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SEMI-THERM® 34
The 34th Annual Thermal Measurement, Modeling and Management Symposium
March 19th - 23rd, 2018

34

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NEW TO SEMI-THERM 34
Panel Discussion: "Challenges in Consumer Electronics Cooling"
Thursday Afternoon, March 22

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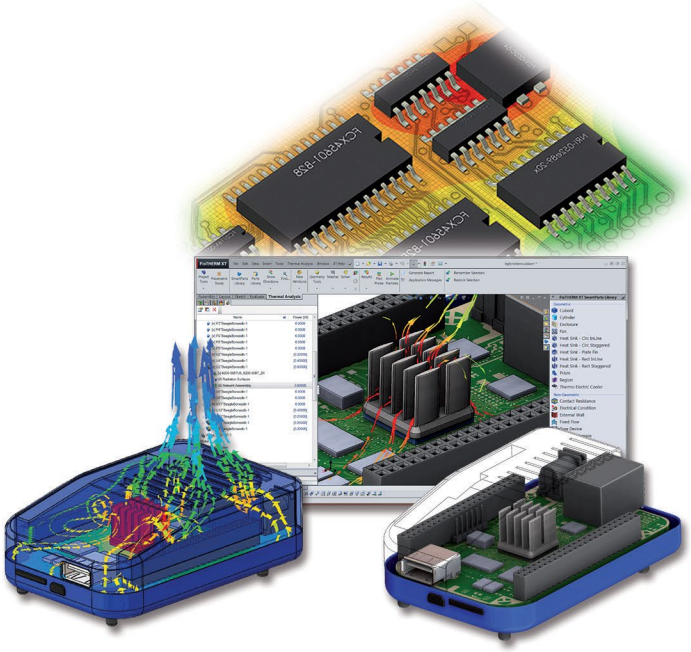

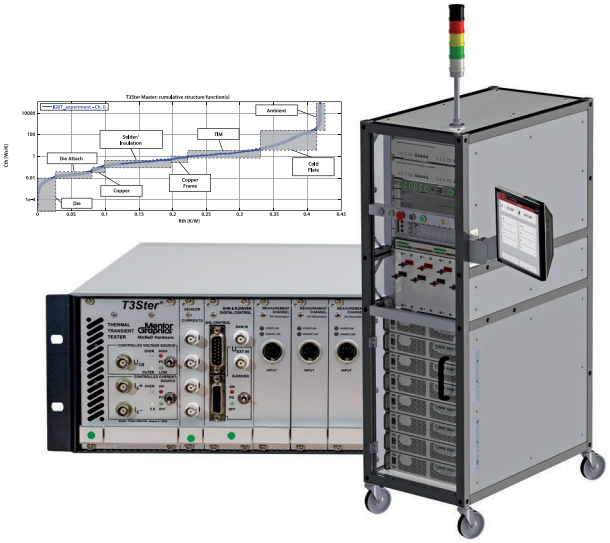

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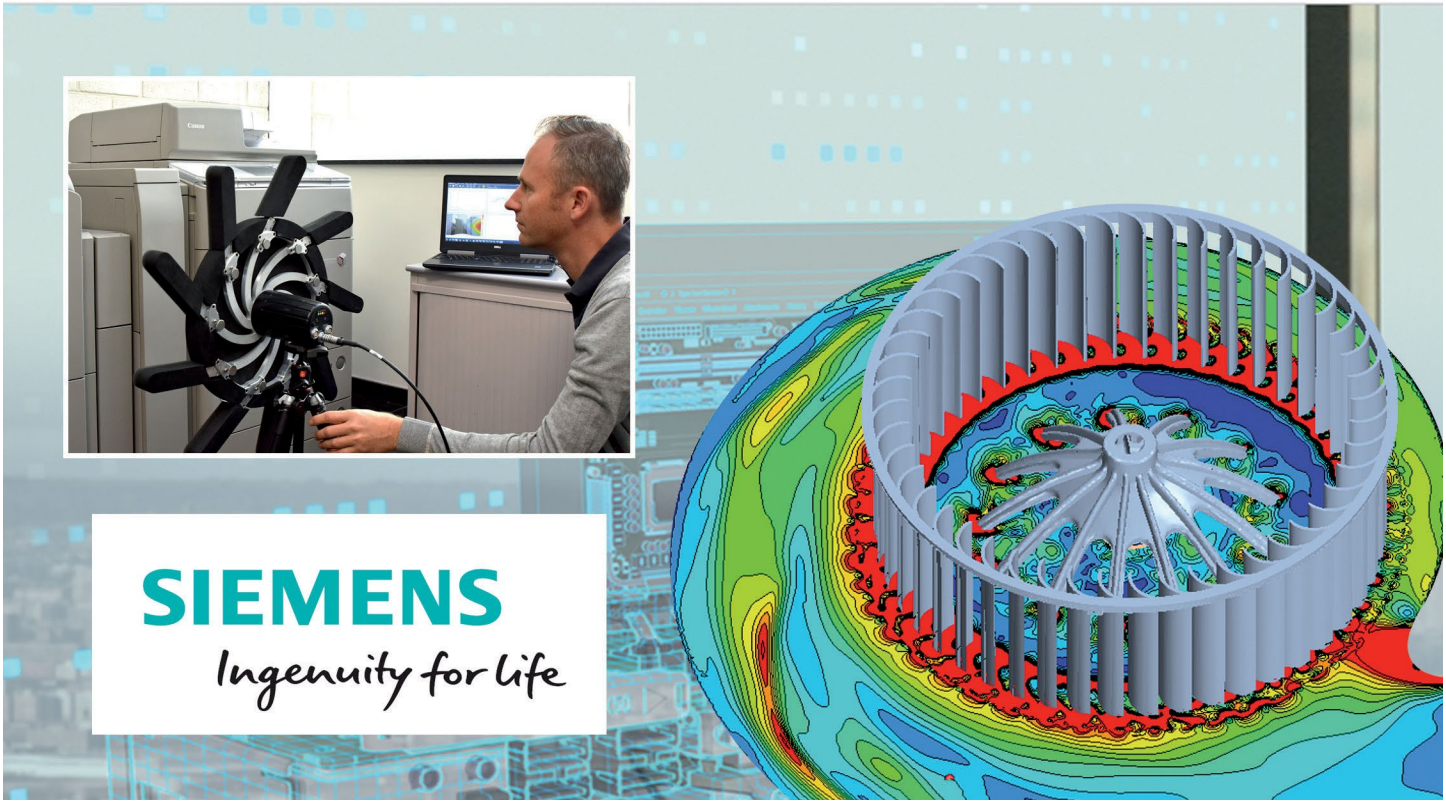

SIEMENS
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Welcome to SEMI-THERM 34!

Jesse Galloway, Symposium Chair

Dear Colleagues,

It is my pleasure to welcome you to SEMI-THERM 34 annual conference dedicated to thermal design, thermal management as well as measurement of semiconductor systems and components. The program committee led by Adriana Rangel, Cisco Systems, has put together a comprehensive program that adheres to SEMI-THERM's mission of providing an annual forum for the exchange of latest technical developments in thermal management of electronic devices, components and systems. In this 34rd annual forum, the program committee has provided excellent opportunities for the exchange of information in the following areas:

- 7 Short courses
- Keynote speech
- 4 "How-To" courses
- Evening tutorial
- 37 Technical papers
- 2 Luncheon speeches
- 6 Vendor workshops
- 2 Days of SEMI-THERM exhibits with over 40 participating vendors
- Awards session including THERMI, Harvey Rosten as well as Thermal Hall of Fame Award
- Panel session on Challenges in Consumer Electronics Cooling

As part of SEMI-THERM's mission to provide educational opportunties in the study of thermal management, all short courses are offered free of charge as part of the full technical conference pass. The courses are offered the first day of SEMI-THERM on Monday, March 19th including morning and afternoon sessions. Our instructors offer a unique perspective on methods, advances and opportunities to employ simulation or experimental methods to quantify thermal performance in various applications. The titles and instructor names for the courses offered are listed below.

"Thermal Challenges for Power Electronics" by Brian Zahnstecher, PowerRox

"Managing Cooling Fan Noise and Power Consumption" by David Nelson, Nelson Acoustics

"Efficient Flow and Thermal Modeling of Large Scale Electronic Systems", by Dr. Jan Visser, Boyd Corporation and Dr. Sukhvinder Kang, Aavid

"Design of LED-based Applications" by Genevieve Martin, Philips Lighting and Dr. András Poppe, Budapest University of Technology and Economics, Budapest, Hungary and Mentor, A Siemens Business.

"Experimental Measurements in Electronics Cooling Systems", by Dr. Alfonso Ortega, Santa Clara University and Dr. Marcelo del Valle, Intel Corporation.

"Computational and Experimental Thermal Characterizaton for the Future of the Microelectronics Insustry: A Philosopy and Promising Directions", by Dr. Peter E. Raad, Southern Methodist University.

"Fundamentals of Vibration and Shock for Electronics Applications", by Nicholus Clinkinbeard, Rockwell Collins.

The symposium will open with this year's keynote address on "Thermal Challenges and Industry Trends of Consumer Electronic Devices" delivered by Dr. Andre Ali, Google. It will be followed by 37 technical presentations offered in 10 different sessions. These sessions include 2.5D and 3D Electronics, Two-Phase and Liquid Cooling, Concurrent Design, Consumer Electronics, Simulation, Data Center and Heat Sinks, Measurements Techniques, Thermal Interfaces, Air Movers and lastly, Automotive/Aerospace/Outdoor.

Keeping a long lasting tradition for SEMI-THERM luncheon speeches, we have invited distinguished speakers to provide insightful views into an on-topic thermal presentation and an off-topic presentation of general interest. This year we have invited Dr. Dustin Demetriou to provide an on-topic presentation on "ASHRAE Technical Committee 9.9 (TC9.9) Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment". The second off-topic presentation will be made by Dr. Helen Hwang on "Tales from the Mars Science Laboratory Thermal Protection System Development (Or, try Not to Panic When Your Heatshield Material Disappears)".

An Embedded Tutorial is included to provide technical background and hands-on knowledge on various topics/systems or components by experts in the associated field. This year, Tom Rogers and Dave Saums will make a presentation on "Selecting Adhesives and Thermally-Conductive Adhesives for Electronics Systems".

To round out a full day of presentations, a delightful evening tutorial will be presented by Dr. Bruce Guenin on "The Internet of Things — A Personal Perspective".

A Panel Session open to the public will be held on Thursday, March 22 from 2:00pm – 4:00pm titled "Challenges in Consumer Electronics Cooling". This live-panel discussion will address how current challenges are being met and will emphasize future challenges, how they are framed, and what approaches and technologies might be applied to overcome them. Panelists in attendance include Mark Carbone (Intel), William Maltz (Electric Cooling Solutions), Andy Delano (Microsoft), Jie Yang (Huawei), Emil Rahim (Google), Guy Wagner (ECS) and Gabriel Khouri (Intel).

The THERMI Award is given each year to a significant contributor to the field of semiconductor thermal management. The THERMI award is intended to recognize a recipient's history of contributions to crucial thermal issues affecting the performance of semiconductor devices and systems. The voting body of past THERMI winners and current year General Chair are pleased to present the 2018 THERMI Award to Dr. Bruno Michel from IBM's Research Laboratory, Zurich, Switzerland. His contributions to the thermal community are many including advances in thermal interface materials, 3D packages, smart systems and integration of IoT.

SEMI-THERM instituted the Thermal Hall of Fame Lifetime Achievement Award. It recognizes a person each year in the electronics thermal management field who has made significant contributions to the development and commercialization of thermal management technologies during the course of their career. Hall of Fame members are entrepreneurial in their own right, pushing the boundaries to develop and commercialize technologies while mentoring those around them. The award will be presented during Thursday's Awards Luncheon. The recipient of the Thermal Hall of Fame Lifetime Achievement Award 2018 is presented to Bernie Siegal. He continues to be instrumental in establishing thermal standards through JEDEC's JC-15 committee on Thermal Characterization Techniques for Semiconductor

Packages. As a co-founder of SEMI-THERM, we are here today attending SEMI-THERM due in large part to Bernie's constant dedication to educating the thermal community at large.

The 2017 Harvey Rosten Award for outstanding work will be presented to János Hegedüs, Gusztáv Hantos and András Poppe for their paper, "Lifetime Isoflux Control of LED Based Light Sources".

SEMI-THERM functions largely as a volunteer organization comprised of dedicated individuals who devote their time throughout the year to bring together a premier symposium on the thermal management of electronics and systems. I would like to thank all those who participated in the publication review process and organization of SEMI-THERM 34. In particular, Adriana Rangel, Cisco Systems, has worked tirelessly as the Program Chair putting together the technical program and organizing planning meetings. Her contributions are greatly appreciated.

The outstanding auxiliary programs including short course instructors and luncheon speakers were organized by the Vice Program Chair, Pablo Hidalgo, Aavid. Excellent job Pablo!

Planning of SEMI-THERM would not be possible without the experienced leadership provided by Ross Wilcoxon, Rockwell Collins, Tom Tarter, Package Science Services, and George Meyer, Celsia Technologies. Thank you for your mentoring and support to the SEMI-THERM 34 planning team. The professional support provided by Paul Wesling is greatly appreciated for the compilation of SEMI-THERM proceedings.

Lastly, and perhaps most importantly, many thanks go to the tireless support Bonnie Crystall, Denise Rael and Robert Schuch provide during the creation of this years' outstanding SEMI-THERM symposium.

