting. His previous positions include: Principal Scientist at Air Force Research Laboratory (AFRL/ERC), Chief Scientist at Raytheon STX (formerly Hughes Aircraft STX), Professor of Mechanical Engineering, and Research Staff Member at Princeton University. He specializes in fluid mechanics and heat transfer, laser optical diagnostics, internal combustion engine, gas turbine and rocket engines, structure of sprays, gas turbine engines, combustion, fuel injection issues and emission of pollutants. Dr. Chehroudi is an AIAA Associate Fellow, a member of Ta Beta Pi and the recipient of several SAE International awards including the Arch T. Colwell Merit Award, the Ralph R. Teeter Award, the SAE International Recognition Award and the SAE International Forest R. McFarland Award in recognition of his efforts and leadership in contributions to the Continuing Professional Development Seminars. He has taught courses in the areas of internal combustion engines, thermodynamics, thermophysics of gas flows, combustion, and measurement system, and has more than 150 publications and over 200 presentations in conferences, national and international journals. Dr. Chehroudi has a Ph.D from Princeton University.

Chen, Joseph
Mr. Joseph Chen is currently an independent automotive drive train consultant. With over forty years of experience in various drive train industries, Mr. Chen specializes in manual and automatic drive train system design, development, and testing. Previously, Mr. Chen served as Chief Engineer in the Electric Drive Unit (EDU) at Shanghai Automobile Inc., China (SAIC) where he was involved with developing various hybrid and e-drive transmissions. Mr. Chen also served twenty years at General Motors where he advanced to Senior Project Engineer for GM Powertrain, USA. Mr. Chen's experience also includes engineering roles at Clark Equipment, Western Gear Technology and Cleveland Gridley Machinery Company. An active member of SAE International, ASME, and AGMA, Mr. Chen has been a frequent presenter of technical papers at various international conferences and seminars and has been granted more than a dozen patents related to drive train applications. A registered Professional Engineer (PE) in Ohio and California, USA, Mr. Chen received his B.S. Mechanical Engineering from the Tatung University in Taiwan, a M.S. Mechanical Engineering from North Dakota State University, and a MBA from Indiana University.

Cheok Ph.D., Ka C.
Ka C. Cheok, Ph.D. is a Professor of Engineering at the Electrical & Computer Engineering Department, Oakland University, Rochester, MI. He conducts theoretical and experimental research in driver's assistance systems, navigation and guidance for autonomous unmanned vehicle systems and mobile robots, UWB tracking of multiple robots and assets. His work focuses on transition of R&D in intelligent systems, heuristics search, fuzzy logic, neural network and optimal control and estimation techniques into practical applications to smart mechatronics systems for the automotive and defense industries. Dr. Cheok has published over 40 technical journal articles and 100 conference papers. He is an Associate Editor for three technical journals and an organizer for the annual Intelligent Ground Vehicle Competition, and has served as a consultant Member for the US Army Science Board.

Chesneau, Howard
Mr. Chesneau is the President of Fuel Quality Services, Inc. A recognized expert on fuel-related issues, he has over thirty years of experience in fuel additives, distillate fuel problems, fuel filtration, and tank remediation. Additionally, Mr. Chesneau has extensive knowledge and field experience in the area of microbial contamination and detection. Mr. Chesneau is on the IASH Board of Directors and is the past Chairman of the SAE Atlanta Section. He is an active member of other professional organizations including SAE, IATA, and ASTM. He currently serves on the IATA Working Group on Microbial Contamination, the ASTM Committee dealing with fuel from middle distillates to heavy oils, the ASTM Committee establishing specifications for biodiesel, and the ASTM Committee on jet fuel. In addition to his committee and working group activities, Mr. Chesneau has authored and co-authored many articles on the subject of fuel storage and handling that have been published in various trade magazines. Mr. Chesneau served as a commissioned officer in the US Army and holds a B.S. degree from the University of Florida.

Comer, Jess J.
Dr. Jess J. Comer has significant teaching experience in the areas of machine design, dynamics of machines, metal fatigue and failure analysis. He is co-author of the text Fundamentals of Metal Fatigue Analysis and is a registered Professional Engineer in South Dakota. Dr. Comer is a member of SAE International, ASME and ASEE. He holds a B.S. and an M.S. in mechanical engineering from South Dakota School of Mines and a Ph.D from the University of Illinois at Urbana-Champaign.

Das, Shuvra
Shuvra Das Dr. Shuvra Das is Professor of Mechanical Engineering and the Associate Dean for Research and Outreach for the College of Engineering and Science at University of Detroit Mercy. His research and teaching interests include engineering mechanics, computational mechanics using finite and boundary element methods, modeling and simulation, inverse problems, mechatronics, modeling and simulation of mechatronics systems, condition based health monitoring of engineering systems, etc. Dr. Das, author of the text entitled Mechatronic Modeling and Simulation Using Bond Graphs has over fifty conference and journal publications and has received several awards, including the Best Teacher award from the North Central section of ASEE and the Junior
**INSTRUCTOR BIOGRAPHIES**

**Achievement award at University of Detroit Mercy. Dr. Das received his Ph.D. and M.S. degrees in Engineering Mechanics from Iowa State University. In addition, he received his B.Tech (Hons.) in Mechanical Engineering from the Indian Institute of Technology in Kharagpur, India.**

**Davis, Gregory**  
Dr. Gregory Davis is a Professor of Mechanical Engineering at Kettering University where he teaches courses in the Automotive and Thermal Science disciplines. He also serves as Director of the Automotive Engine Research Laboratory, and faculty advisor to the Clean Snowmobile Challenge Project. At Kettering, Dr. Hoff and Dr. Davis teach a graduate/undergraduate course on the fundamentals of automotive powertrains and they are co-authors of the text Introduction to Automotive Powertrains.

**Dawson, Lee D.**  
Mr. Dawson has over 35 years of experience in Quality and Reliability engineering. President and CEO of Quality-One International since 1986, Mr. Dawson had previously held engineering and training positions at Ford Motor Company, and Wickes Manufacturing. As CEO of Quality-One, Mr. Dawson has consulted with hundreds of companies and trained thousands of quality and engineering professionals in Failure Mode and Effects and Analysis (FMEA) and Advanced Product Quality Planning (APQP). He periodically teaches these and other related quality and reliability courses for several colleges and universities in the US, Canada, and Australia and speaks at engineering related functions. Mr. Dawson has written and collaborated on several technical books and manuals including Murphy’s Law Overruled (FMEA in Design, Process and Service), Ford Design Institute FMEA Handbook and AIAG Effective Error Proofing COI-18. He has participated, written and presented numerous technical papers at ASQ, ASM and other professional organizations. Mr. Dawson has a B.S. in Metallurgical Engineering from Penn State University and is a Certified Quality Engineer (CQE), Certified Reliability Engineer (CRE) and is a Master Black Belt in the practice of Six Sigma.

**de Ojeda, William**  
Dr. de Ojeda serves as Manager in the Advanced Powertrain Group at Navistar focusing in the areas of combustion and controls where he has led several advanced engine development programs in collaboration with the Department of Energy. He was lead engineer for the design of various variable valve actuation (VVA) systems, including one the first adaptations of a camless system onto a medium duty Diesel engine. He later developed an electro-hydraulic loss motion system for the Navistar MAXXFORCE® engine. This VVA system enabled the successful demonstration of Partially Premixed Compression Combustion with improved engine efficiency at suppressed levels of PM and NOX. More recently he directed the engine development for Navistar’s High Efficiency Vehicle-Engine Supertruck DOE Program based on the Navistar MAXXFORCE® engine. This engine program includes the adaptation of a state-of-art and highly integrated VVA system. Dr. de Ojeda holds multiple patents and publications in the area of VVA, combustion and controls. He has a B.S. in Mechanical Engineering from The Cooper Union in New York, a M.S. in Mechanical and Aerospace Engineering from The University of Virginia and a Ph.D. in Mechanical and Aerospace Engineering from the Illinois Institute of Technology.

**Denys, Eric**  
Eric Denys is currently the Vice President of Sales, Marketing & Technology at Material Sciences Corporation where his technical specialization is in brake NVH. He previously worked for Federal-Mogul. Throughout his career, Mr. Denys has lead teams to achieve best-in-class in brake squeal on numerous vehicle lines and he is the recipient of the 2001 Ford Global Customer Satisfaction Award for his work on high mileage brake squeal reduction. His work has been published in numerous national and international papers, and in an SAE International book on Disc Brake Squeal. He is a 6 Sigma Black Belt. Mr. Denys is the chairman of the SAE Brake NVH Standards Committee. He received a B.S. in Mathematics from the Jean-Bart University, France and a M.S. in Mechanical Engineering from the University of Technology of Compiègne, France and an MBA from the University Of Michigan.

**Dodson, Bryan**  
Dr. Dodson is currently the Executive Engineer for SKF. Prior to joining SKF, Dr. Dodson held the positions of Senior Director Corporate Quality & Continuous Improvement for Collins & Aikman and Associate Director of Quality & Reliability Engineering with global responsibility for Visteon. Dr. Dodson has authored several books including: The Reliability Engineering Handbook, Practical Accelerated Testing, and Weibull Analysis: with Software. Dr. Dodson has also developed several software packages including: the Training Pro Interactive Study Guides, the Reliability & Maintenance Analyst, and Measurement Assurance. Dr. Dodson served as Chair of the committee that created the International Quality Federation’s Six Sigma Exam and also developed the software that delivers this state of the art exam. Dr. Dodson has published numerous articles in technical journals and teaches several courses for technical societies and as an adjunct faculty member at universities. A Fellow of SAE International and ASQ, Dr. Dodson holds a B.S. in Petroleum Engineering, an M.S. in Industrial Engineering, an M.B.A., and a Doctor of Business Administration. In addition, he is a Certified Quality Engineer (CQE), a Certified Reliability Engineer (CRE), a Six Sigma Master Black Belt, and a licensed Professional Engineer in Michigan.

