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SEMI-THERM®

35
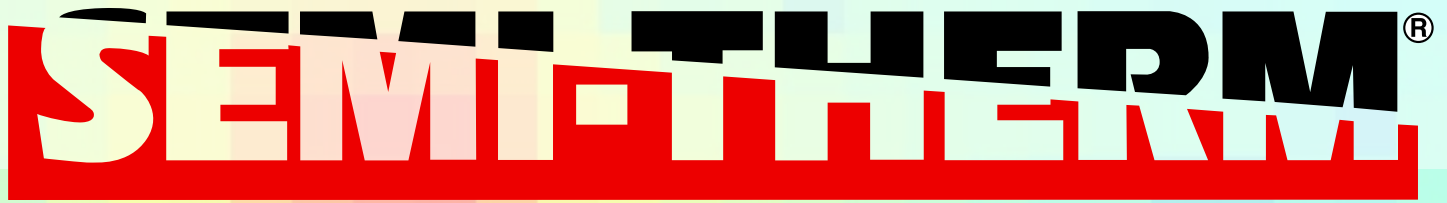
SEMI-THERM® 35
The 35th Annual Thermal Measurement,
Modeling and Management Symposium
March 18th - 22nd, 2019
Thermal Innovations that Make the World's Technology Cool

San Jose, California at the Doubletree by Hilton
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SEMI-THERM 35

Welcome to SEMI-THERM 35!

Adriana Rangel, Cisco Systems, Inc.
Symposium General Chair

Dear Colleagues,

Welcome to the SEMI-THERM 35 annual conference. This year, the program committee has assembled an excellent program dedicated to thermal design, thermal management as well as measurement of semiconductor systems and components.

The SEMI-THERM conference is committed to provide a forum for discussion of the latest advances in electronic thermal management. This year's program provides 6 short courses which are included with the conference registration. They are presented by experts in a variety of topics. The short courses are designed to educate our engineering community and to start our conference with an opportunity to learn and network on the first day, Monday March 18th. An evening tutorial will be presented on Tuesday night and How -to courses complete the evening on Wednesday after the exhibitor reception.

The program committee has also put together a fantastic morning program that includes technical papers, a keynote speaker and 2 luncheon speakers. On Tuesday and Wednesday afternoon, the SEMI-THERM exhibits are open to all as well as vendor workshops, with both providing opportunities to learn more about innovative thermal products and vendors.

At the Thursday luncheon, as part of SEMI-THERM tradition, an award session will include the presentation of the THERMI award, the Harvey Rosten awards, as well as the Thermal Hall of Fame, Lifetime Achievement award. The Best Paper in different categories will also be recognized.

The Harvey Rosten award recipients are James W. VanGilder, Christopher M. Healey, Michael Condor, Wei Tian, Quentin Menusier. The THERMI award recipient is Dr. Peter Raad from Southern Methodist University. The Thermal Hall of Fame Lifetime Achievement will be presented to Márta Rencz, in recognition of significant contributions to the field of electronics thermal management.

I would like to congratulate the Program Chair, Pablo Hidalgo, and Vice- Chair, Marcelo del Valle, for this year's outstanding conference program. I hope you will enjoy attending this symposium, and I look forward to a wonderful week of learning and networking.

Sincerely,

Adriana Rangel
Symposium General Chair

SEMI-THERM 35

SEMI-THERM 35 SYMPOSIUM PERSONNEL

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SEMI-THERM 35 Chair Persons

General Chair

Adriana Rangel, Cisco Systems

Adriana Rangel is a thermal engineer at Cisco, where she is responsible for Catalyst 9200 and 9300 product lines on the enterprise networking group. Previous to Cisco, she worked as a thermal engineer consultant for Electronic Cooling Solutions, where she provided expert thermal analysis for a many bay area tech companies. She also worked as an engineering manager and helped trained junior engineers on CFD software and equipment testing. She has 20 year experience on CFD analysis and experimental testing of electronics, covering a wide range of products. She has a Master's degree in Mechanical Engineering with emphasis in Thermal/Fluids from San Jose State University.