The SEMI-THERM planning committee wants to extend their appreciation to the many sponsors who made this symposium possible.

It is my hope that the participants at SEMI-THERM have a rewarding experience both educationally as well as socially by making stronger connections with leaders in the thermal management and electronics cooling community.

Best Regards,
Jesse Galloway
Symposium Chair

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SEMI-THERM 34 Chair Persons

General Chair

Jesse Galloway Ph.D.

Vice President - Advanced Package Engineering, Amkor Technology, Inc

Jesse Galloway has over 25 years' experience in the electronic packaging industry. For the past 16 years, he has supported package characterization at Amkor Technology in Tempe, Arizona. He currently leads thermal, mechanical and testing engineering teams charged with characterizing the performance of packages subject to varying end-use conditions. His expertise includes thermal experimentation and simulations. Jesse chairs the JEDEC JC15 Committee on Thermal Phenomena in Electronic Packages. He has published over 30 archival and conference papers, presented at SEMI-THERM and ITHERM conferences and co-authored a book chapter in 3D IC Stacking Technology. He holds a Ph.D. in Mechanical Engineering from Purdue University with a focus on boiling heat transfer.

Program Chair

Adriana Rangel, Cisco Systems

Adriana Rangel is as a thermal engineer at Cisco. She has worked on CFD analysis and experimental testing of electronic equipment for 18 years, covering a wide range of products. She has a Master's degree in Mechanical Engineering with emphasis in Thermal/Fluids engineering from San Jose State University.

Program Vice Chair

Pablo Hidalgo, Ph.D., Aavid Thermacore

Pablo Hidalgo is a senior thermal engineer in the R&D group at Aavid Thermacore working on the development of new products for military, aerospace, consumer products, data centers and medical applications. He is also helping to bring new business to the company in the aerospace and consumer electronics industries as well as writing proposals to obtain government funding from various agencies. Previously he spent eight years in the department of mechanical engineering at the Georgia Institute of Technology working as a research engineer. During his tenure at Georgia Tech, he worked in thermal management of high power electronics using diverse flow control techniques and aerodynamics. His professional experience and interests are in thermal management of electronics, single and two-phase cooling, heat pipes and vapor chambers, air-cooled heat exchangers, flow control, turbulent flows and fluid/structure interactions.

Schedule of Events Monday March 19, 2018
Short Courses

Concurrent short courses at SEMI-THERM 34 will be held in the morning and afternoon of March 19, 2018. These sessions are free to regular paid attendees.

8:00 a.m. – 12:00 p.m. **San Jose, Santa Clara, Carmel, Monterey**
Session Chair: Program Vice Chair Pablo Hidalgo, Aavid Thermacore

Short Course 1: Thermal Challenges for Power Electronics
Instructor: Brian Zahnstecher, PowerRox

Short Course 2: Managing Cooling Fan Noise and Power Consumption
Instructor: David Nelson, Nelson Acoustics

Short Course 3: Efficient Flow and Thermal Modeling of Large Scale Electronic Systems
Instructors: Jan Visser, Boyd Corp and Suhkvinder Kang, Aavid Thermacore

Short Course 4: Design of LED-based Applications
Instructors: Genevieve Martin, Philips Lighting and András Poppe, Mentor, A Siemens Business

Afternoon Short Courses
1:30 p.m. – 5:30 p.m. **San Jose, Santa Clara, Carmel, Monterey**
Session Chair: Program Vice Chair Pablo Hidalgo, Aavid Thermacore

Short Course 5: Experimental Measurements in Electronics Cooling Systems
Instructors: Alfonso Ortega, Santa Clara University and Marcelo del Valle, Intel

Short Course 6: Computational and Experimental Thermal Characterization for the Future of the Microelectronics Industry: A Philosophy and Promising Directions
Instructor: Peter Raad, Southern Methodist University

Short Course 7: Fundamentals of Vibration and Shock for Electronics Applications
Instructor: Nick Clinkinbeard, Rockwell Collins

3:30 p.m. – 6:30 p.m. **Bayshore Ballroom Foyer**
Attendee Registration

5:30 p.m. – 6:30 p.m. **Bayshore Ballroom Foyer**
Welcome Reception

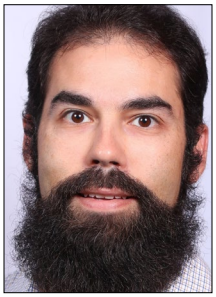
6:30 p.m. – 7:45 p.m. **San Carlos**
SEMI-THERM Program Committee Meeting

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.

Short Courses Monday March 19, 2018

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 Thermacore

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 Thermacore 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, A Siemens Business

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 healthcare 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 applications. 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.

Short Courses Monday March 19, 2018

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 SEMI-THERM Symposium.

Short Courses Monday March 19, 2018

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.

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

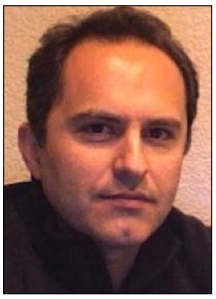
Nick Clinkinbeard is a Principal Mechanical Engineer for Rockwell Collins in Cedar Rapids, Iowa, where he has functioned as both a general design engineer and a vibration and shock specialist. For the past eleven years, he has worked in the Environmental Effects Engineering department, where his duties 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.

SEMI-THERM 34 KEYNOTE

Tuesday March 20, 2018 8:20 a.m.

Thermal Challenges and Industry Trends of Consumer Electronic Devices.
Dr. Andre Ali, Google

There are many thermal design challenges in consumer electronic devices including wearables, portable computing platforms and IOT communication devices. This talk covers industry trends in the consumer electronics hardware business and the role that thermal management and design plays, as well as how to cope with the trends to overcome power and thermal challenges.



Dr. Andre Ali currently heads thermal engineering for Google HW. He is a former chief thermal architect at Apple where he is credited for leading and innovating thermal technologies and design architectures for Apple's MacBook, MacBook Pro, MacBook Air, iPhone and iPad.
He is a former thermal technologist at Intel's mobile product group. His interests and research focus are in electronics thermal management and control, energy efficiency, renewable energy. Dr. Ali invented and published numerous patents and papers in the field of thermal management, CFD and two-phase heat transfer. He also served as keynote speaker, panelist and chair at various conferences and forums worldwide. He has a PhD in Mechanical Engineering from the University of Maryland.

Schedule of Events Tuesday March 20, 2018

7:00 a.m. – 7:45 a.m. — **San Jose**
Speakers' Breakfast — **(March 20 Speakers and Chairs only)**

7:00 a.m. – 5:00 p.m. — **Bayshore Ballroom Foyer**
Attendee Registration

8:10 a.m. – 8:20 a.m. — **Oak and Fir**
Symposium Opening and Welcome
General Chair:Jesse Galloway, Amkor Technology

8:20 a.m. – 9:20 a.m. — **Oak and Fir**
Keynote Address: Thermal Challenges and Industry Trends of Consumer Electronics Devices
Dr. Andre Ali, Google

9:20 a.m. – 9:40 a.m. — **Gateway Foyer**
Networking Break

9:40 a.m. – 11:00 a.m. — **Oak**
Parallel Session 1: 2.5D and 3D Electronics
Session Chair: Jesse Galloway, Amkor Technology

9:40 a.m. – 10:00a.m.
Application of Thermal Network Approach to Electrical-Thermal Co-simulation and Chip-Package-Board Extraction (Peer Reviewed)
Fengyun Zhao[1], Yuanbin Cai[1], Zipeng Luo[1], An-Yu Kuo[2], Xin Ai[2], C. T. Kao[2], Zhemin Zhuang[2]
[1]Huawei Technologies Co., Ltd., [2]Cadence Design Systems, Inc.

Continued

Schedule of Events Tuesday March 20, 2018 Continued

10:00 a.m. – 10:20 a.m.

Investigations of Low Temperature Co-fired Ceramic Heat Spreading Interposer for the Thermal Management of 3D Packages

Si Huang, Simon S. Ang, Department of Electrical Engineering /High Density Electronics Center University of Arkansas

10:20 a.m. – 10:40 a.m.

Delphi-like Compact Thermal Models using Model Order Reduction (Peer Reviewed)

B. Rogié[1], S. Grosjean[2], E. Monier-Vinard[3], V. Bissuel[3], F. Joly[4], O. Daniel[3], N. Laraqi[5], K. Vera[6]
[1]Université Paris Nanterre , Laboratoire Thermique Interfaces Environnement (LTIE), Thales Corporate Engineering, [2]Université Paris - Saclay, UEVE, Laboratoire de Mécanique et d'Energétique d' Evry, Thales Communication and Security, [3]Thales Corporate Engineering, [4]Université Paris - Saclay, UEVE, Laboratoire de Mécanique et d'Energétique d' Evry, [5]Université Paris Nanterre , Laboratoire Thermique Interfaces Environnement (LTIE), [6]Thales Communication and Security

10:40 a.m. – 11:00 a.m.

Multi-Die Packaging and Thermal Super-Position Modeling

Mike Kelly[1], Phillip Fosnot[1], Jonathan Wei[2], Max Min[3], Jesse Galloway[1]
[1]Amkor Technology, [2]eSilicon Corporation, [3]Samsung Foundry

9:40 a.m. – 11:00 a.m. **Fir**

Parallel Session 2: Two Phase Cooling/Liquid Cooling

Session Chair: Pablo Hidalgo, Aavid Thermacore

9:40 a.m. – 10:00 a.m.

Eulerian Multiphase Conjugate Model for Embedded Two-Phase Liquid Cooled Microprocessor (Peer Reviewed)

Pritish R. Parida[1], Mark Schultz[1], Ozgur Ozsun[2], Fanghao Yang[3], Michael Gaynes[4], Arvind Sridhar[2], Gerard McVicker[1], Thomas Brunschwiler[2], Timothy Chainer[1]
[1]IBM T. J . Watson Research Center, [2]IBM Research Zürich, [3]Princeton Plasma Physics Lab, [4]Universal Instruments Corporation

10:00 a.m. – 10:20 a.m.

Recent Advances in Oscillating Heat Pipes for Passive Electronics Thermal Management

Joe Boswell[1], Dr. Corey Wilson[1], Daniel Pounds[1], Dr. Bruce Drolen[2]
[1]ThermAvant Technologies, [2]Consultant

10:20 a.m. – 10:40 a.m.

Experimental Investigation of Direct Liquid Cooling of a Two-Die Package (Peer Reviewed)

Bharath Ramakrishnan[1], Sami Alkharabsheh[1], Yaser Hadad[1], Paul R. Chiarot[1], Kanad Ghose[1], Bahgat Sammakia[1], Vadim Gektin[2], Wang Chao[3]
[1]State University of New York at Binghamton, [2]Futurewei Technologies, [3]Huawei Technologies

10:40 a.m. – 11:00 a.m.

Continued

Schedule of Events Tuesday, March 20, 2018 Continued

Evaluation of Pulsating Heat Pipes for Outdoor Telecom Equipment
Chien-Hung (Sobo) Sun, Te-Hsuan (Rock) Chin, Celsia Technologies TW

11:00 a.m. – 11:20 a.m. **Gateway Foyer**
Networking Break

11: 20 a.m. – 12:40 p.m. **Oak**
Parallel Session 3: Concurrent Design/LED
Session Chair: Ross Wilcoxon, Rockwell Collins

11:20 a.m. – 11:40 a.m.
Natural Graphite Sheet Heat Sinks: A Review of the Material Properties, Benefits and Challenges (Peer Reviewed)
Martin Cermak[1], Majid Bahrami[1], John Kenna [2]
[1]Laboratory for Alternative Energy Conversion, School of Mechatronic Systems Engineering , Simon Fraser University, [2]Terrella Energy Systems Ltd.

11:40 a.m. – 12:00 a.m.
Different Questions of Today's LED Termal Testing Procedures
Gusztáv Hantos[1], János Hegedüs[1], András Poppe [1,2]
[1]Budapest University of Technology and Economics, [2]Mentor, A Siemens Business

12:00 p.m. – 12:20 p.m.
Numerical and Experimental Feasibility Study of Vapor Chambers for LED Applications
H.J. Eggink[1], A.J.H. Frijns[2], T.W.M. Janssen[2], G. Martin[1],
[1]Philips Lighting, [2]Technical University of Eindhoven, The Netherlands

11: 20 a.m. – 12:40 p.m. **Fir**
Parallel Session 4: Consumer Electronics
Session Chair: Bill Maltz, Electronic Cooling Solutions

11:20 a.m. – 11:40 p.m.
Use Of High Conductivity Spreaders On The Back Of Single-Sided PCB To Enhance Heat Transfer And Thermal Capacitance In Electronics Systems (Peer Reviewed)
Dr. Sankarananda Basak, Joshua Een, Intel Corporation, CCG

11:40 p.m. – 12:00 p.m.
Performance and Reliability of a 5G Smartphone RF-Antenna System: Influence of Temperature Field
David Rolando, Mehdi Abarham, Gokul Shankaran, Viral Gandhi, ANSYS Inc.

12:00 p.m. – 12:20 p.m.
An Early System-level Thermal Analysis Methodology for Advanced Electronic Subsystems
Karthik Srinivasan, Preeti Gupta, Wenbo Xia, Zhigang Feng, Stephen Pan, Paul Traynar, Norman Chang, ANSYS Inc.

Continued

Luncheon Speaker

Tuesday March 20, 2018 12:40 p.m.