**Dong, Yibing**  
Dr. Yibing Dong is a Product Architect in the Integrated Electrical System Division (JESD) of Mentor Graphics, Inc. At Mentor, Dr. Dong is responsible for determining the vision and direction for the Capital Analysis product and its derivatives, contributing to the development of Capital Publisher, and supporting strategic customer engagements and market developments. With over twenty years in the automotive industry, Dr. Dong’s experience includes Chief Architect and Development Team Manager at Freescale Semiconductors, Inc. where he worked on Freescale’s Virtual Garage as the key architect for all VG products until its acquisition by Mentor Graphics. Dr. Dong continues his work on the VG product line as Product Architect/VG Engineering at Mentor Graphics. He has created and delivered seminars for the model based EE system engineering process and has received patent recognition in the areas of complexity reduction process, performance development process, and unified data models. Dr. Dong received both his M.S. and Ph.D. in Electrical Engineering from the University of Michigan in Ann Arbor, MI, USA.
Instructor Biographies

Doyle, Joseph
Joseph Doyle is the principal of Strategic Insights, a Michigan-based consulting firm, specializing in executive leadership. He completed a 30-year career with General Motors Corporation, where he held a variety of management positions including: Internal Business Consultant with General Motors University, Senior Research Manager with the Corporate Organization Research and Development Activity, Manager of the Corporate Executive Development Activity, and Lead Consultant with the Corporate Strategy and Decision Support Activity. While at GM, he facilitated Global Task Teams in India, Indonesia, Thailand, England and Australia and served as the Corporate Liaison on Leadership and Strategy to the US Army War College and the National Defense University. Prior to joining General Motors, Mr. Doyle held positions with the U.S. Public Health Service, Ford Motor Company and the Management and Organization Development Department of General Motors Institute (now Kettering University). Dr. Doyle served as a teaching fellow for the Hartwick Leadership Institute and was a member of the advisory council for the Academy of Management Executive Magazine. He was a member of the Advisory Board for the Institute for Management Studies as well as member of the National Research Committee for the American Society for Training and Development. 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.

Drotar, Timothy
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 International 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.

Duan, Zhihui
Mr. Duan is currently Chief Engineer, Hybrid Electric Vehicles at Chery Automotive. Previously, Mr. Duan served as Technical Director of Hybrid Electric Powertrains at Changan New Energy Automobile Inc. China, where he was involved with developing full hybrid electric vehicles and plug-in hybrid electric vehicles. He led a program to develop new generation HEVs and works on power system architecture design, product development, powertrain control, and energy management.

Farahani, Akbar
Currently Vice President and Director of Global Engineering (US, EU, Asia) at ETA Inc., Dr. Akbar Farahani, has over 25 years of experience in product design, development and consulting for automotive OEMs and suppliers in US, Europe and Asia. Dr. Farahani is an expert in vehicle development, meeting requirements for US, EU and Asia (FMVSS, IIHS, ECE, ADR regulations) through design optimization and the use of advanced materials. He also has developed advanced expertise in the use of high strength steel, lightweight product design and load management solutions. Dr. Farahani has led the way in the development of ETA’s award winning Accelerated Concept to Product Process (ACP Process). The new product design development process based on CAE, CAD and Optimization received prestigious recognition as the winner of the 2009 SAE/MITEF Vehicle Innovation Competition. To date, he has published more than 50 papers related to product design, optimization, ACP Process, vehicle crashworthiness/safety, and vehicle durability.

Fulton, Wes
Mr. Wes Fulton is the Founder and CEO of Fulton Findings. Prior, he was a program engineer/manager for AiResearch Los Angeles Division, Allied-Signal Aerospace Corporation. As a program engineer for aircraft actuation projects he had engineering and management responsibility for the Indigenous Defensive Fighter (IDF) leading edge flap actuation system (LEFAS) development and production, the Rockwell/MMB X-31A LEFAS flight test program, and the F-16 Fighting Falcon LEFAS production and deployment support. He co-patented a multi-fuseable shaft (high performance drive train device). Additionally, Mr. Fulton has over 20 years of programming experience as a private programmer and developed SuperSMITH®; Visual, WeibullSMITHTM, LogNormSMITHTM, Normal+SMITHTM, VisualSMITHTM, BiWeibullSMITHTM, and MonteCarloSMITHTM 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.

Elnady, Tamer
Tamer Elnady, Ph.D., is currently Associate Professor of Engineering at Ain Shams University, Cairo, Egypt, where he also serves as Head of the Ain Shams University Sound & Vibration Laboratory. Dr. Elnady is President of the Acoustical Society of Egypt. An expert in Duct Acoustics, he is one of the developers of SIDLAB Software for the simulation of sound propagation in duct systems and serves industry as a consultant in Europe, USA, Egypt, and the Gulf region in the field of muffler design, noise control, and environmental acoustics modeling. Dr. Elnady received his B.Sc. and M.Sc. in Mechanical Engineering from Ain Shams University and his Ph.D. in Technical Acoustics from the Royal Institute of Technology (KTH), Stockholm, Sweden.

English, Ed
Mr. English is currently Vice President & Technical Director for Fuel Quality Services, Inc. where he oversees all aspects directly related to the research, development, and deployment of chemicals, antimicrobials and detection equipment for use in the various stages of the petroleum and biomass fuels industry from the refinery to the end user. He is also responsible for evaluating regulatory and industry issues, compliance with federal and state regulations, formulating policy and implementing programs to address regulatory and industry issues, and performing technical reviews and program audits. Mr. English previously worked in the nuclear power industry. He is nationally recognized for his knowledge and expertise in the area of microbial contamination of fuels, alternative fuels, and materials compatibility and has been an invited speaker for such organizations as the EPA, FAA, CALCUPA, NEWWCC, PEI, NISTM, and SAE, DuPont, and Biofuels Americas. Mr. English is also an active member of numerous professional organizations including SAE, IASH, IATA, and ASTM. He has a B.S. in Chemistry from the University of Florida and two years post-baccalaureate work from the University of Miami.

Instructor Biographies

English, Ed
Mr. English is currently Vice President & Technical Director for Fuel Quality Services, Inc. where he oversees all aspects directly related to the research, development, and deployment of chemicals, antimicrobials and detection equipment for use in the various stages of the petroleum and biomass fuels industry from the refinery to the end user. He is also responsible for evaluating regulatory and industry issues, compliance with federal and state regulations, formulating policy and implementing programs to address regulatory and industry issues, and performing technical reviews and program audits. Mr. English previously worked in the nuclear power industry. He is nationally recognized for his knowledge and expertise in the area of microbial contamination of fuels, alternative fuels, and materials compatibility and has been an invited speaker for such organizations as the EPA, FAA, CALCUPA, NEWWCC, PEI, NISTM, and SAE, DuPont, and Biofuels Americas. Mr. English is also an active member of numerous professional organizations including SAE, IASH, IATA, and ASTM. He has a B.S. in Chemistry from the University of Florida and two years post-baccalaureate work from the University of Miami.

Instructor Biographies

Farahani, Akbar
Currently Vice President and Director of Global Engineering (US, EU, Asia) at ETA Inc., Dr. Akbar Farahani, has over 25 years of experience in product design, development and consulting for automotive OEMs and suppliers in US, Europe and Asia. Dr. Farahani is an expert in vehicle development, meeting requirements for US, EU and Asia (FMVSS, IIHS, ECE, ADR regulations) through design optimization and the use of advanced materials. He also has developed advanced expertise in the use of high strength steel, lightweight product design and load management solutions. Dr. Farahani has led the way in the development of ETA’s award winning Accelerated Concept to Product Process (ACP Process). The new product design development process based on CAE, CAD and Optimization received prestigious recognition as the winner of the 2009 SAE/MITEF Vehicle Innovation Competition. To date, he has published more than 50 papers related to product design, optimization, ACP Process, vehicle crashworthiness/safety, and vehicle durability.

Fulton, Wes
Mr. Wes Fulton is the Founder and CEO of Fulton Findings. Prior, he was a program engineer/manager for AiResearch Los Angeles Division, Allied-Signal Aerospace Corporation. As a program engineer for aircraft actuation projects he had engineering and management responsibility for the Indigenous Defensive Fighter (IDF) leading edge flap actuation system (LEFAS) development and production, the Rockwell/MMB X-31A LEFAS flight test program, and the F-16 Fighting Falcon LEFAS production and deployment support. He co-patented a multi-fuseable shaft (high performance drive train device). Additionally, Mr. Fulton has over 20 years of programming experience as a private programmer and developed SuperSMITH®; Visual, WeibullSMITHTM, LogNormSMITHTM, Normal+SMITHTM, VisualSMITHTM, BiWeibullSMITHTM, and MonteCarloSMITHTM 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.

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Mr. Wes Fulton is the Founder and CEO of Fulton Findings. Prior, he was a program engineer/manager for AiResearch Los Angeles Division, Allied-Signal Aerospace Corporation. As a program engineer for aircraft actuation projects he had engineering and management responsibility for the Indigenous Defensive Fighter (IDF) leading edge flap actuation system (LEFAS) development and production, the Rockwell/MMB X-31A LEFAS flight test program, and the F-16 Fighting Falcon LEFAS production and deployment support. He co-patented a multi-fuseable shaft (high performance drive train device). Additionally, Mr. Fulton has over 20 years of programming experience as a private programmer and developed SuperSMITH®; Visual, WeibullSMITHTM, LogNormSMITHTM, Normal+SMITHTM, VisualSMITHTM, BiWeibullSMITHTM, and MonteCarloSMITHTM 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.
Govindswamy, Kiran
Kiran Govindswamy is currently the Chief Engineer, Vehicle & Driveline Systems at the North American Technical Center of FEV, Inc. He is a member of SAE International, serves on the SAE International NVH Conference Committee, and contributes regularly to several automotive publications focusing on vehicle driveline systems and NVH. His educational background includes a Bachelor’s Degree in Mechanical Engineering from the College of Engineering Pune, India and Master’s and Doctoral Degrees from the Pennsylvania State University.

Hall, Jody N.
Dr. Jody Hall is the Technical Integration Engineer for the Body Manufacturing Engineering Center at General Motors in North America. She is responsible for new steel applications and specifications for all stamped steel body components.

Hall, Thomas J.
Thomas J. Hall currently owns and manages MaxG Technology LLC, a technical consulting and training company, specializing in Vehicle Braking and Stability technology, formerly the Chief Engineer for Global Brake Systems - General Motors for the Robert Bosch Chassis Systems Division. Prior to that, he was the Engineering Manager for System Design and Validation at ITT Automotive, Continental Teves. His experience also includes development of ABS, TCS and Stability Control Systems, responsibility for application of system engineering principles and process to the brake industry and development and promotion of brake system proposals and advance braking technologies. Mr. Hall has a B.S. in Materials & Metallurgical Engineering, and a M.S. and Ph.D. in Materials Science and Engineering from the University of Michigan.