Program Chair

Pablo Hidalgo, Aavid

Pablo Hidalgo is a Senior Thermal Engineer at Aavid working on the development of new products for the military and aerospace industries as well as consumer products, data centers and medical applications. Currently his primary focus is on the development of a new line of products within Aavid for consumer electronics. 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 flow control and aerodynamic techniques. His professional experience and interests are single and two-phase cooling, heat pipes, vapor chambers, R&D, flow control and fluid/structure interactions.

Program Vice Chair

Marcelo del Valle, Intel

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 SEMI-THERM Symposium.

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Schedule of Events Monday March 18, 2019
Short Courses

Concurrent short courses at SEMI-THERM 35 will be held in the morning and afternoon of March 18, 2019. These sessions are free to regular paid attendees.

8:00 a.m. – 12:00 p.m.   **San Jose, San Juan, Santa Clara, Carmel, Monterey**
Session Chair: Marcello del Valle, Intel

Short Course 1: Statistical Analysis Methods for Dealing with Uncertainty in Thermal Testing
Instructor: Ross Wilcoxon, PhD, Principal Mechanical Engineer, Mission Systems, Collins Aerospace

Short Course 2: Design and Optimization of Heat Sinks
Instructor: Dr. Georgios Karamanis, Co-Founder and Senior Engineer, Transport Phenomena Technologies, LLC

Short Course 3: A Holistic Approach to Improve Mission Critical Facility Performance
Instructor: Kourosh Nemati, Application Engineer, Future Facilities Ltd.

Short Course 4: Thermal Challenges in Automotive Electronics
Instructor: Tobias Best, Managing Director, Alpha-Numerics GmbH

Afternoon Short Courses
1:30 p.m. – 5:30 p.m.   **San Jose, Santa Clara, Carmel, Monterey**
Session Chair: Marcello Del Valle, Intel

Short Course 5: Introduction to the Design and Implementation of Indirect Liquid Cooling for Electronic Systems
Instructors: Alfonso Ortega, Ph.D., Professor and Director, Laboratory for Advanced Thermal and Fluid Systems, Villanova University
Rahima Mohammed, Senior Principal Engineer, Intel Corporation

Short Course 6: Design of Experiments (DOE) for Thermal Engineering
Instructor: James Petroski, Principal Consultant, Design by Analysis Technical Consulting

3:30 p.m. – 6:00 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

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Short Courses Monday, March 18, 2019

Short Course 1   Morning   **8:00 a.m. – 12:00 p.m.**
Statistical Analysis Methods for Dealing with Uncertainty in Thermal Testing
Ross Wilcoxon, PhD, Principal Mechanical Engineer, Mission Systems, Collins Aerospace

Statistical analysis is a methodology for using probabilistic methods to address the uncertainty that is inherent to all data. This course will give an overview of fundamental statistical methods that are used to identify the useful signals within a data set that may otherwise be obscured by the noise of data uncertainty. The class will provide the attendees with a better understanding of the how and why various statistical approaches are used as well as give tutorials on how to use a number of statistical analysis methods on actual data.
About the Instructor

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 of avionics. Prior to joining Rockwell Collins in 1998, he was an assistant professor at South Dakota State University.

Short Course 2   Morning   **8:00 a.m. – 12:00 p.m.**
Design and Optimization of Heat Sinks
Dr. Georgios Karamanis, Co-Founder and Senior Engineer, Transport Phenomena Technologies, LLC

This course provides the audience with an understanding of heat sink design and optimization in the context of the thermal management of electronics. The course has two parts. The first part begins with an overview of common methods to manufacture heat sinks such as extrusion, die casting and forging, and discusses their advantages and disadvantages with respect to cost and fin geometry. Attention then shifts to the theory of spreading resistance and how it can be calculated in order to properly size the thicknesses of the bases of heat sinks. Next, the theory of the operation of heat pipes in tubular and flat (vapor chamber) configurations is presented along with their roles in smoothing out temperature gradients in the fins and bases of heat sinks.
In the second part of the course, single-phase conjugate heat transfer, where conduction in the heat sink is coupled to convection in the coolant, i.e., air or water, flowing through the heat sink is highlighted. We discuss why the constant heat transfer coefficient assumption tends to be an invalid one in real heat sinks by using specific examples. Then, the use of computational fluid dynamics (CFD) to compute conjugate Nusselt numbers is considered.
Next, we discuss how to embed pre-computed CFD results for conjugate Nusselt numbers and dimensionless flow resistances for heat sinks in flow network models (FNMs) of circuit packs such as blade servers.
Finally, a case study is presented where the fin height, length, spacing and thickness for 6 longitudinal-fin heat sinks cooling 6 microprocessors are simultaneously optimized by embedding the FNM representation of the circuit pack in a multi-variable optimization scheme.