ASHRAE Technical Committee 9.9 (TC9.9) Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
Presenter: Dr. Dustin W. Demetriou

ASHRAE Technical Committee 9.9 (TC9.9) on Mission Critical Facilities, Data Centers, Technology Spaces, and Electronic Equipment acts as the unbiased engineering leader in datacom heating, ventilation and air conditioning (HVAC) and an effective provider of technical datacom information. This committee was formed in response to the lack of effective information transfer between the building, HVAC and IT industries. TC9.9 expertise includes manufacturers, consultants, researchers, universities, utilities, regulators, contractors and government. These volunteers influence ASHRAE Standards, Research, Programs and Technical Activities (including a series of 13 datacom books).

In response to industry needs, ASHRAE TC9.9 has been very active in updating and producing new publications and standards to help bridge the gap between data center and datacom equipment designers and data center owner/operators. This presentation will specifically highlight and provide insight into three substantial publications produced by TC9.9 over the last year: Thermal Guidelines of Data Processing Environments: Fourth Edition, ANSI/ASHRAE Standard 90.4-2016 Energy Standard for Data Centers, and IT Equipment Power Trends: Third Edition. The presentation will also discuss current and future research underway within ASHRAE, including data center infrastructure management (DCIM), the impact of gaseous contamination and high humidity in IT equipment corrosion and CFD modeling of data centers, and what impact these efforts could have on future TC9.9 standards and guidelines.

Dr. Dustin W. Demetriou is a Senior Engineer at IBM Corporation in the IBM Systems Advanced Thermal Energy Efficiency Lab. He received a Ph.D. in Mechanical and Aerospace Engineering from Syracuse University. His research is focused on the analysis, application, and optimization of energy conversion systems, particularly in the area of high-density data centers and high-performance buildings, and the development of advanced electronics cooling technologies. He has co-authored two books in the ASHRAE Datacom Series, authored or coauthored over thirty journal and peer-reviewed conference publications in the areas of building simulation and energy efficient data centers and has been granted fourteen United States patents. He is the Vice Chair and a voting member of ASHRAE Technical Committee 9.9 on Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment. He serves as the Finance Chair for the IEEE ITherm (Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems) conference. Dr. Demetriou's work has been awarded numerous honors, including the ASHRAE Willis H. Carrier Award, All-University Doctoral Prize at Syracuse University, IEEE TCPMT Best Paper Award, the ASME Journal of Electronics Packaging Best Paper Award, ASME InterPACK best paper in Data Centers and Energy Efficient Electronic Systems and the best paper in the International Journal of Building Simulations. He also holds a MS in Mechanical and Aerospace Engineering from Syracuse University and a BS in Mechanical Engineering from Manhattan College.

Vendor Workshops Parallel Sessions

Tuesday March 20, 2018 2:00 p.m. - 5:00 p.m.
Session Chair Dave Saums, DS&A LLC

2:00 p.m. Mentor, A Siemens Business
Introducing Siemens Simcenter CFD Portfolio for Electronics

John Parry, Senior Industry Manager, Mentor, a Siemens Business
John Wilson, Product Specialist, Mentor, a Siemens Business
Patrick McGah, Applications Engineer, Siemens PLM

Siemens acquisition of Mentor has brought together several leading CFD solutions under the Simcenter portfolio, creating a broad range of thermal simulation technologies. The Simcenter CFD portfolio offers a complete range of simulation physics in the mechanical design of electronic systems and to meet the needs of a wide user demographic from design engineers to thermal analysts and simulation experts.

Topics:
- How the right thermal design solution, used at the right point in the development process can ensure thermal issues are addressed at the outset.
- Ensuring MCAD and EDA design workflows proceed without costly and time-consuming rework
- Recent example simulation studies:
    - Electric vehicle powertrain and autonomous driving sensor/processing electronics
    - Use of thermal measurement data to underpin thermal model fidelity
    - Links to mechanical stress solutions to ensure thermal design reliability can be assessed during development.

CFD simulation tools:
- FloTHERM and FloTHERM XT for thermal designers
- STAR-CCM+ for simulation engineers addressing thermal and multi-physics topics, including acoustics, dust accumulation, and fluid-structure interaction.
- FloEFD for mechanical designers who work in a CAD environment

3:00 p.m. Future Facilities
What's New in 6SigmaET Release12
Keith Bernstein, Operations Manager, Americas, and Chris Aldham, Development Manager
Future Facilities will demonstrate the latest release of their award winning electronics thermal design software, 6SigmaET. Release12 builds upon ET's unparalleled intelligence, automation and accuracy with a focus on four main areas: improved modeling, better performance, increased usability and supply chain collaboration.
Highlights include DELPHI model creation wizard, Linux solver support, ODB++ import, model in virtual reality with Oculus Rift, contact thermal resistance specification on CAD surfaces and new vendor libraries from Pabst and Parker Chomerics.

3:00 p.m. Long Win
Cooling Solutions and Studies for the ICT industry – Transient Fan Tests, Liquid Cooling Tests and Natural Convection Thermal Chamber
Long Win, as a leading-edge designer and manufacturer of test apparatuses, has provided versatile solutions for the ICT industry. We are about to share the following information.
1. Behavioral observations of radial velocity and axial pressure distribution for axial fans in a transient state with a frequency of up to 100 kHz
2. In data centers, TDP (thermal design power) of CPUs and GPGPUs is steadily increasing, but where are the cooling solutions? Liquid cooling could take an important role in the near future.
3. How can we simulate real application conditions of smartphones, laptops, wearable devices and Netcom units by practicing in a controllable natural convection environment?

4:00 p.m. t-Global Technology
Non-silicone Thermal Putty and How to Dispense It: A Hands-on Guide
Dr. Philip Blazdell, GM, t-Global Technology
With the decrease of time to bring a new product to market available, increased economic pressure and more functionality being required from smaller and more reliable devices, selection of the optimum thermal interface becomes a critical component of the design process. One way in which the total cost of ownership and time to market can be reduced is by the use of fully cured, silicone-free thermally conductive putties. Not only do these remove complexity from the bill of materials but allow designers to address challenges in the new way. For their vendor workshop, t-Global Technology will show case such a material and also give a hands-on demonstration of a simple automated dispensing machine appropriate for the optimisation of thermal designs.

Evening Tutorial

Tuesday March 20, 2018 7:30 p.m.

The Internet of Things — A Personal Perspective
Dr. Bruce Guenin

It is commonly acknowledged that the term Internet of Things (IoT) was created in reference to the introduction of RFID tags in 1999. They represented the first wave of autonomous sensors that enabled computers to observe, identify and understand the world—without the limitations of human-entered data. Since then, the types and numbers of sensors providing this function have increased exponentially. Also, through the use of big data analyses and machine learning, computers are able to analyze inputs of large numbers of sensors and can make rapid decisions based on the input data. We are seeing increasing use of this capability in manufacturing, farming, traffic control, healthcare, and the list goes on and on. We have also witnessed computer networks being hacked and huge amounts of data stolen and misused.

Where is all this heading? This presentation will describe current technical approaches for managing inputs from a large number of sensors and possible options for the future as the number of sensors is expected to increase by many orders of magnitude. It will discuss possible business opportunities for electronics cooling vendors in this new technology landscape. It will also address the bigger picture and speculate on what the future may hold for us, in terms of both benefits and risks.

Dr. Bruce Guenin has spent many years in the electronics and computer industries, which has given him a broad perspective on macro trends in these fields.
His previous affiliations include Oracle, Sun Microsystems, and Amkor Technology. He is on the Editorial Board of Electronics Cooling Magazine and is a past chairman of the JEDEC JC-15 Thermal Standards Committee and the SEMI-THERM Conference. His contributions to the thermal sciences have been recognized by receiving the Harvey Rosten Award in 2004 and the Significant Contributor Award by the SEMI-THERM Conference in 2010.
He received a B.S. degree in Physics from Loyola University, New Orleans, and the Ph.D. in Physics from the University of Virginia. He has authored and co-authored over 80 papers and articles in the areas of thermal and stress characterization of microelectronic packages, electrical connectors, solid state physics, and fluid dynamics and has been awarded awarded 18 patents in these areas. As an editor of Electronics Cooling he has contributed, to date, 35 installments of the tutorial column, Calculation Corner.

Schedule of Events Tuesday March 20, 2018 Continued

12:20 p.m. –12:40 p.m.
Package Thermal Challenges Due to Changing Mobile System Form Factors
Cameron Nelson, Jesse Galloway, Amkor Technology

12:40 p.m. – 1:45 p.m. **Pine and Cedar**
Luncheon and Presentation:
ASHRAE Technical Committee 9.9 (TC9.9) Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
Presenter: Dr. Dustin W. Demetriou, IBM

1:30 p.m. – 6:00 p.m **Bayshore Ballroom**
Exhibits Open

2:00 p.m. – 5:00 p.m. **Oak and Fir**
Vendor Workshops Parallel Sessions
2:00 p.m. – Mentor, A Siemens Business
3:00 p.m. – Future Facilities
3:00 p.m. – Long Win
4:00 p.m. – t-Global Technology

6:15 p.m. – 7:30 p.m. **Pine and Cedar**
Dinner

7:30 p.m. – 9:00 p.m. **Oak**
Evening Tutorial:
The Internet of Things: A Personal Perspective
Presenter: Dr. Bruce Guenin

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Schedule of Events Wednesday March 21, 2018

7:00 a.m. – 7:45 a.m. **San Jose**
Speakers' Breakfast
(March 21 Speakers and Chairs only)

7:00 a.m. – 5:00 p.m. **Bayshore BallroomFoyer**
Attendee Registration

8:10 a.m. – 8:20 a.m. **Oak and Fir**
Welcome Message
Program Chair: Adriana Rangel, Cisco Systems

8:20 a.m. – 9:40 a.m. **Oak and Fir**
Session 5: Simulation
Session Chair: Robin Bornoff, Mentor, A Siemens Business

8:20 a.m. – 8:40 a.m.
Developing an Empirical Correlation for the Thermal Spreading Resistance of a Heat Sink (Peer Reviewed)
Nicole Okamoto[1], Andrew Werdowatz[2], Hussameddine Kabbani[1]
[1]San Jose State Univ., [2]KES, Inc.

8:40 a.m. – 9:00 a.m.
Automated Structure Function Object Mapping
Byron Blackmore, Robin Bornoff, Joe Proulx, Andras Vass-Varnai, Mentor, A Siemens Business, Mechanical Analysis Division

9:00 a.m. – 9:20 a.m.
Comparison of Junction Temperature Prediction Methods through Analysis of Isolated-D Thermal Resistance Model Variables of an Application Utilizing Forced Convection of Heat Sinks (Peer Reviewed)
Klitzke, N.A., Polzer, S.C., Wilkins, W.L., Gilbert, B.K., Haider, C.R. , Mayo Clinic - SPPDG

9:20 a.m. – 9:40 a.m.
Power Map Modeling in Integrated Circuits and Power Devices Using ESI Presto
Swati Saxena, Kunal Jain, ESI Group US R

9:40 a.m. – 10:00 a.m. **Gateway Foyer**
Networking Break

10:00 a.m. – 11:00 p.m. **Oak and Fir**
Embedded Tutorial:
Selecting Adhesives and Thermally-Conductive Adhesives for Electronics Systems
Dave Saums, DS&A LLC, Tom Rogers, Polyonics

11:00 a.m. – 11:20 a.m. **Gateway Foyer**
Networking Break

11:20 a.m. – 12:40 p.m. **Oak**
Parallel Session 6: Data Center and Heat Sinks
Session Chair: Marcello del Valle, Intel

Continued

11:20 a.m. – 11:40 a.m.

Dynamic Rack Power Provision to Optimize Rack Power Performance (Peer Reviewed)

Song, Chuan[1], Jiang, Feng[1], Liang, Xiaoguo[1], Zhao, Zheng[2], Liu, Xingxing[2], Sun, Yanbing[1], Ahuja, Nishi[3], Kumar, Mohan J.[3], Zhou, Xiang[1], Li, Xiaozhong[2], Zhang, Lifei[2]

[1]Intel Asia - Pacific Research, [2]Baidu Ltd., [3]Intel

11:40 a.m. – 12:00 p.m.

Quantifying Data Center Performance (Peer Reviewed)

Kourosh Nemati, Aitor Zabalegui, Maira Bana, Mark J. Seymour, Future Facilities Ltd.

12:00 p.m. – 12:20 p.m.

A Transient Thermal Tester as an Alternative to Thermocouples for Characterizing Heat Sinks (Peer Reviewed)

Martin Cermak[1], Weikun Jimmy He[2], Majid Bahrami[1]

[1]Laboratory for Alternative Energy Conversion, School of Mechatronic Systems Engineering, Simon Fraser University, [2]Mentor, A Siemens Business

11:20 a.m. – 12:40 p.m. **Fir**

Parallel Session 7: Measurement Techniques

Session Chair: Kazuaki Yazawa, MicrosanJ

11:20 a.m. – 11:40 a.m.

Using SMT Chip Resistors Beyond Their Rated Thermal Specification (Peer Reviewed)

Jeevan Kanesalingam[1], Fabian Kung Wai Lee[2],

[1]Motorola Solutions, [2]A Medan Bayan Lepas, Penang, Malaysia

11:40 a.m. – 12:00 p.m.

Temperature Dependence of the Thermoreflectance Coefficient of Gold using a Phase-Locked Single- Point Measurement Approach

Assaad El Helou[1], Peter E. Raad[1], Pavel Komarov[2]

[1]Southern Methodist University, [2]TMX Scientific , Inc.

12:00 p.m. – 12:20 p.m.