Haughey, Bill
Bill Haughey is a respected consultant and instructor in the areas of Failure Modes Effects Analysis, Design for Manufacturability and Assembly, Design Review Based on Failure Modes, Design Review Based on Test Results, and other GD3 methodologies. He is a current member of the issuing committee of the SAE J1739 FMEA standard, SAE Automotive Quality and Process Improvement Committee; the SAE Automotive Electronic Systems Reliability Standards Committee; and the AIAG FMEA Fourth Edition Recommended Practice Committee. Mr. Haughey was recently approved to lead the development of a new SAE DRBFM Recommended Practice (J2886). Mr. Haughey formerly worked for GM, where he held various managerial, manufacturing, and engineering positions including Process Lead and Supervisor for FMEA and DFM/A. While at GM, Mr. Haughey also supported Tatsuhiko Yoshimura in the global implementation of the GD3 (DRBFM) methodology, Yoshimura considers Mr. Haughey to be a subject matter expert in the GD3 methodologies, including DRBFM and DRBTR. Mr. Haughey received a B.S. degree from the University of Michigan and M.S from Central Michigan University, and has the following certifications: Black Belt in GD3 (DRBFM and DRBTR); Master Design for Manufacturability and Assembly Engineer; and Certified Internal Auditor.

Heathcote, Barry W.
Barry W. Heathcote is an individual consultant specializing in training and consulting services on the subject of Geometric Dimensioning and Tolerancing. He has more than 30 years experience in the subject matter and has been a lecturer at both public and in-plant seminars and training programs. Mr. Heathcote has trained more than 15,000 people from well over 1,500 companies, the military, technical and trade schools, universities, and technical societies in the United States, Canada, Mexico, and Europe. He is a former designer, group supervisor and technical coordinator with the Babcock & Wilcox Company, where he worked on the breeder reactor and nuclear reactors for both commercial and military installations. Mr. Heathcote has more than 40 years of industrial experience, is a Certified Manufacturing Engineer, a senior member of SME, and a member of ASME. He has been an active member of the ASME Y14.5 Committee on Dimensioning and Tolerancing since 1982 and is a nationally-recognized expert on its application and interpretation.

Heck, Ronald
Dr. Ron Heck is currently an independent consultant. Prior to that, Ron was a research manager responsible for developing catalyst technology for Engelhard Corporation. He has worked on the development of catalytic processes in SCR NOx, NSCR NOx, automotive catalyst, diesel catalyst, PremAirTM catalyst systems, hydrogenation technology, ozone abatement, volatile organic compound abatement, ammonia oxidation, chemical feedstock purification and chemical synthesis. Ron is a member of American Men and Women of Science and Who’s Who in Technology Today. He is an SAE International Fellow and a recipient of the SAE International Forest R. McFarland. He was a co-instructor for courses for SAE International in automotive emission control catalysis and diesel emission control catalysis. He was a member of the Scientific Advisory Board of the Strategic Environmental R&D Program for environmental studies in the Department of Defense. Ron has been involved in over 80 publications in commercial applications of catalysts and holds 36 U.S. patents on catalytic processes. He is the co-author of the book with Dr. Farrauto entitled “Catalytic Air Pollution Control: Commercial Technology” and is the former co-editor of the NewsBrief section of Applied Catalysis B: Environmental. Ron and his former research team from Engelhard received the 2004 Thomas Alva Edison Patent Award from R&D Council of New Jersey for the invention of close coupled catalyst technology for ultra low emission gasoline vehicles. Ron received his B.S. in Chemical Engineering and his Ph.D. from the University of Maryland.

Herliczek, Siegfried H.
Dr. Siegfried H. Herliczek, a consultant specializing in glass, has worked on glass products for automotive, aircraft, and architectural applications including tempered, laminated, and specialty products. He has extensive experience in research and development and has worked at Union Carbide Corporation, Libby-Owens-Ford, and Pilkington Glass. Dr. Herliczek has written numerous papers, presented glass seminars in several countries, and received 15 glass-related patents. He is a member of SAE International, ACS, and SPE. Dr. Herliczek earned a B.S. from the University of Massachusetts and a Ph.D. in chemistry from Northeastern University.

Herman, Edmund
Mr. Herman is President of Creative Concepts Company, Inc. Prior to establishing his consulting business, Mr. Herman worked for General Motors Corporation where he was responsible for new process development in the areas of draw die development for sheet metal stamping dies, mold development for sheet molding compounds, and
pressure die casting dies and processes. He was instrumental in the shift from physical plaster developments to total CAD design of sheet metal draw die developments. Mr. Herman is also an experienced instructor and served as the Education Director for the Society of Die Casting Engineers (now the North American Die Casting Association). He has taught continuing education courses in die casting, stamping and injection molding through Oakland and Wayne State Universities. Mr. Herman is a registered professional engineer in the state of Michigan and has a Bachelor of Science in Industrial Engineering from General Motors Institute and a Master of Science in Industrial Engineering - Operations Research from the University of Michigan.

Hickman, Jeffrey
Dr. Jeffrey Hickman is a Group Leader at the Virginia Tech Transportation Institute. His primary areas of research include community-wide applications of behavior-based safety, self-management, and organizational culture change techniques, assessing driver behavior, fatigue, work/rest cycles, and driver distraction in commercial motor operations. These research projects include competitive research awards from the FMCSA, NHTSA, Mine Health and Safety Administration, National Transportation Research Center, Inc., Transportation Research Board, Canadian Council of Motor Transport Administrators, and the AAA Foundation for Traffic Safety. He has over 60 presentations, 30 scientific publications and technical reports, scientific reviews for the National Institute for Occupational Safety and Health, and currently serves as a reviewer for the Journal of Occupational Health Psychology, Accident Analysis and Prevention, and Journal of Organizational Behavior Management. Dr. Hickman is also the President of Hickman Management Solutions. He has significant experience in the design, delivery, and implementation of targeted solutions for organizations looking to improve safety, productivity, and performance.

Hoff, Craig J.
Dr. Craig J. Hoff is an Associate Professor of Mechanical Engineering at Kettering University, teaching the areas of thermal and mechanical design, with applications in automotive engineering and biomedical engineering. His research interests include loop heat pipes, electronic and vehicle thermal management, and alternative automotive powertrains. Dr. Hoff is the faculty advisor to the Kettering Formula SAE International racecar team and is the Chair of SAE International’s Powertrain Core and Strategy Department of Ford Motor Company where he is responsible for developing new brake products and system recommended practices. Mr. Johnston’s experience includes that of Chairman and member of the Heavy Duty Brake Manufacturers Council and the Commercial Vehicle Safety Alliance regarding technical products and commercial vehicle practices. Mr. Johnston received a B.S. in Mechanical Engineering from Ohio Northern University, a M.S. in Mechanical Engineering from Cleveland State University, and a M.B.A. from Baldwin Wallace College.

Husain, Iqbal
Dr. Iqbal Husain is currently a Distinguished Professor in the Electrical & Computer Engineering Department at North Carolina State University. Prior to joining NC State, he served as a faculty member at the University of Akron, Ohio for many years, was a visiting Professor at Oregon State University, and also lectured at Texas A&M University. Professor Husain’s research interests are in the areas of control and modeling of electrical drives, design of electric machines, development of power conditioning circuits, microinverters for distributed power generation, inverter controls for grid synchronization, and modeling of electric and hybrid vehicle systems. He has worked extensively on the development of SR and PM motor drives for various automotive and industrial applications. Dr. Husain is currently the Co-Director of the Advanced Transportation Energy Center (ATEC) and a faculty member of the NSF Future Renewable Electric Energy Delivery and Management (FREEDM) systems center at North Carolina State. He is the General Co-Chair for Energy Conversion Congress & Expo (ECCE) 2012 in Raleigh, NC, the chairman of the IEEE-IAS Transportation Systems Committee, and the past chairman of the IEEE-IAS Electric Machines Committee. Dr. Husain received the 2006 SAE Vincent Bendix Automotive Electronics Engineering Award, the 2004 College of Engineering Outstanding Researcher Award, the 2000 IEEE Third Millennium Medal, the 1998 IEEE-IAS Outstanding Young Member award, and several IEEE-IAS prize paper awards. Dr. Husain is an IEEE Fellow and a Distinguished Lecturer for IEEE-IAS during 2012-13. He received a B.Sc. from Bangladesh University of Engineering and Technology, and a M.S. and Ph.D. from Texas A&M University.

Jiao, Jianzhong
Dr. Jianzhong Jiao is an internationally recognized lighting expert for light sources and lighting products design, technology development, testing, industry standards and government regulations. Dr. Jiao has been actively involved in professional and industry organizations and standardization activities. He is the Chairman of the SAE International Lighting Committee, past Chairman of the Next Generation Lighting Industry Alliance (NGLIA), Chairman of the NEMA SSL Section Technical Committee, and active member of IESNA Committees, ANSI-NEMA SSL Working Groups, UL LED Standard Technical Panel, as well as member of CIE, SPIE, IET and other organizations. Dr. Jiao is the SAE International Fellow, and has received several industry awards. Dr. Jiao holds a Ph.D. degree in Electrical Engineering from Northwestern University, a M.S. degree in Applied Physics, and a B.S. degree in Mechanical Engineering. He is entitled to 9 U.S. Patents and has over 20 technical publications. Dr. Jiao currently serves as the Director of Regulations and Emerging Technologies at OSRAM Opto Semiconductors Inc. He also serves as an adjunct professor teaching physics and electrical engineering courses at Purdue University and Lawrence Technological University. He has been teaching SAE International seminars since 2003.

Johnston, Paul
Paul Johnston is Senior Director of Compression and Braking at Meritor WABCO and is responsible for application engineering, product planning and new product development. Previously at ArvinMeritor, Johnston was Senior Director of the North American Foundation Brake Business Unit and Worldwide Director of Product Engineering for the CVS Worldwide Braking Division. He has over 38 years of experience in commercial vehicle air and hydraulic braking systems and products. A member of SAE International, Mr. Johnston was the recipient of the 2007 SAE International Award for Outstanding Technical Committee Service. Mr. Johnston is active in the Truck & Bus Council, Truck & Bus Brake Committee, and related subcommittees to develop new brake products and system recommended practices. Mr. Johnston’s experience includes that of Chairman and member of the Heavy Duty Brake Manufacturers Council. He has been involved in the Technology & Maintenance Council and the Commercial Vehicle Safety Alliance regarding technical products and commercial vehicle practices. Mr. Johnston received a B.S. in Mechanical Engineering from Ohio Northern University, a M.S. in Mechanical Engineering from Cleveland State University, and a M.B.A. from Baldwin Wallace College.

Kang, Stephen
Dr. Stephen Kang is currently a Technical Specialist in the Safety Core and Strategy Department of Ford Motor Company where he is responsible for developing safety methods such as component test methods, CAE methods and best practices. He was responsible for developing a truck program from beginning to production launch, and for meeting safety requirements. Dr. Kang has conducted occupant safety and CAE trainings; designed and conducted extensive dynamic component tests; established several Ford internal component design requirements and is responsible for the establishment of an Occupant CAE database at Ford. Dr. Kang is the recipient of the Henry Ford Technology Award in 2005. He serves as an Advisory Board Member for TNO North America and is a certified six-sigma black belt. Dr. Kang has a Ph.D. in Biomechanics from Wayne State University.

