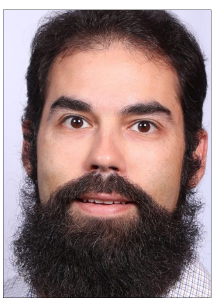
SEMI-THERM 34

Short Courses Monday, March 19, 2018

Short Course 1   Morning **8:00 a.m. – 12:00 p.m.**
Thermal Challenges for Power Electronics
Instructor: Brian Zahnstecher, PowerRox

Careful thermal architecting, design, and qualification are integral to the success of electronic systems, and power electronics are no exception. As the trend to increase power density will only continue in the positive direction, solutions to the thermal challenges become increasingly enabling. From dense enterprise systems to very low power consumer electronics, one cannot depend on increases in power supply conversion efficiency to address all these challenges though the desire for adiabatic or conduction-cooled implementations is driving improvement in this area. As usual, it comes down to an acceptable tradeoff of key project requirements such as cost, size, efficiency, application derating, and development resources/timeline.

This entry- to intermediate-level Short Course will provide an overview of the key thermal factors that must be considered at all aspects of implementing power electronics from inception to field use. Such factors will be evaluated against project requirements and objectives to help attendees internalize and prepare an appropriate methodology that aligns with project priorities, while still ensuring the technical success of the application. Some time will also be spent reviewing real-world examples and case studies to understand past successes and failures, with an emphasis on harsh environment applications.



Brian Zahnstecher is a Sr. Member of the IEEE, Chair of the IEEE SF Bay Area Power Electronics Society (PELS), and the Principal of PowerRox, where he focuses on power design, integration, system applications, OEM market penetration, and private seminars for power electronics. He has successfully handled assignments in system design/architecting, AC/DC front-end power, EMC/EMI design/debug, embedded solutions, processor power, and digital power solutions for a variety of clients. He previously held positions in power electronics with industry leaders Emerson Network Power, Cisco, and Hewlett-Packard, where he advised on best practices, oversaw product development, managed international teams, created/enhanced optimal workflows and test procedures, and designed and optimized voltage regulators. He has been a regular contributor to the industry as an invited speaker, author, workshop participant, session host, roundtable moderator, and volunteer. He has over 13 years of industry experience and holds Master of Engineering and Bachelor of Science degrees from Worcester Polytechnic Institute.

Short Course 2   Morning **8:00 a.m. – 12:00 p.m.**
Managing Cooling Fan Noise and Power Consumption
Instructor: David Nelson, Nelson Acoustics

Excessive cooling fan noise often disrupts progress late in a product's design, and last-minute fixes are usually fruitless. The reasons this occurs remain mysterious to most of the engineering community, which continues to hunt for the largely mythical "quiet fan". In practice, noise emission is determined very early in the design process by non-acoustical factors including cooling requirements, thermal design practices, flow path resistance, form factor and dimensional constraints, upstream turbulence, and of course fan selection.

This short course gives a practical overview of the connection between fan performance, noise emission, and power consumption, and uses fan similarity laws, vendor data, and empirical models to provide estimates of each along with the impact of various design choices. The goal is actionable insight that supports making, justifying, and defending wise design decisions before it's "too late". Examples will be drawn from the instructor's broad consulting experience. Audio demonstrations are used to illustrate key points. Each participant will receive a bound copy of the course slides. Instruction involves math no more advanced than logarithms.

David A. Nelson has over 35 years experience in acoustics and noise control, and is Board Certified by the Institute of Noise Control Engineering. Nelson Acoustics is in its 20th year providing acoustical consulting services to a wide variety of corporate clients on subjects including product noise control. Mr. Nelson promotes "quiet by design" principles with a particular emphasis on fan noise control.