Submicron Local and Time-dependent Thermal Resistance Characterization of GaN HEMTs (Peer Reviewed)

Dustin Kendig[1], Eiji Yagyu[2], Kazuaki Yazawa[3,4], Ali Shakouri[4],

[1]Microsanj, LLC., [2]Mitsubishi Electric Corporation, [3]Microsanj, LLC., [4]Purdue University

12:20 p.m. – 12:40 p.m.

Developing A Steady-State Theta jc Testing Standard For Electronic Packages

Jesse Galloway[1], Eduardo de los Heros[2],

[1]Amkor Technology, [2]Qualcomm Datacenter Technologies, Inc.

12:40 p.m. – 1:50 p.m. **Pine and Cedar**

Luncheon and Presentation:
Tales from the Mars Science Laboratory Thermal Protection System Development (Or, Try Not to Panic When Your Heatshield Material Disappears)

Presenter: Dr. Helen H. Hwang, NASA Ames

Continued


October 23, 2018
thermal LIVE 2018
ONLINE EVENT
The Largest Single Thermal Management Event of The Year - Anywhere.
Thermal Live™ is a new concept in education and networking in thermal management - a FREE 1-day online event for electronics and mechanical engineers to learn the latest in thermal management techniques and topics. Produced by Electronics Cooling® magazine, and launched in October 2015 for the first time, Thermal Live™ features webinars, roundtables, whitepapers, and videos... and there is no cost to attend.
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please visit:
thermal.live
thermal LIVE 2018
Presented by
electronics COOLING

Monday, March 19, 2018

8:00 a.m. – 12:00 p.m.
Morning Short Courses
Session Chair: Pablo Hidalgo, Aavid Thermacore

Short Course 1 — **San Jose**
Thermal Challenges for Power Electronics
Instructor: Brian Zahnstecher, Power Rox

Short Course 2 — **Santa Clara**
Managing Cooling Fan Noise and Power Consumption
Instructor: David Nelson, Nelson Acoustics

Short Course 3 — **Carmel**
Efficient Flow and Thermal Modeling of Large Scale Electronics Systems
Instructors: Jan Visser, Boyd Corp., and Suhkvinder Kang, Aavid

Short Course 4 — **Monterey**
Design of LED-based Applications
Instructors: Genevieve Martin, Philips Lighting, and András Poppe, Mentor Graphics

1:30 p.m. – 5:30 p.m.
Afternoon Short Courses
Session Chair: Pablo Hidalgo, Aavid Thermacore

Short Course 5 — **San Jose, Santa Clara**
Experimental Measurements in Electronics Cooling Systems
Instructors: Dr. Alfonso Ortega, Santa Clara University, and Dr. Marcelo del Valle, Intel

Short Course 6 — **Carmel**
Computational and Experimental Thermal Characterization for the Future of the Microelectronics Industry: A Philosophy and Promising Directions
Instructor: Peter E. Raad, SMU

Short Course 7 — **Monterey**
Fundamentals of Vibration and Shock for Electronics Applications
Instructor: Nick Clinkinbeard, Rockwell Collins

3:30 p.m. – 6:30 p.m. — **Bayshore Ballroom Foyer**
Attendee Registration

5:30 p.m. – 6:30 p.m — **Bayshore Ballroom Foyer**
Welcome Reception

6:30 p.m. – 7:45 p.m. — **San Carlos**
Program Committee Meeting

Tuesday, March 20, 2018

7:00 a.m. – 7:45 a.m. — **San Jose**
Speakers' Breakfast
(March 20 Speakers and Chairs only)

7:00 a.m. – 5:00 p.m. — **Bayshore Ballroom Foyer**
Attendee Registration

8:10 a.m. – 8:20 a.m. — **Oak and Fir**
Symposium Opening and Welcome
General Chair: Jesse Galloway, Amkor

8:20 a.m. – 9:20 a.m. — **Oak and Fir**
Keynote Address: Thermal Challenges and Industry Trends of Consumer Electronics Devices
Dr. Andre Ali, Google

9:20 a.m. – 9:40 a.m. — **Gateway Foyer**
Networking Break

9:40 a.m. – 11:00 a.m. — **Oak**
Parallel Session 1: 2.5D and 3D Electronics
Session Chair: Jesse Galloway, Amkor

9:40 a.m. – 11:00 a.m. — **Fir**
Parallel Session 2: Two Phase Cooling/Liquid Cooling
Session Chair: Pablo Hidalgo, Aavid Thermacore

11:00 a.m. – 11:20 a.m. — **Gateway Foyer**
Networking Break

11: 20 a.m. – 12:40 p.m. — **Oak**
Parallel Session 3: Concurrent Design/LED
Session Chair: Ross Wilcoxon, Rockwell Collins

11: 20 a.m. – 12:40 p.m. — **Fir**
Parallel Session 4: Consumer Electronics
Session Chair: Bill Maltz, Electronic Cooling Solutions

12:40 p.m. – 1:50 p.m. — **Pine and Cedar**
Luncheon and Presentation:
ASHRAE Technical Committee 9.9 (TC9.9) Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
Presenter: Dr. Dustin W. Demetriou, IBM

1:30 p.m. – 6:00 p.m — **Bayshore Ballroom**
Exhibits Open

2:00 p.m. – 5:00 p.m. — **Oak and Fir**
Vendor Workshops Parallel Sessions

6:15 p.m. – 7:30 p.m. — **Pine and Cedar**
Dinner

7:30 p.m. – 9:00 p.m. — **Oak**
Evening Tutorial:
The Internet of Things: A Personal Perspective
Presenter: Dr. Bruce Guenin

Wednesday, M

7:00 a.m. – 7:45 a.m.
Speakers' Breakfast
(March 21 Speakers and C

7:00 a.m. – 5:00 p.m.
Attendee Registration

8:10 a.m. – 8:20 a.m.
Welcome Message
Program Chair: Adriana Ra

8:20 a.m. – 9:40 a.m.
Session 5: Simulation
Session Chair: Robin Born Business

9:40 a.m. – 10:00 a.m.
Networking Break

10:00 a.m. – 11:00 p.m.
Embedded Tutorial:
Selecting Adhesives and Conductive Adhesives f
Dave Saums, DS&A LLC, T

11:00 a.m. – 11:20 a.m.
Networking Break

11:20 a.m. – 12:40 p.m.
Parallel Session 6: Data
Session Chair: Marcello de

11:20 a.m. – 12:40 p.m.
Parallel Session 7: Meas
Session Chair: Kazuaki Yaz

12:40 p.m. – 1:50 p.m.
Luncheon and Presenta
Tales from the Mars Scie
Thermal Protection Syste
(Or, Try Not to Panic Whe
Material Disappears)
Presenter: Dr. Helen H. Hw

1:30 p.m. – 6:30 p.m.
Exhibits Open

2:00 p.m. – 5:00 p.m.
Vendor Workshops Para

5:15 p.m. – 6:30 p.m.
Exhibitor Reception

7:00 p.m. – 9:00 p.m.
How To Courses

AL WEEK

March 19 - March23, 2018
San Jose, CA

arch 21, 2018

San Jose

Chairs only)

Bayshore Ballroom Foyer

Oak and Fir

angel, Cisco Systems

Oak and Fir

hoff, Mentor, A Siemens

Gateway Foyer

Oak and Fir

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or Electronics Systems
om Rogers, Polyonics

Gateway Foyer

Oak

Center and Heat Sinks
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n Your Heatshield

wang, NASA Ames

Bayshore Ballroom

Oak and Fir

llel Sessions

Bayshore Ballroom

Oak and Fir

Thursday, March 22, 2018

7:00 a.m. – 7:45 a.m. — San Jose
Speakers' Breakfast
(March 22 Speakers and Chairs only)

7:00 a.m. – 2:00 p.m. — Gateway Ballroom Foyer
Attendee Registration

8:10 a.m. – 8:20 a.m. — Oak and Fir
Welcome Message
General Chair: Jesse Galloway, Amkor

8:20 a.m. – 9:20 a.m. — Oak and Fir
"THERMI" Award Presentation
Bruno Michel, IBM Zurich Research Laboratory

9:20 a.m. – 9:40 a.m. — Gateway Foyer
Networking Break

9:40 a.m. – 11:00 a.m. — Oak and Fir
Session 8: Thermal Interfaces
Session Chair: Gene Pruss, Laird

11:00 a.m. – 11:20 a.m. — Gateway Foyer
Networking Break

11: 20 a.m. – 12:20 p.m. — Oak
Parallel Session 9: Air Mover Technologies with Low Acoustics
Session Chair: David Nelson, Nelson Acoustics

11: 20 a.m. – 12:20 p.m. — Fir
Parallel Session 10: Automotive/Aerospace/ Outdoor
Session Chair: Shailesh Joshi, Toyota

12:30 p.m. – 1:50 p.m. — Pine and Cedar
Awards Luncheon

2:00 p.m. – 4:00 p.m. — Bayshore Ballroom, Siskiyou, Donner
Panel Discussion: Challenges in Consumer Electronics Cooling
Moderator: Mark Carbone, Intel

4:30 p.m. – 6:00 p.m. — San Carlos
Post Conference Review Meeting

Friday, March 23, 2018

8:00 a.m. – 12:00 p.m. — San Carlos
JEDEC JC15 Meeting
(Members Only)
Chair: Jesse Galloway, Amkor Technology Inc.

Thermal Characterization Techniques for Semiconductor Packages
Activities within JC-15's scope include the standardization of thermal characterization techniques, both testing and modeling, for electronic packages, components, and materials for semiconductor devices.

The following events are open to all Registered **SEMI-THERM** Attendees:

Tuesday:
- Exhibits
- Vendor Workshops
- Evening Tutorial

Wednesday:
- Exhibits
- Vendor Workshops
- How To Courses

Thursday:
- Panel Discussion

Plan on attending SEMI-THERM 35 at the DoubleTree by Hilton in San Jose, CA, March 18-22, 2019.

Consider submitting an abstract for a paper presentation at ST 35.

The Call for Papers (CFP) will be listed at www.SEMI-THERM.org by April 1, 2018.

SEMI-THERM will be accepting abstracts for both peer and non-peer reviewed papers shortly thereafter, with a final submission deadline on September 15, 2018.

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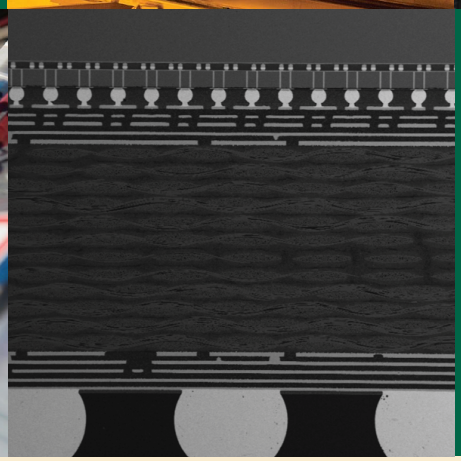

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- Energy-Smart Electronic Systems
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September 18-19, 2018
Binghamton University
Binghamton, NY

binghamton.edu/s3ip

Embedded Tutorial

Wednesday March 21, 2018 10:00 a.m.

Selecting Adhesives and Thermally-Conductive Adhesives for Electronics Systems

Tom Rogers
Technical Director, Polyonics Inc., Westmoreland NH USA
Dave Saums
Principal and Founder, DS&A LLC, Amesbury MA USA

Part I – Thermal Interface Material Categories

Dave Saums (20 minutes)

I. Terminology for Thermal Interface Materials
II. TIM categories
Why does understanding different TIM categories matter?
Fourteen TIM category definitions
Table: Category definitions, basic relative differences
Thermally-conductive adhesive TIMs
Adhesives and mechanical clamping: Differences in packaging and uses of each
III. Thermal performance testing of TIMs
Thermal resistance and bulk thermal conductivity: Which matters for selecting a TIM for an application?
Understanding TIM data sheet performance values and sources of data
Sources of TIM data sheet performance values
Standard test methodologies for TIM performance*

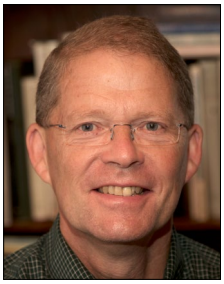
* This must be a very abbreviated discussion, to minimize time consumed.

Part II – Adhesives and Thermally-Conductive Adhesives

Tom Rogers (40 minutes)

I. Adhesive categories
Principal chemistries
Common applications by principal category
Important distinctions
II. Thermally-conductive adhesives
Principal types
Common applications
III. Selection process for thermally-conductive adhesives
IV. High-temperature thermally-conductive adhesives

Part III – Q&A



Dave Saums has thirty-nine years of technical marketing, product development, and business development experience with advanced thermal materials, thermal components, and two-phase liquid cooling systems.

Dave has operated a consulting firm focused on thermal materials and components for fourteen years, in addition to twenty-five years' experience with thermal component and materials manufacturers.

Tom Rogers is the Technical Director at Polyonics, Inc., where he leads the company's product and technology development efforts with an emphasis on specialty films, tapes, and interface materials for electronics applications.

Tom has a BS and MS in Chemical Engineering from the New Jersey Institute of Technology and University of Idaho, respectively. He also has an MBA from Xavier University.