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Khair, Magdi
Dr. Magdi Khair currently holds the position of Chief Technologist at Watlow, where he is assisting with the introduction of new technologies for the diesel engine industry. Dr. Khair recently retired from the position of Institute Engineer in the Engine, Emissions, and Vehicle Research Division at Southwest Research Institute. He is experienced in the areas of engine testing and exhaust emissions control. His prior experience was with AlliedSignal Automotive Catalyst Company with the development of catalytic aftertreatment for light-duty and heavy-duty diesel engines; Ford New Holland with primary responsibility for the development of the 6.6 and 7.8 liter midrange diesel engines to meet 1991 emissions standards; Bendix Diesel Engine Controls where he led the development of advanced electronically controlled diesel fuel injection systems and also established several cooperative engineering programs with European and North American engine manufacturers; and with Chrysler Corporation where he converted the slant six gasoline engine into an open chamber, pilot injected, and electronically controlled diesel engine, supervised a combustion kinetics project, and participated in the design and development of electronic controls for a passenger car turbine engine. Dr. Khair holds 20 U.S. patents in electronic fuel injection, turbocharging, exhaust gas recirculation, and aftertreatment systems. He has also authored and co-authored numerous SAE International and ASME papers. Dr. Khair is the co-author of the Diesel Emissions and their Control a text book marketed by SAE International. Dr. Khair received a B.S. in Automotive Engineering from Ain Shams University, an M.S. in Thermodynamics from the University of Birmingham, England, an M.B.A. from Michigan State University, and a PhD in Engineering Management from Warren National University.

Kipers, Kenneth
Dr. Kenneth Kipers has over 25 years of experience in additive synthesis, fuels, formulation, field testing, and customer service, is a Certified Lubrication Specialist and is currently involved in the consulting and training field specializing in fuels and lubricants. He is an adjunct professor at Richland College in Dallas and an instructor for Dale Carnegie courses, as well. Dr. Kipers has been an expert witness in many cases involving gasoline, diesel, and aviation fuels. He is also an active member of ACS, SAE International, and STLE. Dr. Kipers received a B.S. from San Diego State University and a Ph.D. in physical organic chemistry from the University of California-Los Angeles.

Konstandopoulos, Athanasios
Dr. Athanasios G. Konstandopoulos, recipient of the 2006 Descartes Laureate, is the founder and head of the Aerosol and Particle Technology Laboratory (APTL), a well-known European diesel emission control laboratory at the Chemical Process Engineering Research Institute (CPERI/CERTH) in Thessaloniki, Greece. In 2006, he was elected as Director of CPERI and member of the Board of Directors of the National Centre for Research and Technology-Hellas (CERTH). Since 2006, he has also been a member of the faculty of Chemical Engineering at Aristotle University in Thessaloniki. Dr. Konstandopoulos is a specialist in combustion aerosols and nanoparticles and he has extensive research and engineering consulting experience in the design, modeling, and testing of diesel particulate filter systems and monolithic reactors. 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.

Kosinski, John
John Kosinski is a User Interaction Technical Professional at Visteon Corporation. Mr. Kosinski has 25 years user interaction design experience ranging from automated test and machine tool equipment to emergency vehicle and in-vehicle infotainment systems. He holds multiple patents in controls and user interfaces and brings extensive experience in systems, hardware and software engineering, graphic design and human factors applied to the development of innovative user interface solutions.

Kuhn, Robert (Skip)
Mr. Kuhn is currently a Managing Engineer for JP Research where he manages a technical consultancy for a variety of clients including automotive OEM’s and suppliers. Prior to becoming a consultant, Mr. Kuhn worked for both Ford and Chrysler in a variety of positions that included engine related projects including single failures, multiple failures, class action suits, and individual engine operational and reliability issues, as well as engine testing and development, fleet testing of prototype engines, vehicle chassis and engine packaging, and overall vehicle platform development including engine systems. He holds a B.S. in Mechanical Engineering from Carnegie Mellon University and an M.S. in Automotive Systems Engineering from the University of Michigan Dearborn and is also a licensed Professional Engineer in the State of Michigan.

Kurowski, Paul
Dr. Paul Kurowski is a professor in the Department of Mechanical and Materials Engineering at the University of Western Ontario. His teaching experience includes finite element analysis, machine design, mechanics of materials, kinematics and dynamics of machines, and product development. He is also the President of Design Generator Inc., a consulting firm specializing in product development, design analysis and training in Computer Aided Engineering methods. Dr. Kurowski has published multiple technical papers and taught professional development seminars for SAE International, the American Society of Mechanical Engineers, the Association of Professional Engineers of Ontario, the Parametric Technology Corp. (PTC), Rand Worldwide, SolidWorks Corp. and other companies and professional organizations. He contributes regularly to several engineering publications focusing on the implementation of CAE methods into the product development process. He is a member of SAE International and the Association of Professional Engineers of Ontario. Dr. Kurowski obtained his M.Sc. and Ph.D. in Applied Mechanics from Warsaw Technical University and completed postdoctoral work at Kyoto University.

La, Chi Binh
Chi Binh La is the Business Unit Director, Gasoline and Alternative Fuels, IAV Inc. Chi Binh has over 15 years of experience in engine development covering NVH, mechanical development and calibration, as well as analysis and simulation. In 2012, he joined IAV where he is responsible for the strategic vision and profitable growth of the business unit. Technically the business unit is responsible for the development of gasoline and alternative fueled engines including base engine calibration to vehicle drivability, emissions and OBD. Chi Binh holds a Bachelor’s Degree in Mechanical Engineering from University of Waterloo and a Master’s Degree in Engine Systems from University of Wisconsin.

Lundstrom, Richard
Dr. Richard Lundstrom is an independent research and project engineer specializing in dynamic system engineering, automotive chassis development, and application of the science of improvement. He teaches Chassis Design, Systems Analysis and Mechanical Control Systems at Kettering University, where he also served as team leader for the annual Kettering Industry Symposium. Dr. Lundstrom previously taught several mechanical engineering courses, developed Vehicle Dynamics and Thermal System Design courses, and founded
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directed the Vehicle Dynamics Lab at Lawrence Tech. He has worked as a product engineer with Ford Motor Company and developed and taught a Fundamentals of Vehicle Design course. Dr. Lundstrom is a member of SAE International, ASME, ASQ, ASE and SCCA. He received a B.S. in Mechanical Engineering from the University of Illinois, a M.S. from the University of Michigan and a Ph.D. from Oakland University.

Mango, Angelo E.
Angelo Mango is senior consultant and owner of ATM Consulting, Inc., which provides customized training and consulting services to the supplier community in the areas of quality assurance, quality control, design engineering, document management, and customer service and improvement methods. He has over 25 years of experience in product design, quality assurance, project management and most recently worked as the Senior Supplier Quality Engineer for GM Truck Group responsible for PPAP qualification and approval. Mr. Mango is a recipient of the SAE International Forest R. McFarland Award for distinction in professional development/education. He has a B.S. in Mechanical Engineering from Florida Institute of Technology.

Malburg, Mark
Dr. Malburg is the president of Digital Metrology Solutions, Inc where he provides dimensional and surface metrology consultation and develops analysis and control algorithms, software and custom instrumentation. He is also the president and chief software architect of Verified Technologies – the creators of the award-winning BrakeView® system for the measurement of rotating components and is an adjunct associate professor of engineering at the University of North Carolina at Charlotte. He is currently a member of the ASME B46.1 “Surface Texture” standards committee, a member of the B89 committees for “Roundness”, “Straightness” and “Flatness”, and is a United States Subject Matter Expert for several ISO committees under ISO/TC213 for surface and form metrology. Dr. Mark Malburg holds a B.S. and M.S. in Mechanical Engineering from Michigan Technological University. His graduate work at Michigan Tech addressed the characterization of plateaumed surfaces and the approach he developed was later adopted as an International Standard. He completed his Ph.D. at the University of Warwick researching problems in instrument correlation in surface metrology applications.

Masiak, James
James Masiak has more than 25 years of experience in the implementation of business processes for General Motors. Mr. Masiak’s most recent activities include the implementation of an enhanced engineering product cost management process within GM North America, the alignment of cross functional organizational initiatives, and development of an engineering resource allocation plan for GM Regions. Mr. Masiak was also responsible for the development and implementation of Global Engineering and Business Strategies across all of General Motors International Operations. Mr. Masiak received his B.S. in Mechanical Engineering from Wayne State University, his M.S. in Mechanical Engineering from Massachusetts Institute of Technology, and his M.B.A. from Michigan State University Executive Management Program.

Masoudi, Mansou
Dr. Mansour Masoudi is Manager, Advanced Powertrain Technology, at Paccar Technical Center. Throughout his career, he has carried out various engineering responsibilities working on gasoline and Diesel emission control components and systems, spray injection, thermodynamic processes, engine testing, simulation and math modeling of emission reduction components and energy systems. He formerly held product Research and Development responsibilities at Corning Inc., Delphi Corp. and at Bosch Diesel Systems. Dr. Masoudi holds a M.S. in Mechanical Engineering, M.S. in Management and a Ph.D. in Mechanical and Aerospace Engineering.

Matthews, Ronald D.
Professor Ron Matthews, currently serving as a member of the SAE International Board of Directors, is Head of the General Motors Foundation Engines Research Laboratory on the campus of the University of Texas at Austin. He has been actively involved in engines research for 35 years, including engine control systems since the initial introduction of on-board computers. Dr. Matthews, a Fellow of SAE International, founded the Formula SAE competition in 1981 and has been the Faculty Advisor for a Formula SAE team each year since. He has been author or co-author on over 200 technical papers and reports, mostly in the field of engines.

McVea, William Mark
Dr. William Mark McVea, P.E., is currently Chief Technology Officer for Torvec, Inc., an industry leader in the design and development of patented powertrain engineering technology used primarily in the automotive industry. He is also President and Principal Engineer of KBE+, Inc. where Dr. McVea and his team design and develop complete powertrains for automotive and off-highway vehicles. His prior positions include Professor of Vehicle Dynamics and Powertrain Sciences in the Mechanical Engineering Department at the Rochester Institute of Technology and adjunct professor at Purdue University in their Automotive Sciences Department. He was also formerly a manager of the CAE group within a tier-one powertrain supplier to global automotive markets, a consulting engineer in vehicle dynamics with Gear Consultants, Inc., and a project manager of traction systems for off-highway vehicles with Clark-Hurth International. Dr. McVea has published extensively on the topics of transmission systems, automated design assistant systems, knowledge systems and knowledge based engineering in general. He also holds or is listed as co-inventor on numerous patents related to mechanical power transmissions. Dr. McVea holds a B.S. in Mechanical Engineering from the Rochester Institute of Technology, a Ph.D. in Design Engineering from Purdue University and is a licensed Professional Engineer.