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Short Course 3 Morning **8:00 a.m. – 12:00 p.m.**
Efficient Flow and Thermal Modeling of Large Scale Electronic Systems
Instructors: Jan Visser, Boyd Corp. and Suhkvinder Kang, Aavid

This short course will teach thermal designers how to use different solution techniques in thermal design software to simplify and optimize the thermal design of large scale systems like server systems, heat exchangers, liquid cooling networks etc. In the hybrid solution approach, the solution domain is divided into different types of regions where flow and heat transfer equations are solved using different techniques. The approach recognizes that air and/or liquid flow within some regions or subsystems is well defined (e.g. channels formed between shrouded card arrays, packaged power supplies, heat exchanger fin arrays, pipes, valves etc.) while in other regions it is poorly defined (e.g. air or liquid flow plenums, manifolds, large electronics boards.) Using the hybrid approach, designers can efficiently and accurately model the flow and heat transfer within the entire geometry of large scale systems.

Dr. Jan Visser (pictured) is the VP of Boyd Corporation and responsible for the development of all CFD software and compact models used in the Boyd CFD software. He has 30 years of experience in CFD. Over the last 15 years he specialized in the development of sub models for electronic applications and methods to speed up solution time without sacrificing accuracy. This include the optimization of thermal designs. He is the author of many related publications in journals and technical conferences.

Dr. Sukhvinder Kang is the CTO at Aavid and responsible for advanced thermal technology development programs. He has over 30 years of industry experience in electronics cooling, space, defense, nuclear, and oil exploration applications. He has authored over thirty patents and technical papers on fluid flow and heat transfer and lectured a number of courses and seminars in electronics cooling.

Short Course 4 Morning **8:00 a.m. – 12:00 p.m.**
Design of LED-based Applications
Instructors: Genevieve Martin, Philips Lighting and András Poppe, Mentor Graphics

This course provides insights into the key parameters, strategies and methodologies for the thermal-optical-electrical-mechanical design of LED-based applications. The course presents limitations at the various phases of the product design and provides a view of future perspectives. Practical examples and illustrations are presented for the analysis, concept choice, characterisation. This course has no bias towards a special application field.
A brief course outline:

- Overview of Standards for Product Development & Characterization
- LED System Design Approach
- Modeling of LEDs for the Design Purposes, Multi-Domain Modeling
- Basics of LEDs and Future Trends
- Application Overview and Implication for the LED Choices
- Application Constraints and Consequences of Design Choices

Genevieve Martin is principal engineer and Thermal & Mechanics Competence Leader at Philips Lighting in the Netherlands. In the past, she worked for different application fields mainly dealing with electronics cooling and thermal management in consumer applications, professional and consumer healtcare products. She started working with LED application in 2007 by delivering the first thermal technology roadmap for the department of Lighting at Philips. In 2014, she joined the lighting division and now focuses most of her time in LED based application. As Thermal & Mechanics Competence Leader, her role is to lead the roadmap, propose yearly programs and setup collaboration for research projects. Since 2016, she coordinates the European project Delphi4LED (a 3 year project) dealing with multi-domain compact model of LEDs. An active reviewer in several conferences, she served as General Chair of Semi-Therm 31 and is now a member of the Technical Committee.

András Poppe obtained his MSc degree in electrical engineering in 1986 from the Technical University of Budapest (BME), Faculty of Electrical Engineering. In 1996 he obtained a cand.Sci. degree from the Hungarian Academy of Sciences and his PhD from BME. In 1986-1989 he was a researcher at BME Department of Electron Devices with scholarship of the Hungarian Academy of Sciences; he has been head of the Department of Electron Engineering (BME) since 2013. His research field was circuit simulation and semiconductor device modeling. Later in the 1980's he was a guest researcher at IMEC (Leuven, Belgium). Since 1990 he has been with BME as a lecturer, and since 1996 he has been an associate professor. Co-founding MicReD in 1997 (now part of Mentor – a Siemens business), he is actively involved in the JEDEC JC15 committee and is chairing the CIE TC2-84 technical committee.