Luncheon Speaker

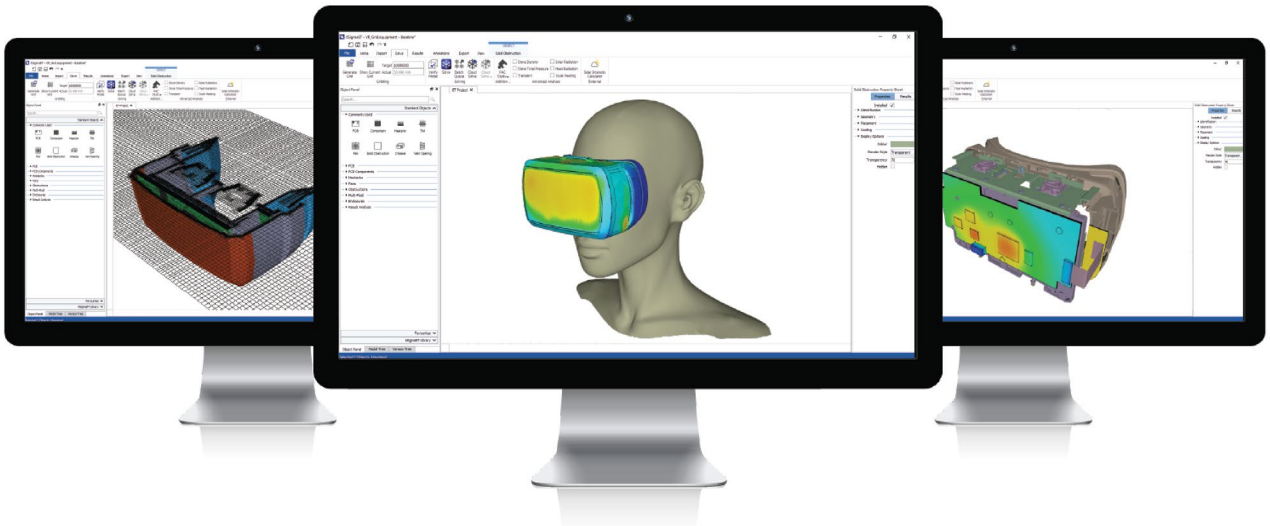
Wednesday March 21, 2018 12:40 p.m.

Tales from the Mars Science Laboratory Thermal Protection System Development (Or, Try Not to Panic When Your Heatshield Material Disappears)

Presenter: Dr. Helen H. Hwang, NASA Ames

In 2012, the entry vehicle for the Mars Science Laboratory (MSL) mission was the largest and heaviest vehicle flown to another planet, designed to be able to withstand the largest heat fluxes in the Martian atmosphere ever attempted. The heatshield material that had been successfully used for all previous Mars missions had been baselined in the design, but during the development and qualification testing demonstrated catastrophic and unexplained failures. With only 10 months remaining before the original launch date, the TPS team led by NASA Ames designed and implemented a first-ever tiled, ablative heatshield. Highlights from MSL of the testing difficulties and innovations required to execute a new heatshield design will be presented, along with a sneak peak of the Mars 2020 mission.

Dr. Helen H. Hwang received her Ph.D. from the University of Illinois at Urbana-Champaign in Electrical Engineering studying semiconductor plasma processing. She has been at NASA Ames Research Center for the past 20 years, specializing in planetary entry vehicles. She was the Thermal Projection System (TPS) Project Manager for the Mars Science Laboratory (MSL) mission and continues in that role for the current Mars 2020 mission. She has also served as the Principal Investigator for the Mars 2020 Entry, Descent, and Landing Instrumentation 2 (MEDLI2) Project. She currently oversees the proposal and flight projects as the Science Missions Development Manager for the Entry Systems and Technology Division.



How-To Courses
Evening concurrent sessions — Wednesday March 21, 2018

7:00 p.m. – 8:00 p.m. — **Oak**

Applying the Steinberg Component Fatigue Equation to Estimate Life
Nick Clinkinbeard, Rockwell Collins

Several years ago, Dave S. Steinberg presented an empirically-based equation to estimate component fatigue life during equipment exposure to vibration, as published in Vibration Analysis for Electronic Equipment and Preventing Thermal Cycling and Vibration Failures in Electronic Equipment. Although widely used, the equation was developed for a specific set of boundary conditions (simply-supported boundary conditions on four edges of a rectangular printed circuit board) that limits its application. This How-To session will describe the fundamental approach developed by Steinberg to estimate the fatigue life of electronic components. In addition, it will describe a method developed by the author, by reverse-engineering Steinberg's equation and applying engineering judgment, to extend the approach to estimate component fatigue on circuit boards with many different shapes and boundary conditions.

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.

7:00 p.m. – 8:00 p.m. — **Fir**

How to Select an Air Mover
Presented by: Guy Wagner, Electronic Cooling Solutions Inc.

This How-To session focuses on the basics of fan/blower selection and their interaction with system airflow. Topics will include basic types of air movers, choosing the proper type of air mover for the system, determining the most efficient operating point, the effect on noise and power draw, and other applications.

Guy Wagner has 45 years of experience in the electronics industry. His experience includes cooling of a wide variety of electronics using natural, forced air and liquids, avionics cooling, medical device cooling, IC packaging technology, disk drive and computer system design. Mr. Wagner is an expert in the development of cooling technology for systems ranging from small handheld natural convection devices to liquid cooled 20 KW neural network learning machines. He has authored over 40 papers and presentations at international conferences and holds 29 patents.

Before becoming a Director at Electronic Cooling Solutions, he held positions as a Director of Engineering at Cornice Inc., Chief Scientist for the HP/Agilent Technologies PolarLogic Business Unit, and Member of Technical Staff at AT&T Bell Laboratories.

Guy's degrees in Mechanical Engineering are from Iowa State University.

How-To Courses
Evening concurrent sessions

Wednesday March 21, 2018

8:00 p.m. – 9:00 p.m. **Oak**

How to Use Content to Turn Thermal Management Sales Leads into Customers
Graham Kilshaw, ITEM Media

The days of having a sales plan that relies primarily on cold actions to generate leads – calls, emails, and visits – is long gone. Now, you need a multi-pronged sales approach that incorporates timely content that entices a prospect to come to you, and builds a relationship of trust between your company and your prospects. But how do you know what types of content to create and – even more importantly – how to use content in the sales cycle?

Join Graham Kilshaw, CEO of ITEM Media, in this interactive session as he takes you through the steps in building a realistic content marketing strategy, while providing you the opportunity to ask questions and contribute thoughts along the way.

Some of the topics discussed will include how to:

- Deliver the right content at the right time
- Develop key accounts with personalized content
- Repurpose content to minimize workload
- And more.

By the end of the presentation, you'll have completed a checklist of next-steps and developed a toolbox of content development and marketing tactics that you can take back to the office and begin implementing immediately.

Graham Kilshaw is the CEO of ITEM Media: a marketing agency and publisher that services the electronics industry with sales-driven marketing strategies and its media brands Electronics Cooling (dedicated to thermal management) and Interference Technology (dedicated to EMI/EMC). From his 20 years' experience as CEO, Graham has developed a comprehensive understanding of the business needs of the US and international electronics industry. Combined with his background in sales, media, and marketing, Graham has transitioned ITEM Media from a traditional print publisher to a marketing powerhouse specialized in multi-channel marketing, events, content development, and sales enablement - all for its clients within the electronics equipment, components, materials, software, and testing service spaces.

8:00 p.m. – 9:00 p.m. **Fir**

App Development Challenge
Ross Wilcoxon, Rockwell Collins

The App Development Challenge overview will describe two apps developed for Android platforms to provide users with simple tools for estimating electronics cooling performance issues such as heat sink thermal resistance, cooling air requirements, heat pipe performance, etc. The app will be made available to SEMI-THERM attendees for their own use. In addition, this session will include an open discussion of how to extend this activity to encourage SEMI-THERM participants to develop their own mobile apps that can be used to analyze thermal systems, evaluate design options, provide useful information for analysts, teach important concepts in the field of electronics cooling, etc. The goal will be for conference attendees to share their apps, with the most useful ones being recognized at the conference.

Ross Wilcoxon is a Principal Mechanical Engineer in the Rockwell Collins Advanced Technology Center. He conducts research and supports product development related to component reliability, electronics packaging and thermal management for communication, processing, displays and radars. Ross is also an editor for Electronics Cooling Magazine and a past General Chair for SEMI-THERM. Prior to joining Rockwell Collins in 1998, he was an assistant professor at South Dakota State University.

Vendor Workshops Parallel Sessions
Wednesday March 21, 2018 2:00 p.m. - 5:00 p.m.
Session Chair Dave Saums, DS&A LLC

2:00 p.m. – Mentor - A Siemens Business
Improvements in thermal characterization techniques & electronics acoustic trouble shooting
Andras Poppe & Byron Blackmore - Mentor, A Siemens Business
Charles Rice, Siemens PLM
Thermal Characterization: the latest enhancements in the application of accurate thermal transient test technology (MicReD T3Ster) and uses of structure function analysis of a semiconductor heat flow path from junction to ambient are presented. Topics will cover rapid device thermal properties assessment, calibration of thermal simulation models through to thermal reliability and quality assessment. Highlights:

- JESD 51-14 standard & a technique for improving structure function accuracy: Initial electric transient compensation
- Automatically calibrating multiple detailed thermal models in FloTHERM simultaneously (power electronics module example)
- Quality assessment in manufacturing: volume testing application of thermal characterization
- Diode device characterization – a new fast, intuitive test approach

Acoustic Testing: The second topic of this workshop is acoustic trouble-shooting in consumer electronics industry using 3D sound source localization. The unique capability of the Siemens LMS Soundbrush to combine real-time 3D sound intensity with sound source localization within a compact all-in-one solution will be discussed. Additionally, fan aero acoustic noise prediction using Simcenter simulation will also be reviewed.

3:00 p.m. – ANSYS
Electro-Thermal Analysis through a Multiphysics System Simulation Approach
Aravind Sathyanarayana, Ph.D., Application Engineer, ANSYS
Abstract: Today's rapidly evolving products are getting smarter and often include complex interactions between components, sub-assemblies and systems. As product complexity grows, so does the challenge of integrating the individual components in a system to ensure they work as expected. Optimizing each component of the system separately does not guarantee optimal behavior of the entire system. This calls for a system simulation approach integrating each individual component to create a complete virtual prototype. In industries such as automotive, aerospace and industrial automation, organizations use robust systems-level simulation to identify potential problems, early in the design stages, that other build-and-test methods cannot detect.
Recent breakthrough developments in simulation technology and high-performance computing make it possible to analyze these systems with high accuracy and fidelity. In this workshop, ANSYS experts will discuss how simulation can be used to analyze products using domain specific tools and solve a system level model through the example of a planar magnetic transformer in a system level setting. The system level model consists of an enclosure with PCB and its components. The electromagnetic performance of the planar magnetic transformer alone is first evaluated using 3D eddy current analysis. The performance of the transformer in a system level setting is analyzed through a bi-directional, iterative electro-thermal coupling. Finally, a Reduced Order Model (ROM) is created to represent the full 3D model as a 1D system. The ROM representation enables analyses, typically orders of magnitude faster than the detailed simulation.

Schedule of Events Wednesday March 21, 2018 Continued

1:30 p.m. – 6:30 p.m. — **Bayshore Ballroom**
Exhibits Open — *Continued*

2:00 p.m. – 5:00 p.m. — **Oak and Fir**
Vendor Workshops Parallel Sessions
2:00 p.m. – Mentor, A Siemens Business
3:00 p.m. – ANSYS

5:15 p.m. – 6:30 p.m. — **Bayshore Ballroom**
Exhibitor Reception

7:00 p.m. – 9:00 p.m. — **Oak and Fir**
How To Courses

Thursday March 22, 2018 12:30 p.m.

The 2017 Harvey Rosten Award



Paper: Lifetime Isoflux Control of LED Based Light Sources
János Hegedüs, Gusztáv Hantos, András Poppe
For Outstanding Work in the Field of Thermal Analysis of Electronic Equipment.

János Hegedüs received his BSc degree in electrical engineering from the Budapest University of Technology and Economics (BME, Hungary) in 2012 and completed the joint Erasmus+ international master's program of BME, the Heriot Watt University (UK) and the Vestfold University Collage (Norway) with an MSc degree in smart systems integration in 2015. He has been active in LED multi-domain characterization since 2013, starting as an engineering intern at Mentor Graphics MicReD where he conducted combined thermal and radiometric/photometric measurements of LEDs in order to derive the first multi-domain LED models aimed for a commercial thermal simulator. His BSc and MSc thesis were also related to LED modeling and currently he is working towards his PhD at BME, Department of Electron Devices in the field of LED modeling, considering also the elapsed LED operating time. János Hegedüs is actively involved now in the Delphi4LED H2020 ECSEL project of the EU.

Gusztáv Hantos received his electrical engineering BSc and MSc degrees from the Budapest University of Technology and Economics (BME) in 2009 and in 2012, respectively. He also obtained an MBA degree from BME in 2012. Currently he is the manager of BME's thermal testing laboratory. He has been participating in BME's thermal research projects since 2009. Most recently he coordinated the LED round-robin testing of the Delphi4LED project. He conducted MOSFET and LED ageing and reliability experiments in the NANOTHERM project of the EU and he contributed to OLED multi-domain characterization in the framework of the Fast2Light EU FW7 project. Currently he is working on his PhD dissertation related to reliability testing of semiconductor components.