Miller, Joseph D.
Since 2005, Joe Miller has served as the chairman of the United States Technical Advisory Group to ISO TC22/SG3/WG16, which is developing ISO 26262: Road Vehicles - Functional Safety. This was recognized by the SAE International Technical Standards Board Outstanding Contribution Award. He is the Chief Engineer of Systems Safety at TRW Automotive responsible for the systems safety process. Prior to this, he has managed systems engineering, manufacturing planning, and program control for electric steering. He has also engineered communication, avionics, infrared, and radar systems, as well as and thick and thin film components. Joe has 20 US patents, a Master of Engineering (EE) and a Master of Business Administration.

Nazri, G. Abbas
Dr. Nazri is currently the technical director of new technologies at Frontier Applied Sciences and Technologies, LLC. and is also an adjunct professor of Physics and Chemistry at Wayne State University, Oakland University, and University of Windsor, Canada. Dr. Nazri began his career as a Research Scientist at General Motors Global Research and Development Center after two years of postdoctoral fellowships at the Lawrence Berkeley National Laboratory. He also served as a visiting Professor at the University of Pierre and Marie Curie, Paris France, Institute of Condense Matter Chemistry at Bordeaux France, and Institute of Materials at Nantes, France. He is an active organizer of Symposia on advanced batteries and is on the International Science Advisory Board of several Lithium Battery Meetings and Conferences. Dr. Nazri has published over 100 scientific papers, 12 proceedings volumes, two text books on science and technology of lithium batteries, and is the holder of 15 U.S. patents. His research interests are in the area of materials for advance batteries for transportation applications, supercapacitors, solid-
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state hydrogen storage materials, electrochemical catalysis, synthesis of novel materials, and advanced analytical techniques for real time study of electrochemical systems. Dr. Nazri received his Ph.D. in Physical Chemistry from the Center for Electrochemical Sciences, Case Western Reserve University.

**Palazzolo, Joseph**

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. His prior professional experience includes all-wheel systems design and development, power transfer unit and transfer case design, and torque management device development at Visteon Corporation, Warn Industries, and Ford Motor Company. Mr. Palazzolo is an ASE certified Master Technician, chaired the SAE International All-Wheel Drive Standards Committee, and has been an active SAE International member since 1990. He is a past recipient of the SAE Forest R. McFarland Award for distinction in professional development and education (2007) and also achieved the SAE Master Instructor designation (2010). Mr. Palazzolo is the award winning author of High-Performance Differentials, Axles & Drivelines. He has designed, built, campaigned and supported various race cars and teams for both professional and amateur racing organizations. His scope of work has been entire vehicle inclusive but also focused on competitive, high-performance drivetrain systems. He holds a Bachelors degree in Mechanical Engineering from Cleveland State University and a Masters degree in Automotive Engineering from Lawrence Technological University. He has received numerous patents for his work and creativity in advancing mobility systems.

**Park, Talus**

Talus Park is the Calibration Skill Team Leader at AVL Powertrain Engineering based in Plymouth, Michigan. He is responsible for diesel and gasoline engine calibration, transmission calibration as well as certification services throughout North America. His team is focused on utilizing innovative tools and methods to deliver high quality calibration projects with maximum efficiency. Mr. Park has over twelve years of experience in the transportation industry focused on calibration. He earned both his Bachelor’s and Master’s degrees in mechanical engineering from West Virginia University.

**Piacenti, Vincent**

Mr. Piacenti is Senior Manager at Robert Bosch LLC in Farmington Hills, Michigan and is responsible for Diesel Fuel Injection Hydraulic Systems Integration for North American diesel-engine applications. This encompasses simulation, adaptation and testing of high-speed, high-pressure fuel injection systems, concentrating on Common-Rail systems, both solenoid-valve and Piezo. Included is research of alternate fuels for diesel engine applications. Experienced in all types of diesel fuel injection and various gasoline systems, Mr. Piacenti is a contributing author to the Springer Handbook for Mechanical Engineers. Mr. Piacenti holds a B.S. in Mechanical Engineering and has been with Bosch for over thirty years, seven of which were at the Bosch Headquarters for Diesel Fuel Injection in Stuttgart, Germany.

**Pike, Jeffrey A.**

Jeffrey A. Pike is President, Biomechanics Consulting, Inc. and Adjunct Professor, Biomedical Engineering, Wayne State University. He previously held the position of Senior Technical Specialist, Occupant Injury/Biomechanics, Ford Motor Company, from which he recently retired. He has extensive professional experience in biomechanics, injury mechanisms and causation, occupant protection, testing, regulatory requirements and regulatory process and medical records review. Mr. Pike has organized and presented at numerous technical forums, including sessions at two White House Conferences as well as SAE International Symposia on Vehicle Rollovers, Occupant Protection and Lower Limb Injuries. He has also taught SAE International regulatory and forensics seminars for 21 years and has been a guest lecturer at MIT, the Medical College of Wisconsin, the University of Michigan, Harvard Medical School and the University of Virginia. Mr. Pike is an SAE International Fellow and received the Forest R. McFarland Award in 2004 for his contributions to SAE International professional development activities. His publications include technical papers, book chapters and principal author of two textbooks published by SAE: Automotive Safety: Anatomy, Injury, Testing and Regulation and Neck Injury: The Use of X-Rays, CT’s and MRI’s to Study Crash-Related Injury Mechanisms. His educational background includes studies at Polytechnic Institute of Brooklyn, New York University and the University of Michigan.

**Porter, Alexander (Alex) J.**

Alexander J. Porter is the Chief Engineer for Programs, Performance, and Durability at Intertek, and has been with the company since 1992. Since 1996, he has been developing accelerated testing methods for mechanical components and systems. Mr. Porter has three patents relating to accelerated testing equipment and has authored over 40 articles and technical papers on accelerated testing. Alex is the author of the book Accelerated Testing and Validation, Elsevier 2004. 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. Alex 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.

**Rakouth, Heri**

Heri Rakouth, Ph.D., is Manager, Technology Exploration at the Innovation and Technology Office (ITO) of Delphi Corp. in Troy, MI. In this capacity, he coordinates technology innovation activities across three out of the five divisions of Delphi. He spearheaded cross-divisional efforts that have led to the build of the telematics business development team for the aftermarket and the launch of the V2X proof of concept project currently implemented for the Land Transport Authority of Singapore.

Dr. Rakouth has about 30 years experience in both aerospace/defense telecommunications and automotive electronics industries. He has held various responsibilities at Thomson CSF/Thales and Renault in France as product engineer and technical manager before joining Delphi in 1996. Dr. Rakouth is also an adjunct professor at Oakland University teaching undergraduate and graduate classes in Power Electronics and Wireless Communications. Dr. Rakouth has published over 20 IEEE or equivalent technical papers and tens of classified and non-classified reports. He holds several U.S. and European patents. He holds MS and PhD degrees in Electrical Engineering, from the University of Pierre and Marie Curie (UPMC) of Paris (1979 and 1982) along with an MBA from Saginaw Valley State University (1999) and an MS in Manufacturing Management from Kettering University (2000).

**Ranganathan, Raj P.**

Dr. Raj Ranganathan is well known for his expertise in heat transfer. Prior to his current position, he was a Director at CD-Adapco. In addition, Dr. Ranganathan worked for General Motors and Caterpillar in the U.S. primarily in gasoline and diesel engines. He received GM’s highest award for innovation, the 2007 Boss Kettering Award. He has been associated with SAE International for 20 years and received the Forest McFarland Award in 2006. Raj has co-authored over 40 papers, patents, pending and proprietary research reports. Dr. Ranganathan received both a M.S. and Ph.D. in Mechanical Engineering with specialization in the area of heat transfer from Purdue University.
INSTRUCTOR BIOGRAPHIES

Reddy, Sam
Dr. Reddy is the owner of Evaporative Emissions Consulting, Inc., which was formed in 2009 after Sam’s retirement from General Motors R&D Center. He has 30 years of experience in fuels and fuel vapor emission control research and development. Dr. Reddy has been working on evaporative emission research and development with significant research in the area of diesel fuel cold temperature wax plugging problems and diesel fuel stability. He holds twenty six U.S. patents and has authored ten SAE International papers in the same field. Dr. Reddy obtained his B.S. CHE from Osmania University in India, M.S. CHE from UCLA, and Ph.D. CHE from the University of Michigan and is a licensed engineer in the state of Michigan.

Reinhart, Thomas
Thomas Reinhart is a Program Manager for NVH in the Engine, Emissions, and Vehicle Research division of Southwest Research Institute. Previous roles include Senior Manager for NVH at Visteon Chassis Systems, where Mr. Reinhart was responsible for the NVH analysis and development of axles, drive shafts, and power steering systems. From 2001 to 2004, he was NVH Program Manager at Roush Industries, Inc. where he was responsible for NVH testing and development of diesel and gasoline engines, as well as transmissions, axles and accessories. Diesel fuel system noise was a special focus of this work. Prior to Roush, he was Director of Noise & Vibration Technology at Cummins, Inc. Mr. Reinhart has been involved in solving noise and vibration issues in engines, as well as in a wide variety of engine applications, including pickup trucks, heavy duty trucks, construction equipment, and marine. Mr. Reinhart has developed noise reduction features for diesel engines, four of which have been patented. He has published 15 technical papers on Powertrain NVH topics. Mr. Reinhart received his B.S. and M.S. in mechanical engineering from Purdue University. He also spent a year studying automotive engineering at the Technical University of Hannover, Germany. His master’s thesis focused on the application of acoustic intensity measurements to diesel engines.

Rosebro, Jack
Jack Rosebro has taught hybrid, plug-in hybrid, and electric vehicle technology to a wide variety of automotive industry professionals for the past ten years. Since 2006, he has developed and delivered curriculum for Perfect Sky, Inc. throughout the US and Canada. He also consults to community colleges that are integrating hybrid and electric vehicle technology into their curricula. Jack writes about hybrid technology, regulatory issues, and sustainable mobility for Green Car Congress, and is a frequent speaker at industry conferences. Previously, Jack developed and taught courses on hybrid and electric vehicles, air/fuel systems, OBD-II self-diagnostic systems, and emission control systems. He received his M.Sc. in Engineering from Blekinge Institute of Technology in Sweden.