Dr. Georgios Karamanis is a Co-Founder and Senior Engineer at Transport Phenomena Technologies, LLC. He received his Ph.D. and M.S. in Mechanical Engineering from Tufts University. He has expertise in analytical, numerical and experimental technics relevant to convective transport. He is the PI in a NSF Phase I SBIR awarded to Transport Phenomena Technologies, LLC, to develop specialized thermal modeling software for Data/Telco centers.

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Short Courses Monday March 18, 2019

Short Course 3   Morning   **8:00 a.m. – 12:00 p.m.**
A Holistic Approach to Improve Mission Critical Facility Performance
Kourosh Nemati, Application Engineer, Future Facilities Ltd.

In recent years, data center designers & operators have focused on energy consumption, particularly PUE, to decrease operating expenses (OPEX). Hybrid cooling solutions, containment, and air-side or water-side economizers are examples of solutions implemented in data centers to achieve lower PUE. While these solutions have a positive effect on OPEX, they can also increase Capital Expenses (CAPEX) significantly. Meanwhile, a major driver of increased OPEX and PUE continues to go largely unnoticed – the fact that IT equipment, cooling infrastructure and data halls are all designed and tested separately. Since all these processes operate independently, it is a tremendous challenge to integrate them into one tool. However, if this can be achieved, data center energy consumption can be improved while providing sufficient cooling for IT, even during critical failure.

This entry-to-intermediate-level short course will demonstrate a comprehensive "Chip to Facility" CFD modeling process, using the Future Facilities software platform. The course will cover the entire process of detailed server modeling and room-level modeling, including different types of cooling strategies and control systems both in design and operational planning. Additional topics will be presented, including: a standard for data center model calibration, model integration to DCIM/ITSM via API web services, and an overview of external (generator yard and rooftop) modeling.

Kourosh Nemati is an application engineer at Future Facilities. He received his doctoral degree from the State University of New York at Binghamton. During his Ph.D., he has been involved in several data center thermal management projects, specialized in transport in data centers using both empirical and numerical approaches from server to room levels. He is a member of ASHRAE TC9.9, Green Grid and the NSF ES2 research project.

Short Course 4   Morning   **8:00 a.m. – 12:00 p.m.**
Thermal Challenges in Automotive Electronics
Tobias Best, Managing Director, Alpha-Numerics GmbH

Growing demands on electronic equipment in the automotive industry means a very precise consideration of thermal management is required. For several decades, there has been a trend that the performance increases, but the equipment gets smaller, leading to higher packing density. In addition to this challenge, which is common in other electronics industry segments, the automotive industry offers yet another hurdle. The installation space for the electronic equipment is usually not a simple boundary condition from a thermal point of view.

The thermal impact from solar radiation, noise-insulation (which acts as heat-insulation) and the effect of engine heat on electronics installed in the engine compartment all need to be considered. Without considering these effects in the design of the thermal management, the equipment might work as a prototype, but could completely fail in the field.

This short course will give an overview of the challenges an engineer will face when developing electronic equipment especially for the automotive industry. The course will concentrate on the physical area around thermal management and will show examples of the many challenges faced. The use of simulation to visualize the thermal behavior of the design and the creation of a digital twin for virtual prototyping will also be covered. The seminar will highlight some physical background concerning electronics cooling and will give ideas to help meet the latest requirements.

With more than 20 years experience using an industry specific CFD simulation tool and working as a consultant for the automotive industry, **Tobias Best** is currently owner and Managing Director of Alpha-Numerics GmbH in Germany.