András Poppe obtained his PhD degree from the Budapest University of Technology and Economics (BME) in 1996. Currently he is the head of the Department of Electron Devices of BME. He has been active in characterization of LEDs and OLEDs since 2003; he initiated the development of an equipment aimed at the combined thermal and radiometric/photometric testing of power LEDs. He also has more than 2 decades of expertise in multi-domain modelling and simulation of semiconductor devices. He had significant contributions to JEDEC's and CIE's LED testing standards / recommendations; currently he is chairing the TC2-84 technical committee of CIE and is an active member of the JEDEC JC15 committee. András Poppe is the leader of the LED modelling workpackage of the Delphi4LED project of the EU.

The Harvey Rosten Award

The award is for outstanding work, recently published or in the public domain, which advances the analysis or modeling of thermal or thermomechanical effects in electronic equipment or components, including experiments aimed specifically at the validation of numerical models. The award is in the form of a plaque and a $1000 cash prize. The award was established by the family and friends of Harvey Rosten, to commemorate his achievements in the field of thermal analysis of electronics equipment, and the thermal modeling of electronics parts and packages. The Award is made annually to encourage innovation and excellence in these and closely related fields.

The recipient is selected by the Selection Committee, made up of eminent practitioners in the electronics-thermal field.
The criteria for selection are:

- The work represents an advance in thermal analysis or thermal modeling of electronics equipment or components, including experiments aimed specifically at validating numerical models.
- The work demonstrates clear application to practical electronics design.
- The work demonstrates insight into the physical processes affecting the thermal behavior of electronics components, parts and systems.
- The work is innovative in embodying this understanding in either thermal analysis or thermal modeling.
- A pragmatic approach is taken in the application of the work.

Schedule of Events Thursday, March22, 2018

7:00 a.m. – 7:45 a.m. — **San Jose**
Speakers' Breakfast
(March 22 Speakers and Chairs only)

7:00 a.m. – 2:00 p.m. — **Gateway Ballroom Foyer**
Attendee Registration

8:10 a.m. – 8:20 a.m. — **Oak and Fir**
Welcome Message
General Chair: Jesse Galloway, Amkor Technology

8:20 a.m. – 9:20 a.m. — **Oak and Fir**
"THERMI" Award Presentation
Bruno Michel, IBM Zurich Research Laboratory

9:20 a.m. – 9:40 a.m. — **Gateway Foyer**
Networking Break

9:40 a.m. – 11:00 a.m. — **Oak and Fir**
Session 8: Thermal Interfaces
Session Chair: Gene Pruss, Laird

Continued

Schedule of Events Thursday March 22, 2018 Continued

9:40 a.m. – 10:00 a.m.
Thermal Resistance of Electrical Insulation Bolted and Clamped Discrete Power Devices
Mikel Garcia-Poulin,[1] Mehran Ahmadi[1], Majid Bahrami[1], Eric Lau[2], Chris Botting[2]
[1]Laboratory for Alternative Energy Conversion, School of Mechatronic Systems Engineering, Simon Fraser University, [2]Delta-Q Technologies Corp.

10:00 a.m. – 10:20 a.m.
Using Electrical Capacitance and Mechanically Representative Hardware to Evaluate the Thermal Mechanical Stability of Thermal Interface Materials (Peer Reviewed)
Lauren Boston[1], Andrew Yu[1], Michael Gaynes [2]
[1]Binghamton University, [2]Universal Instruments Corporation

10:20 a.m. – 10:40 a.m.
Investigation of Pressure Dependence of Interface Thermal Resistance in Thermal Greases by Transient Thermoreflectance (Peer Reviewed)
Mihai G. Burzo, Ming Li, University of Michigan - Flint

10:40 a.m. – 11:00 a.m.
In-Plane Thermal Diffusivity Measurement of Highly Thermal Conductive Thin Films by the Flash Method
Heng Wang, Jozef Gembarovic, Silviu Apostolescu, Daniele Paganelli, Piero Scotto, TA Instruments-Waters LLC

11:00 a.m. – 11:20 a.m. **Gateway Foyer**
Networking Break

11: 20 a.m. – 12:20 p.m. **Oak**
Parallel Session 9: Air Mover Technologies with Low Acoustics
Session Chair: David Nelson, Nelson Acoustics

11:20 a.m. – 11:40 a.m.
In Search of a Quiet Fan
David Nelson, Nelson Accoustics

11:40 a.m. – 12:00 p.m.
NASA ISS Portable Fan Assembly Acoustics
Andrew Boone, PE[1], Christopher S. Allen[2],
[1]MEI Technologies, [2]NASA JSC

Continued

Schedule of Events Thursday March22, 2018 Continued

12:00 p.m. – 12:20 p.m.
Design and Optimization of Contra-Rotating Fans
Ralph Peter Mueller[1], Oliver Velde[1], Christian Friebe[2]
[1]CFturbo Inc., [2]ILK Dresden

11:20 a.m. – 12:20 p.m. **Fir**
Parallel Session 10: Automotive/Aerospace/Outdoor
Session Chair: Shailesh Joshi, Toyota (TEMA)

11:20 a.m. – 11:40 a.m.
An Electro-Thermal Performance Analysis of SiC MOSFET vs Si IGBT Automotive Traction Inverters Under Various Drive Cycles
Asantha Kempitiya, Wibawa Chou, Infineon Technologies Americas Corp.

11:40 a.m. – 12:00 p.m.
Generative Heatsink Design for an Automotive Audio Amplifier
Robin Bornoff, Brad Subat, John Wilson, Mentor, A Siemens Business, Mechanical Analysis Division

12:00 p.m. – 12:20 p.m.
Light-Weight and High-Performance Air-Cooled Heat Sinks
Mohammad Reza Shaer, Richard W. Bonner III, Advanced Cooling Technologies, Inc.

12:30 p.m. – 1:50 p.m. **Pine and Cedar**
Awards Luncheon

2:00 p.m. – 4:00 p.m. **Bayshore Ballroom, Siskiyou, Donner**
Panel Discussion: Challenges in Consumer Electronics Cooling
Moderator: Mark Carbone, Intel

4:30 p.m. – 6:00 p.m. **San Carlos**
Post Conference Review Meeting

Schedule of Events Friday March23, 2018

8:00 a.m. – 12:00 p.m. **San Carlos**
JEDEC JC15 Meeting
(Members Only)
Chair: Jesse Galloway, Amkor Technology
Thermal Characterization Techniques for Semiconductor Packages
Activities within JC-15's scope include the standardization of thermal characterization techniques, both testing and modeling, for electronic packages, components, and materials for semiconductor devices.

Thursday March 22, 2018 12:30 p.m.

THERMI Award

Each year, SEMI-THERM honors a person as a Significant Contributor to the field of semiconductor thermal management. The THERMI award is intended to recognize a recipient's history of contributions to crucial thermal issues affecting the performance of semiconductor devices and systems.
The voting body of past THERMI winners and the current year General Chair are pleased to present the 2018 THERMI Award to:

Dr. Bruno Michel

IBM Zurich Research Laboratory

Bruno Michel received a Ph.D. degree in biochemistry and computer engineering from the University of Zurich, subsequently joining IBM Research to work on scanning probe microscopy and accurate large-area soft lithography. As part of the Advanced Micro Integration effort, he improved thermal interfaces and miniaturized convective cooling. Based on this technology and heat driven heat pumps, he demonstrated improved efficiency and energy re-use in datacenters as well as photovoltaic thermal solar concentrators. He developed microfluidics, 3D packaging with interlayer cooling and electrochemical chip power supply as a new density roadmap that can replace the currently slowing Moore's Law. Most recently he is focusing on smart system integration of IoT and wearable devices, combining efforts that span from new sensing principles over ultra-miniaturized compute platforms to multi sensor data fusion and cognitive computing.

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Extension MEDIA

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Panel Discussion

Thursday March 22, 2018 2:00p.m – 4:00p.m.

Challenges in Consumer Electronics Cooling

"Challenges in Consumer Electronics Cooling" will address how current challenges are being met and will emphasize future challenges, how they are framed, and what approaches and technologies might be applied to overcome them. Each panelist will give a 10 minute presentation from their perspective, with 30 minutes for audience questions.

Moderator: Mark Carbone, Intel

Co-Topic Champions: Consumer Electronics

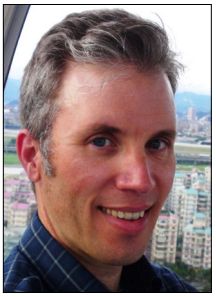
William Maltz, President, Electronic Cooling Solutions, wmaltz@ecooling.com

and Mark Carbone, Senior Thermal Engineer, Intel, mark.carbone@intel.com

Mark Carbone, is a member of Client Research & Development at Intel.
His heat transfer work spans 35 years as both a manager and a design engineer. It includes electronics cooling and temperature control designs for everything from phones and tablets to mainframes and one supercomputer. Highlights include jet impingement liquid cooling for high power multi-chip modules, cooling and control system responsibility for all Macintosh computers at Apple, heat sink design and manufacture, and architecture of the industry's first single touch full wafer tester. His qualifications include a BS in Mechanical Engineering, 2nd concentration in Physics at the University of Hartford, an MS in Mechanical Engineering from the Rensselaer Polytechnic Institute and an MBA in Management from New York University. He has 13 issued patents.

William Maltz is the president and founder of Electronic Cooling Solutions, and has over 30 years of experience in thermal management of electronic systems. Mr. Maltz has worked on the design of thermal solutions for products that range from low power consumer products to high performance multiprocessor computer systems and high-end core routers. His technical responsibilities include managing multiple projects and working closely with engineering management at a number of companies.
Mr. Maltz has been an active organizer for SEMI-THERM and the IMAPS Advanced Technical Workshop on Thermal Management. He is also a co-author for a number of technical papers.

Panelists:



Andy Delano leads the Microsoft surface team's thermal architectural efforts primarily focusing on the Pro product line. Prior to joining Microsoft in 2012, Andy managed an r&d team within Honeywell's specialty materials division developing and launching highly successful products for the electronics packaging industry. Andy started his career in 1998 as a thermal engineer at Hewlett-Packard working on enterprise server and workstation thermal design. While at HP, Andy was also an adjunct professor at CU and taught heat transfer, thermodynamics, and thermal systems design between 1999 and 2005. Andy obtained his Ph.D. in mechanical engineering from Georgia tech in 1998 and his thesis was on a single pressure absorption refrigerator originally patented by Albert Einstein. During the first part of his graduate studies, Andy also worked on the design and production of the 1996 Olympic Torch and spent 6 weeks traveling with the torch relay.

Panel Discussion

Thursday March 22, 2018 2:00p.m – 4:00p.m.

Challenges in Consumer Electronics Cooling

Panelists (continued):

Jie Yang is a Staff Thermal Engineer with Huawei.
He holds a Ph.D. from Huazhong University of Science and Technology in Wuhan, with an undergraduate degree from University of Science and Technology Beijing.
Specializations include:
- Software & hardware thermal management and coupling design
- Thermal modeling methodology and model extraction for dynamic compact thermal model in both chip and system levels
- Thermal behavior for phase-changing material and its application for electronic devices

Emil Rahim is a senior thermal engineer at Google, leading the thermal architecture of multiple consumer devices. Prior to joining Google, Emil worked as a thermal engineer, with focus on consumer electronics, at Electronics Cooling Solutions, Qualcomm, Amazon's Lab126, and GoPro. Emil holds a PhD degree in mechanical engineering from the University of Maryland, he authored and co-authored five journal articles, thirteen conference publications, and four published US patents.

Guy Wagner is a Director at ECS in their Rocky Mountain Office, and has 45 years of experience in the electronics industry. His experience includes: IC and system cooling and packaging technology, disk drive design, computer system design, and design of telephone switching systems. He is an expert in cooling of electronics systems and IC packages. Guy has authored and presented 40 papers at international technical conferences and has 29 patents.
Prior to joining ECS, Mr. Wagner was Chief Scientist at HP in Fort Collins and a Member of the Technical Staff at Bell Laboratories. Mr. Wagner received his MS in Mechanical Engineering at Iowa State University.

Gabriel Khouri is a Director of Engineering - Drone Development at Intel. He has led thermal mechanical engineering for over 25 years. In the last five years, he led teams in product design exploration, feasibility, and innovation in various electronics industries such as mobility/converged computing, ambient compute, virtual reality, and drone technology. Prior to Intel, Mr. Khouri led the product development of high volume consumer electronics at Motorola where he played a major role in the introduction of a multitude of products to the global market.