Roslund, Jerry L.
Dr. Jerry Roslund is an independent consultant specializing in the Design of Experiments (DOE) and Reliability Methods. Prior to retiring from GM, he provided leadership as a GM Technical Fellow for Statistical Methods and Reliability and as a Validation Technical Integration Engineer at GM North America Vehicle Engineering. Specifically, Dr. Roslund conducted seminars on the Key Aspects of Quality, Reliability and Durability (GRD), Weibull Analysis, and Design of Experiments (DOE) for leaders and engineers within both GM and GM Suppliers. Dr. Roslund joined General Motors at Detroit Diesel Allison, transferred to Saturn, and retired from GM in 2007. Dr. Roslund spent 24 years at General Motors solving problems using statistical methods and providing in-house consulting on a daily basis. He also developed numerous course textbooks and conducted over 200 seminars providing a wealth of experience and a vast number of case studies. Dr. Roslund is a member of SAE International, ASQ, and the Society of Reliability Engineers. He received his B.S. degree in Mechanical Engineering from the University of Nebraska, M.S.M.E. from Cleveland State University, and Ph.D. in Systems Engineering from Oakland University.

Ruth, Richard R.
Mr. Ruth is currently president of Ruth Consulting LLC which specializes in passenger car and light truck Event Data Recorders and restraint systems performance in crashes. He has 10 published papers on EDR accuracy and assists civil attorneys and prosecutors in Frye and Daubert hearings to get EDR data admitted in court. He has taught over 30 classes in EDR imaging and data analysis to law enforcement and private reconstructionists, and is a regular speaker at national and regional crash reconstruction conferences. He is a beta tester for new releases of the Bosch Crash Data Retrieval system. Mr. Ruth is a member of the SAE J698 Event Data Recorder Committee, and a member of ISO’s EDR related TC22/SC12/WG7, and a former member of the ASTM 4150 group that developed an EDR procedure. Prior to consulting, Mr. Ruth worked 33 years for Ford Motor Company, and during his last 10 years managed the engineers who did field investigations of safety system performance in real world crashes including EDR imaging and analysis, and championed the release of Ford EDR data to the Bosch Crash Data Retrieval system, personally writing some of the data limitations. He handled law enforcement requests for EDR readout assistance, was a member of Ford’s EDR policy committee, was Ford’s representative to the SAE EDR standards committee, and helped shape Ford and Auto Alliance responses to NHTSA on Part 563 EDR legislation. Mr. Ruth has a B.S. in Electrical Engineering from Michigan Technological University and an M.B.A. from the University of Michigan Ross Business School, and is a registered professional engineer.

Saha, Pranab
Pranab Saha is the principal consultant and co-founder of Kolano and Saha Engineers, Inc., an independent professional engineering and consulting company in acoustics, noise and vibration control. A well-known authority on automotive noise control and body interior systems, Dr. Saha has directed and participated nationally and internationally in numerous advanced noise control engineering programs and training seminars for various OEMs and suppliers in India, Mexico, and USA. Dr. Saha is currently the Chair of the SAE International Engineering Meetings Board, a Professional Development Instructor, and the Lead Faculty Member of the SAE International Vehicle Interior Noise Academy. He is also the past-chairman of the SAE Acoustical Materials Committee and has helped develop several standards in acoustics. Dr. Saha is an active member of ASA, ASME, ESD, INCE, NSPE, SAE International, and a contributing editor of Sound and Vibration publication. He has presented technical papers, organized and chaired numerous technical sessions sponsored by SAE International and other professional organizations. Dr. Saha has also won several awards presented by the SAE International and the Michigan Society of Professional Engineers (MSPE) and has been named an SAE Master Instructor. Dr. Saha holds a B.S. in Mechanical Engineering from the University of Calcutta, a M.S. in Engineering Sciences from the University of Florida and a Ph.D. in Mechanical Engineering (Acoustics Specialty) from the Georgia Institute of Technology.

Schmid, Steven R.
Dr. Schmid is an Associate Professor at the University of Notre Dame, where he conducts research and teaches courses in manufacturing, metal forming, tribology and design. Prior to joining academia, Dr. Schmid was a project engineer at Triodyne, Inc., a consulting firm specializing in machine and manufacturing/product consulting with a special emphasis on safety. As such, he has visited hundreds of manufacturing facilities as diverse as sugar cane plants in Hawaii to battery factories in Vermont, and has been a consultant to industry and
government. He is a past recipient of the Society of Manufacturing Engineers John T. Parsons Outstanding Young Manufacturing Engineer Award, has won numerous teaching awards, and was named a Kaneb Center Teaching Faculty Fellow at the University of Notre Dame in 2003. Dr. Schmid has organized numerous conferences, and has written over 80 technical papers and eight books and book chapters. He holds a Professional Engineer’s license and is a Certified Manufacturing Engineer. Dr. Schmid is a graduate of the Illinois Institute of Technology and Northwestern University.

Seyboldt, Charles F.
Mr. Charles Seyboldt has degrees in Mechanical Engineering and Law. He has over 15 years of experience in the transportation industry, having engineering responsibilities covering a broad range of product and manufacturing technologies. He is a registered Professional Engineer and a registered patent agent.

Shahed, S. M.
Dr. S. M. Shahed is Corporate Fellow at Honeywell Turbo Technologies, a business unit of Honeywell International, where he has developed and applied advanced boosting technology to reduce emissions and improve the fuel economy of gasoline and diesel engines for passenger cars, commercial vehicles and equipment. He previously worked for Cummins Inc. and Southwest Research Institute and held faculty positions at the University of California and the University of Texas. He is a Fellow of SAE International, ASME and the Institution of Engineers. Dr. Shahed served as 2002 President of SAE International. He has received several prestigious international awards including the I Mech E James Clayton Award, the SAE International Hoening Memorial Award, the SAE International 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.

Simula, Glen
Mr. Glen Simula is President and CEO of GS Engineering, Inc., a company he founded in 2001 to provide lightweight vehicle technology to the military and commercial vehicle sectors. Mr. Simula’s expertise includes tactical vehicle design and development, structural optimization of lightweight components for military vehicles, and dynamic analysis and simulation of tracked and wheeled vehicles. His program experience includes Lightweight Military Track, MRAP Development, and FMTV Development. Prior to founding GS Engineering, Mr. Simula was a Senior Research Engineer at the Keweenaw Research Center – Michigan Technological University where he was the program manager for military vehicle design and analysis and the subject matter expert for military vehicle suspensions. Prior to joining Michigan Technological University, he was a Senior Staff Stress Analyst for Bechtel Power Corporation where he conducted finite element analysis of Class I nuclear systems. Mr. Simula received his B.S. Mechanical Engineering from Michigan Technological University and a M.S. Mechanical Engineering from the University of Michigan-Ann Arbor.

Sittsamer, Murray
Murray Sittsamer is founder of Luminous Group, a consulting firm specializing in streamlining and standardizing workflow for companies. Murray has over 22 years experience in operations management, strategic planning, new process launches, financial analysis, quality systems and process improvement. During the past ten years Murray has focused his work on supporting automotive OEMs and suppliers with their quality and productivity improvement efforts, especially in the areas of Advanced Product Quality Planning (APQP), Failure Mode and Effects Analysis (FMEA), variation reduction and Problem Solving. Before entering the consulting field in 1994, Murray served as director of distribution support and quality systems for Gelman Sciences. While there he led a successful 15-month effort to obtain ISO 9000 quality system registration and had the role of project manager for a highly publicized groundwater contamination dispute. Murray earned his undergraduate degree in industrial engineering from the University of Pittsburgh and holds a Master of Science in Industrial Administration from Carnegie Mellon University.

Sozer, Yilmaz
Dr. Sozer is currently on the faculty of the Electrical and Computer Engineering Department at the University of Akron where he is developing a research and teaching program on Alternative Energy Systems. His research interests are in the areas of control and modeling of electrical drives, alternative energy systems, design of electric machines, integrated and belt-driven starter/alternator systems, high-power isolated DC/DC converter systems, large industrial static power conversion systems that interface energy storage and distributed generation sources with the electric utility. Dr. Sozer previously worked at Advanced Energy Conversion in Schenectady NY and developed expertise in all aspects of electronic power conversion and its control. He has been involved in IEEE activities which support power electronics, electric machines and alternative energy systems. He is serving as an associate editor for the Transaction on IEEE IAS Electrical Machine Committee and secretary for the IEEE IAS Sustainable and Renewable Energy Systems Committee. Dr. Sozer received his B.S. in Electrical Engineering from the Middle East Technical University Ankara, Turkey and his M.S. and Ph.D. in Electric Power Engineering from Rensselaer Polytechnic Institute.

Speirs, Robert G.
Robert Speirs is Associate Professor of Plastics Programs at Ferris State Univ. Additionally, Speirs instructs many plastics engineering technology seminars covering material selection, product design and advanced plastics processing. Along with his vast teaching experience, Speirs brings practical industrial experience from his work with Baxter Travenol Laboratories and Dow Chemical. Speirs also has taught continuing education seminars in injection molding, mold design and injection molding troubleshooting for molders throughout North America and in Singapore and Hong Kong.

Spek, Erik J.
Mr. Spek is Chief Engineer for TÜV SÜD Canada, a member of the global TÜV SÜD third party testing services organization for cell and battery manufacturers, vehicle OEMs and utility grid users of energy storage systems. He is also a consultant in the field of energy storage systems focusing on applications, verification testing, cell and battery production facilities safety and sodium ion battery development. Mr. Spek is co-holder of a patent for next generation sodium metal chloride architecture for low cost and very high energy density. He has authored articles on Weibull statistics for battery life and BEV range modeling and has been active in the battery industry since 1984. Mr. Spek is a member of SAE International and is a Certified Manufacturing Engineer with SME. He received an M.A.Sc. from the University of Waterloo and is a registered Professional Engineer in Ontario, Canada.