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Short Course 5 Afternoon **1:30 p.m. – 5:30 p.m.**

Experimental Measurements in Electronics Cooling Systems

Instructors: Dr. Alfonso Ortega, Santa Clara University and Dr. Marcelo Del Valle, Intel

The experimental characterization of temperature, airflow, and velocity, among others, is one of the most common needs in the evaluation of thermal performance and reliability of electronic systems. Because of the apparent simplicity of building and using thermocouple sensors, the errors that commonly occur in the measurement of both air and solid component temperatures are not well appreciated. Similarly, the errors that may occur in the measurement of flow and velocity are often not well understood and often ignored. If ignored, these errors will propagate throughout the measurement chain and lead to high uncertainty in the measurements to be interpreted. Because experimental verification has become an essential part of computational simulation using CFD tools, lack of certainty in the "real" data will also lead to an inability to validate the computational simulations.

In this course, we will discuss and perform hands-on demonstrations of practical temperature and velocity measurements that are common in the characterization of electronic equipment. We will point out difficulties in the use of point-sensors such as thermocouples and thermistors in the measurement and interpretation of temperature, flow, and velocity of flowing fluids in air and liquid cooled systems, and in the measurement of the temperature of solid materials. We will discuss the errors that commonly occur in alternative methods such as Infrared measurements. With understanding of the source of errors, we will discuss the use of uncertainty analysis in order to understand and control the propagation of error in the measurement chain.

Dr. Alfonso Ortega is the Sobrato Professor of Engineering and the Dean of the School of Engineering at Santa Clara University, a position that he occupied in August 2017.

Prior to his current position, he was at Villanova University for eleven years where he was the James R. Birle Professor of Energy Technology and the Director of the Laboratory for Advanced Thermal and Fluid Systems, which he founded in 2005. From 2011 to 2017 he was the founding Director of the NSF Center for Energy Smart Electronic Systems (ES2) at Villanova University. The NSF ES2 Center, which includes partner universities Binghamton University, University of Texas-Arlington, and Georgia Tech, is an industry-university research partnership that seeks to address critical issues of energy utilization in data centers through directed research in areas such as thermal management, controls, workload optimization, and sustainability. Most recently, Dr. Ortega has directed research in the areas of passive and active two phase cooling of servers, dynamic air cooling strategies that couple with real time load scheduling, the use of second law principles to identify energy inefficiencies in air-cooled data centers, and waste energy recovery using organic Rankine cycles and thermoelectrics technology.

Dr. Ortega received his B.S. from The University of Texas-El Paso, and his M.S. and Ph.D. from Stanford University, all in Mechanical Engineering. He was on the faculty of the Department of Aerospace and Mechanical Engineering at The University of Arizona in Tucson for 18 years, where he directed the Experimental and Computational Heat Transfer Laboratory. From 2004 to 2006, Dr. Ortega was the Program Director for Thermal Transport and Thermal Processing in the Chemical and Transport Systems Division of The National Science Foundation in Arlington, Virginia, where he managed the NSF's primary program funding heat transfer and thermal technology research in U.S. universities. From 2006 to 2017 he was on the faculty of Mechanical Engineering at Villanova University. He served as Associate Dean of the College of Engineering for Graduate Programs and Research from 2007-2012. From 2012-2016 he served as the inaugural Associate Vice President for Research and Graduate Programs at Villanova.

Dr. Marcelo del Valle is a Thermal/Mechanical engineer at INTEL Corporation. He received his B.S.M.E from Universidad de Santiago, Chile, M.S.M.E. from University of Nevada, Reno and his Ph.D. in Mechanical Engineering from Villanova University. Dr. del Valle has worked extensively in experimental measurements in the thermal sciences for more than 7 years. His doctoral research involved detailed experimental characterization and modeling of air to liquid heat exchangers in data center applications. He has published and presented extensively in problems arising from thermal management of electronics, spanning from the chip/module to the facility level, single and two-phase liquid cooling, and thermal management in energy systems. He is part of the program committee of the IEEE Semitherm Symposium.