SEMI-THERM®

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We are proud to sponsor:

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Lifetime Achievement Award

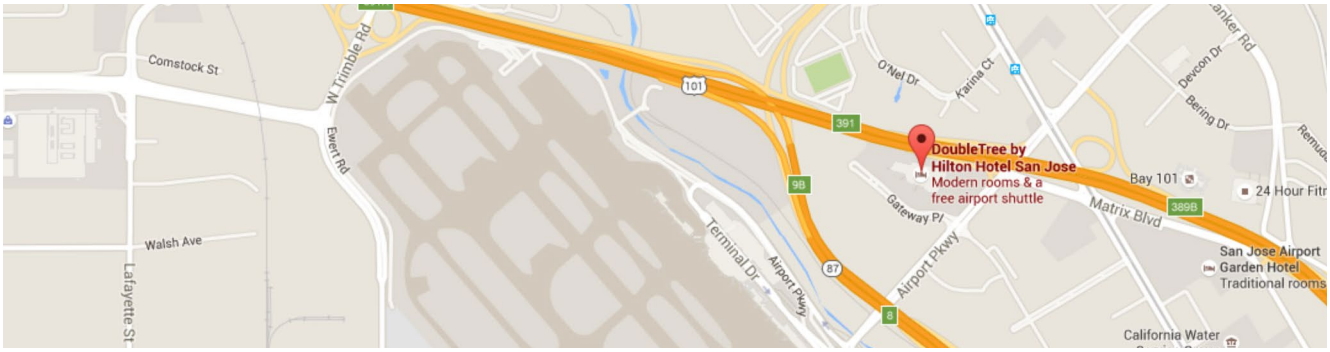
Presented To

Bernie Siegal

In Recognition of Significant Contributions
to the Field of Electronics Thermal Management

Bernie Siegal's first involvement in semiconductor thermal matters came in 1966 while working at the microwave semiconductor group within Hewlett-Packard Associates (HPA). Bernie and an associate developed an automated system for making thermal resistance measurements on microwave diodes and authored a feature article describing the method, which appeared in the October 1967 issue of the HP Journal. From that beginning to today, Bernie has been an active participant in the semiconductor measurement, modeling and management field. In 1974, Bernie founded SAGE Enterprises, Inc. and began offering test equipment for measurement of thermal resistance for many different types of semiconductor devices. The thermal testing techniques Bernie developed eventually became incorporated into many of the industry (SEMI and EIA/JEDEC) and US military measurement (Mil Std 750) standards. Besides being actively involved in many of the various standards-creating committees, Bernie is co-founder and primary force behind the start of SEMI-THERM, the premier technical symposium in the field. He has authored over 40 technical papers, presented seminars to world-wide audiences, and conducted several short courses for the UC Berkeley Extension program. His current company, THERMAL ENGINEERING ASSOCIATES, INC. (TEA), maintains his involvement in the field. Bernie holds M.B.A. (Santa Clara University), M.S.E.E. (San Jose State University), and B.S.E.E. (Cornell University) degrees. He was elected a Fellow of the IEEE and received the IEEE Significant Contributor Award for his work in the semiconductor thermal field. He currently serves as the Chairman of the IEEE CPMT Silicon Valley Chapter.

SEMI-THERM 34 Location: DoubleTree by Hilton San Jose
2050 Gateway Place, San Jose, CA 95110
Phone: 1 (408) 453-4000



EXHIBITOR LISTINGS

AI Technology, Inc.
AI Technology, Inc. has more than 25 years of experience and successes in helping military, aerospace, computer, and super-computer manufacturers with thermal compound and thermal interface materials for building some of the most reliable electronic devices and computers. Since pioneering the use of flexible epoxy technology for microelectronic packaging in 1985, AI Technology, Inc. has been one of the leading forces in development of patented applications of advanced material and adhesive solutions for electronic interconnection and packaging. The company continues to provide adhesive solutions for component and substrate bonding for both military and commercial applications. It's thermal interface material solutions of patented phase-change thermal pads, thermal grease and gels and thermal adhesives set many bench marks of performance and reliability for power semiconductor and modules, computer and communication electronics.

Analysis Tech
Semiconductor Thermal Testers: Complete measurement systems for device thermal resistance, impedance, & die-attach quality using transient & steady state electrical-junction temperature-measurement. Transient structure function analysis is used to delineate internal-package resistances & measure Rjc via JEDEC 51-14. Power Cycling systems for device life-testing with automatic monitoring of thermal deterioration with age. Test services offered. Thermal Interface Material Testers: ASTM D5470 based testers offering fast & accurate measurement of thermal conductivity & contact resistance of electronic-packaging materials over a wide range of thickness, pressure, & temperature. Test services offered. Event Detectors: Electrical reliability-testers for passive interconnects including solder joints & connectors, with easy integration to thermal-cycle, drop-test, shock, and vibration gear; based on JEDEC and IPC standards for interconnect reliability testing.
www.analysistech.com

Alpha Novatech, Inc.
Alpha Novatech, Inc. is your partner for Thermal Solutions.
We offer a wide variety of standard heat sinks and accessories. Our product line includes natural convection, forced convection, and active heat sinks. We also offer various attachment methods and hardware for almost any application. In addition, we can offer free heat sink thermal simulations. Standard or custom heat sinks in prototype to production quantities Quick and easy customization without NRE fees, while featuring short lead times Standard parts are carried in stock Lead time for custom parts of 1-2 weeks is possible for initial quantities.

ANSYS
ANSYS is the leading provider of electronic cooling, electromagnetic field, circuit and system simulation software for the design of high-performance electronic equipment. Companies throughout the world rely on ANSYS software to solve thermal integrity, mechanical reliability, signal integrity, power integrity and EMI challenges in IC, package and PCB and perform power optimization in custom IC's. Ansys develops open and flexible simulation solutions that enable users to simulate design performance directly on the desktop, providing a common platform for fast, efficient and cost-effective product development, from design concept to final-stage testing and performance validation. Engineers rely on ANSYS to achieve first-pass system success when designing mobile communication devices, broadband networking components and systems, integrated circuits (ICs), printed circuit boards (PCBs) and electromechanical systems. ANSYS' unique multiphysics platform provides a highly-accurate design flow for fast, efficient and simulation driven product development.

EXHIBITOR LISTINGS

Cadence

Cadence enables electronic systems and semiconductor companies to create the innovative end products that are transforming the way people live, work and play. Cadence® software, hardware and semiconductor IP are used by customers to deliver products to market faster. The company's System Design Enablement strategy helps customers develop differentiated products—from chips to boards to systems—in mobile, consumer, cloud datacenter, automotive, aerospace, IoT, industrial and other market segments. Cadence is listed as one of Fortune Magazine's 100 Best Companies to Work For. Learn more at cadence.com.

CFturbo GmbH

The Germany-based company CFturbo GmbH offers sophisticated software and engineering solutions for conceptual design of Turbomachinery components like impellers, vaned and vaneless stators and volutes or complete Turbomachinery stages. CFturbo® software can be used to design axial, radial and mixed-flow pumps, blowers, compressors and turbines, as well as for diffusers, stators, return channels and volutes. Recently new developed modules to create axial fans, axial turbines, axial pumps and inducers allow the design of a greater variety of Turbomachinery models then before. Additionally, the company offers a wide range of consulting and engineering services for Turbomachinery applications including design, simulation, optimization and prototyping. Experimental investigation on Turbomachinery can be provided with experienced partners.

Celsia

Celsia specializes in custom heat sink design and manufacturing using liquid two-phase devices: heat pipes and vapor chambers. Through its US headquarters and Taiwan design & production facility, the company's goal is to deliver fast, affordable, and reliable thermal solutions for the most demanding applications including high density electronics, performance CPU / GPU, amplifiers, HBLEDs, ASICS, and rugged systems. In recent years, Celsia has shipped over 2.5 million thermal assemblies to a global custom base in the telecommunications, computer, test equipment, defense, laser, and medical markets.

Chilldyne

Chilldyne sells liquid cooling systems optimized for data centers. Our direct-to-chip liquid cooling Cool-Flo® system offers all the benefits of liquid cooling without reducing uptime and with no worries about leaks. The system utilizes hybrid air-and-liquid-cooled heat sinks and negative pressure to deliver a zero-downtime, leak-proof, low-cost solution. Our system is optimized for ease of installation and operation so that all the rack and server level connections do not require a plumber. The system installs into most servers and racks with no modifications making the switch to modern liquid cooling an easy decision.

CEJN North America

CEJN North America, the Quick Connect Solution Provider, delivers couplings and solutions for your liquid cooling needs. Our Leak-Free, Non-Drip coupling series offers high flow and minimal pressure drop; and Blind Mating options range from DN 3 to DN 19. CEJN's new UltraFlow Series features an extremely high flow combined with an unequalled low pressure drop. Customized solutions are also available. At CEJN, we develop our products for a future in liquid cooled data centers. Contact us: PHONE: 847-263-7200, by email: customer.service,usa@cejn.com, or via www.cejn.us

COFAN USA

At COFAN USA, we keep your hot technology cool. COFAN USA is an industry leading manufacturer in thermal management solutions with inhouse thermal engineering team providing thermal simulation service and consultation to our customers. With more than 20 years of expertise, we've had the pleasure of serving a diverse customer base in many industries. We offer quick turnaround product inquiries and prototyping services. We pride ourselves in giving the best possible customer service, the highest quality products with the shortest lead time, and competitive pricing in the industry. To learn more about us, please visit www.cofan-usa.com

EXHIBITOR LISTINGS

CoolIT Systems

CoolIT Systems specializes in scalable liquid cooling solutions for individual servers through to the world's largest data centers. Through its modular, rack-based Direct Contact Liquid Cooling technology, Rack DCLC™, CoolIT enables dramatic increases in rack densities, component performance and power efficiencies. From cold plates specifically designed for the latest high TDP processors from Intel, NVIDIA and AMD, through to manifolds and heat exchangers, CoolIT's reliable technology installs into any server or rack, ensuring ease of adoption and maintenance.

Delta Fan and Thermal Products Group

The Delta Fan and Thermal Products Group designs and builds innovative cooling systems that perform at the highest levels – even in the harshest environments.

The Delta Fan and Thermal product line offers a full range of axial fans, blowers, heat pipes, vapor chambers and liquid cooler products.

The unique patented design and innovative structure greatly increases cooling performance and reduces system noise. Delta fans and thermal products can be found worldwide, serving a wide range of industries and organizations. Highly efficient cooling solutions can be customized to fit the needs of virtually any business

CPC

CPC thinks beyond the point of connection to help protect valuable electronics. Designed specifically for liquid cooling applications, rugged couplings withstand long periods of connection yet disconnect reliably without drips.

Eisele

Eisele Connectors, Inc. manufactures a complete line of robust all-metal push-in fittings, acid-resistant and corrosion-free stainless-steel components, multiple-media connectors and plastic tubing used in Automation, Food, Pharma, Medical, Robotics, Automotive, and Packaging industries. We also provide technical support and specialize in providing custom leak-free connection solutions for applications where others simply don't. Our sales office and warehouse are located in Grand Rapids, Michigan to provide quick shipping and technical support to our growing customer base in North America. All of our products are 100% made in Germany.

DegreeC

DegreeC engineers airflow and delivers solutions. We make airflow sensors, instruments for measuring airflow, and custom-designed intelligent systems that deliver precise flows of air exactly where it's needed. We do this at chip scale, board level, box scale, room scale and for entire buildings. Our largest application is intelligent cooling systems to address the heat generated by densely packed electronics for a variety of industries...but we also offer airflow-based solutions for non-thermal applications - where precise measurement and control of the quantity and/or direction of airflow is critical.

Element Six

Element Six, a De Beers Company, designs, develops and produce diamond supermaterials. Poly- and single crystal diamond products and composites are used in fine machining and polishing applications. New technologies using CVD diamond include thermal management for laser diodes, power devices, RF amplifiers and resistors. Element Six also manufactures high power laser optics, beam splitters, IR spectroscopy accessories and high energy radiation sensors.

EXHIBITOR LISTINGS

ESI Group

ESI Group - Leading Innovator in Virtual Prototyping Software and Services. Specialist in material physics established in more than 40 countries, ESI has developed a unique proficiency in helping industrial manufacturers replace physical prototypes by virtually replicating the fabrication, assembly and testing of products in different environments.

ESI offers solutions for simple physics to complex coupled physics. ESI-PRESTO is a complete CFD analysis solution for the thermal management in the electronics industry that will help in the design of high-performance components and systems at the lowest cost.

Exatron

Exatron is an American made provider of low to high volume, fully integrated automation for programming, IoT, MEMS, test & mark applications. We start with pick & place, inline, rotary, or gravity feed transport mechanisms. Pick any combination of input and output, JEDEC tray, tape & reel, tube, boat, stack, or bowl feed. We interface to any OEM or in-house programmer. We build in laser markers, labelers, and ink jet printers. Add on top/bottom inspection, OCR, 1D/2D bar code vision. Tie this all together with Exatron generated Windows GUI. Building beyond your expectations since 1974.

Fujipoly

Fujipoly is a world leader in the manufacture of Sarcon® Thermal Interface Materials, which are used to help keep sensitive electronic components cool by eliminating the air gap between the component and heat sink. Our products range in thermal conductivity from 1.0m watt/m-K to 17 watt/m-K, offering some of the lowest thermal resistance in the industry. Our product line-up consists of soft Gap Filler Pads, Conformable Putties, Form-In-Place Gap Fill Materials, as well as custom and standard die-cut thin film materials. Our wide range of material types, coupled with the widest range of thermal conductivity, allows us to meet most design criteria. Fujipoly has nine locations in North America, Europe, and Asia making it easy for us to assist our customers at the local level.

Future Facilities

We set Future Facilities up to deliver the power of engineering simulation into the hands of an emerging data center industry. We created a tool optimized for data centers, designed to be used by the DC professional, and made it powerful, intelligent, automated and connected. Five years later, we tuned our technology to deliver the same benefits to the thermal management of electronics and provide an integrated toolset for these two converging industries. We develop engineering simulation software that allows our customers to quantify and qualify business decisions balancing risk against cost. Our offering covers the full spectrum starting from electronics design to data center design and operations. Our software provides a safe, offline environment in which to create virtual prototypes, troubleshoot existing designs and run what-if scenarios for future configurations.

H.C. Starck

As a global leader in technology metals, H.C. Starck manufactures thermal management components from W and MoCu composites, CuMoCu laminates, plated Mo and W flat products for demanding applications in aerospace, military, high speed trains and automotive industries. The reliability and efficiency of semiconductor devices and electronic packaging are optimized through maximization of the thermal conductivity of heat dissipating components. H.C. Starck provides enhanced thermal conductivity and unique capabilities to tailor excessive heat dissipation hot spots by minimizing thermal resistance through optimization of CTE between the device and thermal component using our low CTE robust refractory metal and composite products.