Spence, W. Cory
Cory Spence is a trial lawyer and registered patent attorney with Kirkland’s IP litigation group in Chicago, IL. During his career, he has established a record of success in litigation, arbitration and mediation involving all areas of intellectual property law. He has won, or favorably resolved, patent, trade secret, contract, unfair competition and related antitrust claims in state and federal courts throughout the United States. Cory has extensive experience with complex, international patent litigation involving multiple parties and jurisdictions, including Asia. Cory is actively involved in a number of professional organizations, including the Richard Linn American Inn of Court and the Licensing Executives Society. He is a published author and frequent
speaker on intellectual property issues. He has also spoken at numerous legal seminars and conferences, including IBC's International Patent Litigation conference and conferences held by LES USA & Canada, LES Scandinavia, and LES International. Since 2001, Cory has been registered to practice before the United States Patent and Trademark Office. During his career, he has been repeatedly recognized as an “Illinois Rising Star,” in the area of intellectual property and he maintains a BV® Martindale-Hubbell Peer Review Rating, the highest rating possible for a lawyer of his seniority. He is also a Certified Licensing Professional (CLP). Cory is a graduate of the University of Houston Law Center. Prior to joining Kirkland & Ellis, he obtained separate Bachelor of Science Degrees in Chemical Engineering and Biophysics (“Physics in Medicine”) from the University of Notre Dame.

**Timmis, Eric**

Eric Timmis is the owner of BusinessIsAContactSport.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. Mr. Timmis has over thirty years of diversified experience across several industries, which includes the delivery of value engineering facilitation services to Ford Motor Co. and its supplier community and training for Eaton Corporation's, Product Development Group. He is also a recognized speaker at various national conferences. Eric received a B.Sc. in Civil Engineering from the University of Birmingham in England and is a member of the Institution of Civil Engineers.

**Tschirhart, Michael**

Michael Tschirhart is a Human Factors Technical Fellow and Human-Machine Interaction (HMI) R&D Manager at Visteon Corporation where he is responsible for the development of advanced HMI product concepts and intellectual property; and directing global advanced user research activities. Dr. Tschirhart joined Visteon Corporation in 2000 and has since held leadership roles in marketing, research and advanced product development. Prior to Visteon, he held positions in market research, organizational development and process improvement at Ford Motor Company. He is a certified Six Sigma Master Black Belt and holds a master's degree in Statistics and a doctorate in Cognitive Psychology, both from the University of Michigan. He has taught at the College for Creative Studies in Detroit and the Ross School of Business at the University of Michigan in Ann Arbor.

**Tuteja, Arjun D.**

Dr. Arjun D. Tuteja has over 28 years of industry experience, mostly in advanced development of diesel engine systems. At Detroit Diesel Allison (a Division of General Motors), and later at GM Powertrain, Dr. Tuteja 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.

**Vakili, Mohammad**

Mr. Vakili is currently a consultant in the friction material industry. Throughout his career he has held numerous positions including the Vice President of Technology & International for Fritec; Director & VP of Technical Services in the friction material industries and various related industries including Wagner Automotive, HKM, ITT, and Continental. He has traveled extensively around the world and visited most “who’s who” of the friction manufacturing industries in order to select the best suitable products for a given OE or OES application. Mr. Vakili recently was a co-publisher of a research work on Automotive Wheel Dust Evaluation & Testing with Ford Motor Co. and Link Engineering. He has been a speaker and chairperson at the Brake Colloquium, FMSI, and BMC and has taught a course in “Friction Material Topics” for Continental Automotive System employees in the U.S. and Europe. A member of AIChE and SAE International, Mr. Vakili has a B.S. and M.S. in Chemical Engineering from the University of Massachusetts.

**Van Gilder, John**

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. Prior to that, Mr. Van Gilder was a Product Assurance Engineer at Delphi where he focused on improving design and manufacturing process reliability, including implementation of quality tools such as design of experiments, quality function development, statistical process control, etc. for spark plugs and exhaust oxygen sensors. Mr. Van Gilder was also a Commissioned Officer in the United States Navy working in materials research and development. 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.

**Vannoy, E. Harold**

Mr. Vannoy currently is a consultant specializing in product design assurance, process design assurance, and reliability engineering. He began his career with General Motors Delco Electronics Division, establishing a product assurance group for computer systems, then he served as supervisor of reliability and service activities at GM Emission Control System Center, supervisor of electrical and electronic groups in the Reliability Engineering Department for Cadillac Motor Car Division, and Manager of Product Assurance at AC Spark Plug Division, where he also established an on-site master’s degree program in reliability engineering.

Mr. Vannoy serves on the SAE International Reliability Committee and has established reliability engineering courses with several universities. He earned a B.S. and M.S. in Electrical Engineering from the University of Missouri-Rolla and is a Registered Professional Engineer in the state of Indiana, a Certified Reliability Engineer, and a member of Eta Kappa Nu, SAE International, SRE, IEEE, and ASQ.

**Walker, R. W. (Bill)**

Bill Walker is the owner and principal engineer at Walker Technical Services where he provides consulting services in design, testing, and certification for manufacturers and operators of aerospace and mobile equipment throughout North America, Europe, and Asia. Mr. Walker has almost four decades of experience in test engineering, regulatory compliance engineering, and product safety engineering. Mr. Walker previously held the position of Manager of Safety and Compliance at John Deere Forestry, Inc., where he oversaw safety engineering, regulatory compliance, product liability management, intellectual property management, and standards development activities for the world-wide manufacturer of advanced forestry equipment. Additionally, Mr. Walker held the positions of Manager of Testing at Diamond Aircraft Industries, Director of Engineering, Manager of Flight Testing, and Test Engineer at Eurocopter Canada, Ltd. He is currently a member of SAE International MTC4 (forestry machinery), ISO TC23/SC15 (Forestry Machinery), TC23/SC3 (Safety and comfort of the operator), and TC23/SC14 (Operator Controls, Operations Symbols and other displays, and Operator Manuals). He has also served on Canadian Standards Association Technical Committees on Mobile Forestry Machines and Rollover Protective Structures. Mr. Walker
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received a B.Sc. Aerospace Engineering from Northrop University and M.A.Sc. in Aerospace Engineering from the University of Toronto Institute for Aerospace Studies.

Walker, James James Walker is currently a Principal Engineer specializing in chassis, brake, and electronic brake control systems at Carr Engineering, Inc. His prior professional experience includes brake control system development, design, release, and application engineering at Kelsey-Hayes, Saturn Corporation, General Motors, Bosch, Ford Motor Company, and Delphi. Mr. Walker created scR motorsports consulting in 1997, and subsequently competed in seven years of SCCA Club Racing in the Showroom Stock and Improved Touring categories. Through scR motorsports, he has been actively serving as an industry advisor to Kettering University in the fields of brake system design and brake control systems. Since 2001, he has served as a brake control system consultant for StopTech, a manufacturer of high-performance racing brake systems. In addition to providing freelance material to multiple automotive publications focusing on chassis and brake technology, Mr. Walker is the author of the book High-Performance Brake Systems: Design, Selection, and Installation. In 2005, he was presented with the SAE International Forest R. McFarland Award for distinction in professional development and education and in 2010 he was awarded the SAE International Master Instructor designation. He obtained his B.S.M.E. in 1994 from GM Institute Engineering & Management Institute.

Dr. Joseph D. Walter is presently on the faculty of The University of Akron’s College of Engineering as an adjunct professor where he teaches graduate and undergraduate courses in both the Mechanical and Civil Engineering Departments. Prior to joining academia, Dr. Walter was managing director of Bridgestone-Firestone’s Technical Center Europe located in Rome, Italy, and served on the Board of Directors of Bridgestone-Firestone Europe located in Brussels, Belgium. He has served as a mechanical engineering evaluator for the Accreditation Board for Engineering and Technology, ABET, and has also served on the original Committee of the National Academy of Sciences that addressed the future fuel economy (CAFE) goals for the nation, which is detailed in the 1992 book: “Automotive Fuel Economy—How Far Should We Go?” Dr. Walter received his Ph.D. from Virginia Tech and an MBA from The University of Akron. He is a member of several professional organizations, including SAE International and the Rubber Division of the American Chemical Society.

Richard Walter is the President and Founder of HEM Data Corporation. A pioneer in PC-based data acquisition and analysis, he has acquired data from in-vehicle networks since they were mandated in 1996. Mr. Walter previously worked at the Bendix Research Laboratories where he was awarded five patents for automotive inventions and gained valuable testing experience. He taught at Lawrence Technological University and has conducted numerous seminars and training sessions. He has had several articles and papers published in engineering journals including SAE International and Sensors Magazine. Mr. Walter is a member of SAE International, ASME and The Vibration Institute and is a registered professional engineer in Michigan. Mr. Walter has a B.S. in mechanical engineering from the University of Detroit, an M.S. in mechanical engineering from Wayne State University and an M.M.E. in engineering management from the University of Detroit.

Walter, Jack Mr. Williams is the principal at Airflow & Aerodynamics Engineering, LLC and an independent consultant specializing in the design and development of thermal management systems and vehicle aerodynamics. He is an adjunct faculty member at the Lawrence Technological University (LTU) and a guest lecturer for their MSAE Program on Automotive Mechanical Systems. In addition to his consulting work, he conducts professional development seminars for engineers on cooling systems, HEV battery thermal management, and road vehicle aerodynamics. Mr. Williams has over thirty years engineering management experience in product development at Ford Motor Co. Additionally, he was an aerodynamics project leader with the USAF Aeronautical Systems Division at Wright-Patterson Air Force Base, Ohio where he specialized in engine/aircraft integration, gas turbine engine performance, inlet design, and aircraft mission analysis. An active member of the SAE International, Mr. Williams has authored over twenty technical papers, given invited lectures at major mid-west universities, and has received professional awards and international recognition for his innovative work. He is a recipient of the Henry Ford II Technology Award, the SAE International Industrial Lectureship Award, the SAE International Oral Presentation Award, and the SAE International Forest R. McFarland Award. He holds a B.S. in Aeronautical Engineering from the University of Detroit and an M.S. in Aerospace/Mechanical Engineering from the United States Air Force Institute of Technology.

Wine, Mark Mark Wine is a senior development engineer at Drew Technologies Inc. which is a manufacturer of J2534-1 devices. His work includes developing and supporting the J2534-1 compliant CardDAQ and Mongoose family of products. Mr. Wine has over 25 years of experience in product and software development including 10 years developing vehicle communication products. Most recently, Mr. Wine has been working with GM and Allison Transmission on advanced J2534-1 applications. Prior to working in automotive, Mr. Wine delivered product training and technical support throughout Asia. He has a B.S. in Electrical Engineering from Montana State University.

Wang, Wego Dr. Wang is currently an aerospace engineer in the Engine Certification Office of the Federal Aviation Administration, where he serves as the focal point for Parts Manufacturer Approval. He has been a technical instructor and a researcher in mechanical engineering and materials science for more than twenty years. Dr. Wang taught at Northeastern University and is currently an adjunct faculty at Boston University and the University of Massachusetts - Lowell. He received many awards, commendations and recognitions from the Army Research Laboratory, the FAA and other institutions. Dr. Wang authored or co-authored over 40 technical/professional articles, and presented lectures/reports at numerous seminars/conferences. Active with professional societies, he is on the executive committee of ASM International Boston Chapter and was the 2005-06 Chairman of the Chapter. He also served on the executive committee of TMS Boston Section, where he was president from 1993-95. Dr. Wang has a B.S. in Mechanical Engineering from National Cheng - Kung University, a M.S. in Mechanical Engineering from National Taiwan University, and a M.S. and Sc.D. in Materials Science and Engineering from Massachusetts Institute of Technology.