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Short Courses Monday March 18, 2019

Short Course 5   Afternoon   **1:30 p.m. – 5:30 p.m.**
Introduction to the Design and Implementation of Indirect Liquid Cooling for Electronic Systems
Alfonso (Al) Ortega, Ph.D., Professor and Director, Laboratory for Advanced Thermal and Fluid Systems, Villanova University
Rahima Mohammed, Senior Principal Engineer, Intel Corporation

The capacity of liquid cooling systems to manage heat dissipation from electronics far exceeds the capacity of air-cooled systems, a fact that has been known and pursued for decades. The preference for air cooling is readily justified because of ease of use and compatibility with electronics and their reliability. Air-cooling performance is ultimately limited by volumetric constraints on the size of the extended surface heat sink attached to high power components, acoustic limits on the allowable volumetric flow rates, and availability of air-movers that can deliver flow at pressure heads sufficiently high to overcome the pressure drop in volumetrically dense finned structures. Practically speaking, air cooling strategies cannot achieve heat sink resistances much below 0.1 C/W and component heat dissipations much greater than 100 W. Transitioning to liquids such as water or refrigerants as the primary heat transfer medium requires more exacting design and adaptation of infrastructure at system and component levels to accommodate delivery of liquid flow to high power devices. This short course is intended for engineers who want to better understand strategic considerations in the selection of indirect liquid cooling solutions as compared to air-cooled solutions. The course will focus on the design and performance considerations for indirect (cold-plate based) liquid cooling solutions that use either single phase (liquid) or two-phase (boiling) convection as the primary strategy for heat removal. Topics to be covered include the following:

- Design drivers for liquid cooling transition in different platforms: Server, Desktop, Mobile
- System ramifications and trade-offs of solutions using liquid versus air cooling
- Design principles for single phase liquid-cooled cold plate design at conventional scales
  and emerging principles and data for micro-scale heat sink design
- Understanding the behavior of boilers/evaporators with mini or microscale features
- Design principles for liquid cooling systems and their implementation

Dr. Alfonso Ortega is the James R. Birle Professor of Energy Technology at Villanova University. He is the Director of the Laboratory for Advanced Thermal and Fluid Systems and the Founding Director of the Villanova site of the NSF Center for Energy Smart Electronic Systems (ES2) founded in 2011. He 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. For two years, he served as the Program Director for Thermal Transport and Thermal Processing in the Chemical and Transport Systems Division of The National Science Foundation, where he managed the NSF's primary program funding heat transfer and thermal technology research in U.S. universities.

Dr. Ortega is a teacher of thermal sciences and experimental methods. He is an internationally recognized expert in the areas of thermal management in electronic systems. He has supervised over 40 M.S. and Ph.D. candidates to degree completion, 5 postdoctoral researchers, and more than 70 undergraduate research students. He is the author of over 300 journal and symposia papers, book chapters, and monographs and is a frequent short course lecturer on thermal management and experimental measurements.

He is a Fellow of the ASME and received the 2003 SEMI-THERM Thermie Award and the 2017 THERMI Achievement Award in recognition of his contributions to the field of electronics thermal measurements.

Rahima Mohammed is a Senior Principal Engineer and serves as the lead of the Customer Delight Office for strategic customers in Performance, Power and Competitive Analysis (P2CA) team of Intel Corporation. She has been with Intel over 20 years after graduate schooling from Yale. Before joining P2CA, she served as the Data Center customer solutions technologist and led data mining efforts on customer returned parts and as test and validation lead for server products in Manufacturing Validation Engineering (MVE). She also served as the advanced test module technologist in Manufacturing Development Organization (MDO). Prior to that, she served as the path finding czar for strategic emerging technologies across market segments and also setup the innovation programs for the division. Rahima led the team to deliver 15 advanced validation platform designs and pioneered innovative temperature margining thermal tools for over thirty-five silicon products. She also chairs various technical steering committees and serves on Industry advisory boards. She demonstrates consistent leadership in IP creation, and has published 100+ papers in Intel internal and external conferences and filed 5 patents. She serves as a reviewer for various conferences like Itherm, Interpack, and a program committee member of IEEE SEMI-THERM conference and Burn-in-test strategies workshop. She served as the vice-program chair, program chair, and general chair of SEMI-THERM conferences in 2014, 2015, and 2016, respectively. She has served as the senior advisor for Women at Intel Network of Guadalajara, Mexico for the past 8 years. She has been working with GHC and AnitaB since 2011.