Indium Corporation

Indium Corporation is a premier materials manufacturer and supplier to the global electronics, semiconductor, thin-film, and thermal management markets. Products include solders and fluxes; brazes; thermal interface materials; sputtering targets; indium, gallium, germanium, and tin metals and inorganic compounds; and NanoFoil®. Founded in 1934, Indium has global technical support and factories located in China, Malaysia, Singapore, South Korea, the United Kingdom, and the USA.

For more information about Indium Corporation, visit www.indium.com or email abrown@indium.com. You can also follow our experts, From One Engineer To Another® (#FOETA), at www.facebook.com/indium or @IndiumCorp.

EXHIBITOR LISTINGS

Jones Tech PLC
Jones Tech provides creative thermal and EMI solutions to improve the reliability of electronic equipment. Established in 1997, with its rich R&D resources and manufacturing experience, Jones Tech has been serving consumer electronics, telecommunications, IT, medical, and renewable energy customers. We are a long-term supplier to 4 of the top 5 Silicon Valley companies. Our thermal interface material (TIM) includes thermal pads, gel, grease, thermal phase change materials (PCM), and graphite TIM. For heat spreaders, we are a leading supplier of synthetic and natural graphite. We have in-house rotary and flatbed die-cutting capabilities. For heat storage materials, we offer PCM pads, gel and potting material. We can help with manual or robotic dispensing. Additionally, we help solve problems with EMI and RF related components.

Long Win
Long Win specializes in research, design, manufacture and service of scientific instruments for thermal managing, material & fluid mechanic and educational fields. Long Win holds a leading position on research, measurement and inspection apparatus for the electronic cooling market. Some of their product lines include thermal-related measurement apparatus for fan performance, TIMs, cooler modules, heat pipes, vapor chambers, IC packages, LEDs, liquid cooling, thermal and flow test for servers, racks and data center, and natural-convection simulation. They have more than 100 types of apparatus in their 18,000 sq. ft. lab which is located in Taiwan and a lab based in Livermore, California.

KULR
KULR's proprietary carbon fiber-based architecture replaces less efficient aluminum and copper based heat spreaders and exchangers, which are energy intensive and less environmentally friendly to produce. Carbon fiber thermal interface materials are superior alternatives to particle based thermal interface materials for higher performance, lower contact pressure, higher compliance, and longer reliability.

Man Zai
As a leader in electronic liquid cooling system, Man Zai offers a wide range of thermal modules for CPU, VGA, LED, Bio-Chemical and automotive electronic device. The thermal team is equipped with state of the art hardware and software, which includes wind tunnel testing, hydraulic test equipment, simulation software, helium & air leakage test equipment and ultra-high-speed pre-filling technology. We are able to establish long-term relationships with several world-wide famous brand names. The quality system and sophisticated R&D capability in Man Zai will provide our customers the best thermal solution.

LISAT
LISAT manufactures High Quality Thermal Interface & EMI materials. We offer High Thermal Conductivity from 1W to 15W. Our Graphite thicknesses are up to 1,000um (1.00mm). We bond Graphite with Copper/Aluminum Foil for better structure. We have Removable Thermal Gel. Our Non-Cure Sealant (without curing) replaces Gaskets and Epoxy.
Our products: Thermal Interface Material (TIM), Silicon Free TIM, Thermal Gel & Grease, Graphite, Conductive Plastic, Elastomer, Fabric-Over-Foam, Microwave Absorbing Material, Metal Finger Stock, EMI Shielding Solution, Non-Cure Sealant, Switching Power Supply Desktop, Wall Mount Adaptor, Metal Core PCB (MCPCB) and Ceramic PCB.

Materion
Materion Advanced Materials is an industry leader in providing durable and best-cost solutions for ceramic packages and hermetic cover/lids for the microelectronics industry. We offer a comprehensive portfolio of packaging materials in precious or non-precious material and can customize innovative electronic package materials to satisfy your unique needs. Our high-reliability packaging also supports most configurations, applications and volume requirements. Because of our industry expertise, extensive global manufacturing capabilities and R&D proficiency, we are able to meet customers' packaging requirements today and partner with them to meet future challenges.

EXHIBITOR LISTINGS

Mentor, A Siemens Business
Electronics Cooling & Multi-physics CFD Simulation Update:

Siemens acquisition of Mentor Graphics has brought together several leading CFD solutions under the Simcenter portfolio. A complete range of simulation physics for the mechanical design of electronic systems now meets the needs of a wide user demographic from design engineers to thermal analysts and CFD simulation experts. Solutions include:

- FloTHERM and FloTHERM XT for thermal analysts and designer engineers
- STAR-CCM+ for simulation specialists addressing thermal and multi-physics CFD tasks, including acoustics, dust accumulation, and fluid-structure interaction.
- FloEFD - CAD-embedded CFD for mechanical engineers working primarily in the CAD environment

MicReD – Thermal Characterization Test Solutions

MicReD T3Ster® thermal transient test technology provides accurate, fast, repeatable measurement for semiconductor thermal characterization, thermal model calibration, failure diagnosis and manufacturing defect identification. Find out about Structure Functions (Rth-Cth profiles), TIM material testing, LED thermal/photometric characterization and power semiconductor thermal reliability testing using active power cycling and degradation diagnosis with the Power Tester Product Range.

Acoustic Testing (Siemens PLM):
Acoustic troubleshooting and sound source localization for consumer electronics is possible with the unique Siemens LMS Soundbrush & Sound Camera solutions that combine real-time 3D sound intensity measurement and 3D sound field visualization on CAD geometry.

MSC Software
MSC Software is a leading provider of Computational Fluid Dynamics (CFD) software including SC/Tetra (general purpose unstructured mesh), scSTREAM (general purpose Cartesian mesh), and HeatDesigner (Cartesian mesh for electronics). Since inception in 1984, Cradle has established itself as a major innovator that is advancing the role of simulation in engineering design. Our software products are well known for ease of use, exceptionally fast and powerful meshing, efficient solvers, sophisticated physical models, and professional post processing. In 2016, has joined MSC Software Corporation, the worldwide leader in the field of multidiscipline simulation.

NeoGraf Solutions, LLC
NeoGraf Solutions, LLC is a company with a rich history that stretches back over 135 years. With a strong culture of innovation and development, NeoGraf offers the largest portfolio of flexible graphite thermal management solutions. NeoGraf offers solutions for a variety of markets ranging from Thermal Interface materials for Computing and Power Electronics to heat spreaders for the most demanding of smartphones.
6 R&D 100 awards over the past 15 years, including eGRAF® HITHERM™ Thermal Interface Material, eGRAF® SPREADERSHIELD™ heat spreaders, both Natural and Synthetic Graphite, and the 1st compressible graphite TIM, is a testimony to the long history of technical innovation.

Package Science Services
We are IC packaging experts. Decades of experience support development of standard and custom high performance IC packages that precisely match the performance of your chip or device on time and within your budget. Our engineering teams provide package selection, design, layout, prototype, and production solutions. Design, modeling and simulation tools are used for signal and power integrity, thermal/mechanical, and manufacturing process simulation and analysis. To close the loop, thermal and electrical test labs provide in-house validation and testing services. Located in Santa Clara, CA. Contact us and come by for a tour of our labs and discuss how we can help you solve your IC packaging challenges.

QuantaCool Corporation
Highly efficient, environmentally friendly, reliable
passive two-phase cooling systems for data centers and high-performance computers. QuantaCool Corporation has developed and patented two-phase cooling systems that use highly efficient proprietary cold plates to remove heat without pumps or water. Waste heat to be moved to remote locations with greater reliability. QCC's technology improves heat management and enables energy recovery possibilities. QuantaCool has introduced both PolarRak™ and PolarBox™ systems to serve the Data Center and High Performance computing segments.
The QCC PolarRack™ System, requires less initial capital, increases data center capacity, and reduces total energy costs by up to 80%. QCC's PolarBox™ is intended for use by gamers and bit coin miners who require intensive computing power.

EXHIBITOR LISTINGS

Schlegel
Introducing our OpTIM-Thermal Interface Materials & BandSorb™ Absorbers.
OpTIM products are a line of thermal interface materials that offer a wide range of thermal performance and physical properties and can resolve even the most challenging thermal problems.
Our TIMs have already been used in various electronic equipment's /components including advanced micro-processors, high speed memory modules, micro heat pipe assemblies and LED Lightning.
Our new BandSorbtm™ SC product line will help to suppress unwanted EMI/RFI energy. BandSorbtm SC series is suitable for most commercial, telecommunication, automotive, military and medical applications. The high magnetic loss of the BandSorbtm™ SC series is designed to exhibit high loss and is intended to be applied to metal surfaces. When placed on the inside of a microwave cavities BandSorbtm SC series will reduce the Q of the cavity, eliminate surface currents and generally dampen reflections.

Schunk Carbon Technology
Schunk Carbon Technology is a world leader in the development and production of carbon and graphite materials and components for the automotive and railway industries. Additionally, we provide two graphite-based solutions for the electronics cooling industry. The composite, Aluminum Graphite (ALG), combines the low coefficient of thermal expansion and density of graphite with the excellent thermal properties of aluminum to create an ideal thermal management material for high-reliability applications.
With its ready machinability, we can produce customized ALG parts in various quantities with a range of platings. Latent Heat Carbon is our newest flagship composite based on phase change materials. It is an exemplary material for thermal storage applications and wherever temperature peaks and spikes must be buffered. Our patented Expand-to-Shape process allows us to create uniquely complex parts to suit every customer's individual needs at an attractive cost.

Shin-Etsu MicroSi
Shin-Etsu MicroSi is the leader in Thermal Interface Material, and we have developed an extensive line of Molding Compounds, Encapsulents, Silicon and Epoxy coatings along with die Attachment Materials. The quality of our thermal interface material is among the most advanced in semiconductor manufacturing and has a wide range of use in thermal interface material applications. Some of which include thermal gels and grease, phase change materials, and high hardness silicone rubber pads. Shin-Etsu products are delivered globally to many major and minor companies involved in the fabrication process of electronics and microelectronics.

Stäubli
Stäubli is an innovative mechatronics solutions provider with three dedicated activities: Connectors, Robotics and Textile. With a workforce of over 4500, Stäubli has a presence in 25 countries and agents in 50 countries around the world. As one of the leading manufacturers of quick connector systems, Stäubli covers connection needs for all types of fluids, gases and electrical power. These standard or specific products – including single and multiple connectors, tool changers and quick mold change systems – combine performance, quality, safety, dependability and durability.

TennMax
TennMax is a leader in EMI shielding and Thermal Management. Our primary focus is to provide a complete solution utilizing our advanced knowledge in conductive silicones, gasketing, plastic metallization, heat pipe assemblies and phase change materials.
TennMax offers both Silicone and Non-Silicone thermal interface materials, which can be provided as a pad or dispensible gel form. We also have full thermal design and manufacturing services targeted towards full custom thermal assemblies.

EXHIBITOR LISTINGS

t-Global Technology

t-Global Technology is a leading supplier of advanced thermal management solutions. We design, develop and manufacture our own range of interface materials based on the stringent needs of our key markets. From our European and Asian locations, we offer design support, rapid sampling and full engineering support.
It is this corporate philosophy that has fuelled our growth and allowed our customers to come to market with technologically appropriate products. Our continued links with key customers, academic institutions and industrial decision makers will feed t-Global Technology's development so that we remain your number one choice for all your thermal management needs.

Tran-Tec LLC

Since 1971 Tran-Tec has been supplying the electronics industry with thermal solutions. From prototype through production we offer a library of over 200 extrusion profiles, dozens of bonded fin options, liquid cooled chill plates, and 47 years of experience. Tran-Tec offers full CNC Machining, class II anodizing and finishing as a one-stop shop for your heat sink needs.

Thermal Engineering Associates

TEA is a company founded by Bernie Siegal, a 35+-year veteran and recognized technical leader in the semiconductor thermal field. The company's mission is to provide a central source for the products and services necessary for proper semiconductor thermal measurement and modeling and solutions to attendant thermal management problems. Through its own products and services, augmented by an extensive network of technical experts around the world, TEA can assist customers in finding solutions. The Tech Briefs and Hot Links pages provide useful information to those interested in semiconductor and electronics thermal issues. We welcome the opportunity to discuss your thermally-related measurement, modeling and/or management requirements.

WACKER

WACKER is a global silicone leader with a broad portfolio of products designed for the needs of the electronics industry. Our SEMICOSIL®, SilGel®, and ELASTOSIL® brands are globally recognized in the industry. Please stop by our booth and learn how our potting gels, adhesives, and newest thermal interface materials can help you meet your design challenges.

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KULR

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Scholarships will be given to each of the best papers in the general or specific technology areas described below.

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Best Student Paper at SEMI-THERM

Annual
Celsia, Inc.
$1,000
Best Student Paper in the area of
Two-Phase Thermal Management Technology and/or Application

Annual
Thermal Engineering Associates, Inc.
$1,000
Best Student Paper in the area of
Thermal Measurement Technology and/or Application

Annual
Center for Energy-Smart Electronic Systems
Binghamton University
$1,000
Best Student Paper in the area of
Energy-Smart Electronic Systems Technology and/or Application

To be eligible, candidates must:
- Be senior undergraduate or graduate students at a recognized university
- Part of a significant contributor on an academic or industry team
- Be the first or second student author of the technical paper
- Be the paper presenter at SEMI-THERM

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