Wang, Ying Ms. Wang currently holds the position of Deputy Director in the Engineering and Product development Department at SAI/CMotor, (SEAT and ATBS) in Shanghai. Prior to her current position, Ms. Wang was Senior System Engineer & Electrochemist at Johnson Control Saft in Milwaukee, Wisconsin and Manager, Senior Scientist, and Project Leader with Polyfuel Inc. in Mountain View, California. Ms. Wang received her B.S. Analytical Chemistry from Jilin University and her Ph.D. in Electroanalytical Chemistry from the Chinese Academy of Sciences.
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Zachos, Mark
Mark Zachos is currently an adjunct professor at the University of Michigan. He is the President of Dearborn Group, Inc. and has more then twenty years of networking experience. Mr. Zachos participates in many SAE international and ISO multiplexing committees, including the following: J1939, J2284, J2411, and J2367. He holds a B.S. and an M.S. in engineering from the University of Michigan.

Zielinski, Kevin
Kevin Zielinski currently owns and operates Red Cedar Media LLC, a training and corporate communications consulting, design, development and delivery company based in Michigan. Previously, Kevin was Senior Applications Specialist for EDS (including General Motors/EDS and Hewlett Packard/EDS) specializing in technical training delivery, training consulting, courseware design and development, and e-Learning. He has designed, developed and delivered over 40 lecture- and web-based courses attended by General Motors and EDS employees worldwide. Mr. Zielinski has also served as Adjunct Professor for the Wayne State University College of Engineering and WSU/Focus:Hope for many years. His areas of expertise include: e-Learning design and development, Quality Tools and Methods (Design of Six Sigma, Robust Engineering, Design of Experiments (DOE), Statistical Tolerance and GD&T); Design for Manufacturing and Assembly (DFMA); Engineering Economics; and Plant Floor Throughput Improvement. He has been an instructor for SAE International Professional Development since 1990, and is a recipient of SAE International’s Forest R. McFarland Award (April 2005). He holds a bachelor’s and master’s degree in engineering from Wayne State University.

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May 21  Vehicle Dynamic Basics for Off-highway Trucks--I.D.# C1239

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Jun 25-26  Sound Package Materials for Vehicle Noise Control--I.D.# 92032
Jun 26  Brake Noise Problem Resolution--I.D.# C0831
Jun 26  Introduction to NVH Aspects of Hybrid and Electric Vehicles--I.D.# C1128
Jun 26  Introduction to Contemporary Muffler Design Techniques--I.D.# C1352

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Jun 16  Tire and Wheel Safety Issues--I.D.# C0102
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Jun 24-26  Commercial Vehicle Braking Systems--I.D.# C0233
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<td>Understanding the FAA Parts Manufacturer Approval Process--I.D.# C1324</td>
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<tr>
<td>Sep 24-25</td>
<td>ARP4761 and the Safety Assessment Process for Civil Airborne Systems--I.D.# C1245</td>
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**Troy, Michigan – SAE International Professional Engineering Education Center**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>Sep 9-11</td>
<td>Applying Automotive EDR Data to Traffic Crash Reconstruction--I.D.# C1210</td>
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<tr>
<td>Sep 9-10</td>
<td>Military Tactical Vehicle Product Development - Concept to Production--I.D.# C1248</td>
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<tr>
<td>Sep 10-11</td>
<td>Controller Area Network (CAN) for Vehicle Applications--I.D.# C0120</td>
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Professional Development Schedule

Charleston, South Carolina – held in conjunction with the SAE 2015 Brake Colloquium & Exhibition

Oct 8   Brake Friction Materials: Testing, Quality and Selection--I.D.# C1020
Oct 8   Introduction to Brake Noise, Vibration, and Harshness--I.D.# C1337
Oct 9   Brake Noise Problem Resolution--I.D.# C0831

Web Seminar – Live Online

Oct 5-16 Introduction to Commercial and Off-Road Vehicle Cooling Airflow Systems--I.D.# WB1240
Oct 6-15 Principles of Electric Drives--I.D.# WB0941
Oct 19-30 Vibration Analysis Using Finite Element Analysis (FEA) --I.D.# WB1401
Oct 20  Advanced GD&T Competencies: Datum Usage--I.D.# WB1319
Oct 22  Advanced GD&T Competencies: Profile of a Surface--I.D.# WB1320
Oct 27  Advanced GD&T Competencies: Composite Positioning--I.D.# WB1321

Norwalk, California – Cerritos Community College

Oct 5   Introduction to Composites Fabrication and Assembly in Aerospace, Space, and Transportation--I.D.# C1311
Oct 6-7 Automated Systems for Aerospace and Space Applications--I.D.# C1313
Oct 8   RFID Selection, Application, and Use in Aerospace, Space, and Transportation--I.D.# C1310
Oct 20-23 Accessing and Interpreting Heavy Vehicle Event Data Recorders--I.D.# C1022

Phoenix, Arizona – Exponent, Inc.


Troy, Michigan – SAE International Professional Engineering Education Center

Oct 1   Safe Handling of High Voltage Battery Systems--I.D.# C1019
Oct 2   Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems--I.D.# C0235
Oct 5-7 Vehicle Dynamics for Passenger Cars and Light Trucks--I.D.# 99020
Oct 5-6 Tolerance Stack-Up Analysis--I.D.# C0022
Oct 8-9 Design Review Workshop--I.D.# C1306
Oct 21-23 Designing On-Board Diagnostics for Light and Medium Duty Emissions Control--I.D.# C0831
Oct 22-23 Engine Failure Investigation and Analysis--I.D.# C1344
Oct 26-28 Injuries, Anatomy, Biomechanics & Federal Regulation--I.D.# 85049
Oct 27  Introduction to Gears--I.D.# C0822
Oct 28-30 Internal Combustion Systems: HCCI, DoD, VCT/VVT, DI and VCR--I.D.# 85049
Oct 29-30 Sheet Metal Stamping: Robust Formability--I.D.# C0713
Oct 29-30 Creating and Managing a Product Compliance Program--I.D.# C1213

Greer, South Carolina – BMW Performance Center

Nov 16-18 Applied Vehicle Dynamics--I.D.# C0414

Web Seminar – Live Online

Nov 2-6 Accelerated Concept to Product (ACP) Process using a 3G Design Approach--I.D.# WB1403
Nov 3-5 Driver Distraction from Electronic Devices: Insights and Implications--I.D.# WB140
**PROFESSIONAL DEVELOPMENT SCHEDULE**

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<tr>
<td>Nov 10-17</td>
<td>Acoustic Fundamentals for Solving Noise and Vibration Problems</td>
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<tr>
<td>Nov 11-20</td>
<td>Root Cause Problem Solving: Methods and Tools</td>
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<td>Nov 16</td>
<td>Success Strategies for Women in Industry and Business</td>
<td>McLean, Virginia</td>
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<tr>
<td>Nov 17-18</td>
<td>Understanding and Supporting Aircraft Accident Investigation and Reconstruction</td>
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<tr>
<td>Nov 10-17</td>
<td>Improving Fuel Efficiency with Engine Oils</td>
<td>Troy, Michigan – SAE International Professional Engineering Education Center</td>
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<tr>
<td>Nov 2-3</td>
<td>Gasoline Direct Injection (GDI) Engines</td>
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<td>Nov 4-6</td>
<td>Chassis &amp; Suspension Component Design for Passenger Cars &amp; Light Trucks</td>
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<td>Nov 4-6</td>
<td>Strategic Leadership</td>
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<tr>
<td>Nov 4-6</td>
<td>Turbocharging Internal Combustion Engines</td>
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<td>Nov 9-11</td>
<td>Vehicle User Experience: Human Factors Principles and Techniques for Design</td>
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<td>Nov 9-10</td>
<td>Introduction to Welded Joints</td>
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<td>Nov 10</td>
<td>Developing In-Vehicle User Interfaces: Design Principles and Techniques</td>
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<td>Nov 11-12</td>
<td>Introduction to Hybrid and Electric Vehicle Battery Systems</td>
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<td>Nov 18-20</td>
<td>Geometric Dimensioning &amp; Tolerancing (GD&amp;T)</td>
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<td>Nov 18-20</td>
<td>Principles of Cost and Finance for Engineers</td>
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<td>Nov 23-24</td>
<td>Vehicle Frontal Crash Occupant Safety and CAE</td>
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<td>Nov 23-24</td>
<td>Introduction to Failure Mode and Effects Analysis for Product and Process</td>
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<td>Dec 7-8</td>
<td>Understanding the FAA Aircraft Certification Process</td>
<td>Norwalk, California – Cerritos Community College</td>
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<td>Dec 7-9</td>
<td>Applying Automotive EDR Data to Traffic Crash Reconstruction</td>
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<td>Dec 8-9</td>
<td>Diesel Engine Technology</td>
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<td>Aircraft Cabin Safety and Interior Crashworthiness</td>
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<td>Dec 1-2</td>
<td>Leading High Performance Teams</td>
<td>Troy, Michigan – SAE International Professional Engineering Education Center</td>
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<td>Commercial Vehicle Braking Systems</td>
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<td>Robust Design</td>
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<td>Accelerated Test Methods for Ground and Aerospace Vehicle Development</td>
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<td>Dec 8-10</td>
<td>Managing Engineering &amp; Technical Professionals</td>
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<td>Dec 9-11</td>
<td>Weibull-Log Normal Analysis Workshop</td>
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<td>Dec 14-15</td>
<td>Threaded Fasteners and the Bolted Joint</td>
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<td>Dec 15-16</td>
<td>Engineering Project Management</td>
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<td>Dec 16-18</td>
<td>Fundamentals of Metal Fatigue Analysis</td>
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<td>Tolerance Stack-up Fundamentals</td>
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<td>Dec 2-4</td>
<td>Overview and Impact of the Automotive Functional Safety Standard ISO 26262</td>
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<td>Dec 4</td>
<td>Introduction to AS9100: Requirements and Value-Added Implementation</td>
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<td>Turbocharging for Fuel Economy and Emissions</td>
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<tr>
<td>Dec 14-17</td>
<td>Introduction to Design Review Based on Failure Modes (DRBFM)</td>
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