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Short Courses Monday March 18, 2019

Short Course 6   Afternoon   **1:30 p.m. – 5:30 p.m.**
Design of Experiments (DOE) for Thermal Engineering
James Petroski, Principal Consultant, Design by Analysis Technical Consulting

This course is intended to introduce people to the concept of Design of Experiments (DOE) and how it can be applied to engineering for effective design and experimentation. Beginning with a discussion of effective experimentation, the class will progress through different types of experimentation used today, the role of statistics in planning experiments and the product designs they influence, to an overview of various types of DOE's.
In depth presentation of certain DOE types will be given and the reason why the DOE type is chosen for a particular situation. The course will then show the process of setting up a "typical" DOE and follow with two examples, one from an analytical design using a DOE and a second of an experimental DOE of a system.

James Petroski is the founder and Principal Consultant of Design by Analysis Technical Consulting. Mr. Petroski has been involved in thermal, shock and vibration management of electronics systems for DOD, NASA and commercial applications with over 35 years' experience in the field of electronics packaging and LED thermal management. He received his Bachelors in Engineering Science and Mechanics from Georgia Tech and a MS degree in Engineering Mechanics from Cleveland State University. He has authored numerous papers related to LED and electronics packaging, has over thirty patents pertaining to solid-state lighting and electronics cooling, and is currently a member of the ASME K-16 Subcommittee on Heat Transfer in Electronics.

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SEMI-THERM 35 KEYNOTE
Tuesday March 19, 2019 9:10 a.m.

Challenges in the CPU and GPU Markets

The technical challenges for CPU and GPU products have gone through several inflections over the last 25 years. This talk will focus on these inflections as well as look forward to what may lie ahead.

Tom Dolbear, AMD
Since October 2017, Tom has been the Senior Director in AMD's Radeon Technology Group leading the global board hardware engineering team responsible for electrical design, power regulation, and thermal/mechanical design for GPUs and graphics cards for the mobile, gaming, and datacenter/machine learning markets. From 2009 to October 2017, Tom directed AMD's global packaging organization, developing solutions for Playstation™ 4 and Xbox™ One, for Fiji and Vega GPUs utilizing 2.5D technology, and for the Epyc™ and Ryzen™ processors. Tom was the catalyst behind the integration of the AMD and ATI packaging teams in 2008. From 1995 to 2009, he worked in several architecture, packaging, and platform engineering roles within AMD, including being a key contributor to bringing Opteron™ to the server market, the achievement of the first 1GHz CPU, and the development of AMD's first unique motherboard infrastructure for K7 CPUs.

Prior to joining AMD in 1995, he was a Member of Technical Staff at MCC, the first pre-competitive research consortium in the United States. He holds fifteen patents in the field of electronic packaging. He graduated from The University of Texas at Austin with a BS in Mechanical Engineering and from Stanford University with a MS in Mechanical Engineering.

Schedule of Events Tuesday, March 19, 2019

7:00 a.m. – 7:45 a.m.   **San Jose**
Speakers' Breakfast   **(March 19 Speakers, Session Chairs and Co-Chairs only)**

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

8:00 a.m. – 12:00 p.m.   **Bayshore Ballroom**
Exhibitor Setup

8:00 a.m. – 8:10 a.m.   **Oak and Fir**
Symposium Opening and Welcome
General Chair: Adriana Rangel, Cisco Systems, Inc.

8:10 a.m. – 9:10 a.m.   **Oak and Fir**
Session 1: LEDs
Session Chair: Jim Petroski, Mentor, A Siemens Business

8:10 a.m. – 8:30 a.m.
A Methodology to Determine the Sites of Variability in an LED Assembly
Robin Bornoff[1], Thomas Mérelle[2], Josephine Sari[3], Alessandro Di Bucchianico[3], Gabor Farkas[1]
[1]Mentor - A Siemens Business, [2]PI Lighting, [3]Eindhoven University of Technology

Continued

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8:30 a.m. – 8:50 a.m. **Oak and Fir**

Accurate Thermal Transient Measurements Interpretation of Monochromatic LEDs

Anton Alexeev[1], Genevieve Martin[2], Grigory Onushkin[2], Jean-Paul Linnartz[2]
[1]Eindhoven University of Technology, [2]Signify

8:50 a.m. – 9:10 a.m.