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Short Course 6 Afternoon **1:30 p.m. – 5:30 p.m.**
Computational and Experimental Thermal Characterization for the Future of the Microelectronics Industry: A Philosophy and Promising Directions
Instructor: Peter Raad, Southern Methodist University

Transistor scaling has led to rapid and profound developments in both commercial and consumer electronics, which have had a transformative impact on society at large. As is the nature of human appetite, there seems to be only a desire for more, with ever-wider capabilities and possibilities. Unfortunately, the same cannot be said about transistor scaling, which appears to have reached hard stops, leading the microelectronics industry to switch from scaling to novel architectures that use three-dimensional device manufacturing and integration of chips. Whenever such foundational change occurs, engineering perspectives and approaches must follow. This calls for a thorough evaluation of needs, strategies, and opportunities.

In this short course, we will (i) review the fundamental promises of both numerical and experimental approaches to the characterization of the thermal behavior of microscale, three-dimensional, transient devices, (ii) outline a general philosophy guided by the anticipated directions that the industry is taking, and (iii) propose experimental and computational directions that hold promise in addressing current design trends as well as anticipated directions.

Peter E. Raad is a professor of mechanical engineering at Southern Methodist University (SMU) in Dallas, Texas. He first joined SMU in 1986 and has previously served as the associate dean of its School of Engineering. From 2000 to 2012, he founded and directed the Hart eCenter at SMU, a university-wide center to address the impact of the interactive networked technologies on society, and The Guildhall at SMU, a first of its kind graduate program in digital game development.

Raad has received over $2.5 million in funding support for his research in tsunami mitigation and in metrology of submicron electronics. In 2006 he founded TMX Scientific, a company to innovate and commercialize deep submicron thermal measurement systems and ultrafast thermal computational engines. Raad's work in the thermal management field includes the development of innovative deep-submicron thermal metrology techniques and systems, as well as novel coupling of computations and measurements to provide transient, three-dimensional temperature fields in electronic structures with inaccessible internal features.

His honors include the Allan Kraus Thermal Management Medal (2014); the Harvey Rosten Award for Excellence in the Physical Design of Electronics (2006); the ASME North Texas Section Engineer of the Year (1999-2000); the Next-Gen's Top 25 People of 2007 (most influential in the video gaming industry); and Outstanding Graduate (four times) and Undergraduate (three times) Faculty Awards at SMU.

He has published over 50 journal articles, and given more than 100 conference and invited talks. He holds U.S. and international patents in thermal metrology and computational characterization of multiscale integrated circuits. He is a Fellow of ASME and a Senior Member of IEEE. He received his BSME (with honors, 1980), MS (1981), and PhD (1986) in mechanical engineering from the University of Tennessee - Knoxville.

SEMI-THERM 34 General Chair: Jesse Galloway, Amkor Technology
Program Chair: Adriana Rangel, Cisco
Program Vice-Chair: Pablo Hidalgo, Aavid Thermacore

For program details, registration, exhibition and hotel information visit
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Short Course 7 Afternoon **1:30 p.m. – 5:30 p.m.**
Fundamentals of Vibration and Shock for Electronics Applications
Instructor: Nicholus Clinkinbeard, Rockwell Collins

Vibration and shock can be extremely detrimental to products fielded in rugged environments. This is particularly true for electronic systems designed to meet multiple functional requirements while also surviving extreme thermal, moisture, erosion, and electromagnetic conditions. This course is designed to guide engineers and other professionals to consider shock and vibration during the entire product design lifecycle, not just detailed design or qualification. Specifically, the following will be discussed:
The topics will include some theory, but will focus on application to product development.

- Introduction to response spectra
- Vibration and shock testing
- Design for vibration and shock
- Concepts in shock and vibration
- Vibration and shock requirements for rugged applications
- Reliability and production vibration requirements

Nick Clinkinbeard is a Principal Mechanical Engineer for Rockwell Collins in Cedar Rapids, Iowa, where he has functioned as both a general design engineer and a vibration and shock specialist. For the past eleven years, he has worked in the Environmental Effects Engineering department, where his duties have focused primarily on shock and vibration—specifically including requirements capture and design support, classical and finite element analysis, test lab development and support, and training. Nick is also a Vice President of Education for the Institute of Environmental Sciences and Technology, and has taught courses on vibration and shock testing for the organization. Nick has BS and MS degrees in mechanical engineering from Iowa State University, where he is currently pursuing a PhD in the field.

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