Implementation of a Multi-Domain LED Model and its Application for Optimized LED Luminaire Design

János Hegedüs[1], Gusztáv Hantos[1], Robin Bornoff[2], Márta Rencz[3], András Poppe[3]
[1]Budapest University of Technology and Economics, [2]Mentor, A Siemens Business
[3]Mentor, A Siemens Business, Budapest University of Technology and Economics

9:10 a.m. – 10:10 a.m. **Oak and Fir**

Keynote Address: Challenges in the CPU and GPU Markets

Tom Dolbear, AMD

10:10 a.m. – 10:30 a.m. **Gateway Foyer**

Networking Break

10:30 a.m. – 12:10 p.m. **Oak**

Parallel Session 2: Two Phase Cooling

Session Co-Chairs: George Meyer and Sobo Sun, Celsia Inc.

10:30 a.m. – 10:50 a.m.

Assessment of Critical Heat Flux on Finite Size Surfaces Under Pool Boiling

Julia Reed, Vijay K. Dhir, University of California, Los Angeles

10:50 a.m. – 11:10 a.m.

Molecular Dynamic Simulation of Evaporative Heat Transfer on Graphene Coated Silicon Substrate for Electronics Cooling

Binjian Ma[1], Rui Zhou[1], Li Shan[1], Junhui Li[1], Damena Agonafer[1], Baris Dogruoz[2]
[1]Washington University in St. Louis, [2]Cisco Systems Inc.

11:10 a.m. – 11:30 a.m.

Experimental and Numerical Investigation of Microdroplet Evaporation on Porous Pillar Structures

Li Shan[1], Binjian Ma[1], Baris Dogruoz[2], Damena Agonafer[1]
[1]Washington University in St. Louis
[2]Cisco Systems, Inc.

11:30 a.m. – 11:50 a.m.

Heat Pumps to Upgrade Data Center Waste Heat: Integration with 2-Phase Cooling

Steven G. Schon[1], Rehan Khalid[2], Aaron P. Wemhoff[3], Alfonso Ortega[3]
[1]QuantaCool (CTO) and Villanova University (Research Fellow, Department of Mechanical Engineering)
[2]Villanova University, Department of Mechanical Engineering (Ph.D. candidate)
[3]Villanova University, Department of Mechanical Engineering (Professor)

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Luncheon Speaker
Tuesday March 19, 2019

The Future of Innovation – Fusing Art and Technology

Innovation is one of the most overused buzz words in modern society. If everything is "innovative" then surely nothing is?! Another popular mantra nowadays is to bring the humanities into the tech world for increased revenue owing to diverse perspectives. However, these are examples of popular sound bites that generate "check-the-box" exercises and thus limit our ability to progress humanity through technological evolution. In this talk I discuss the need to deeply understand what innovation truly is (and is not) and I share real examples of ways to develop innovative solutions by fusing art and technology.

Domhnaill Hernon is Head of Experiments in Arts and Technology (E.A.T.) at Nokia Bell Labs. He graduated with a B.Eng in Aeronautical Engineering, a Ph.D in fundamental fluid mechanics from the University of Limerick and an Executive M.B.A. from Dublin City University, Ireland. He is passionate about turning research/ideas into reality and exploring the bounds of creativity to push the limits of technology. Domhnaill was previously responsible for turning Bell Labs disruptive research assets into proto-solutions that could be tested at scale in the market and he established new methods to overcome the "Innovation Valley of Death". He is currently responsible for Bell Labs global activities in E.A.T. where he collaborates with the artistic/creative community to push the limits of technology to solve the greatest human need challenges.

Schedule of Events Tuesday March 19, 2019 Continued

11:50 a.m. – 12:10 p.m.   **Oak**
Thermal Performance of Metal Foam Heat Sink with Pin Fins for Non-Uniform Heat Flux Electronics Cooling
Yongtong Li[1], Liang Gong[1], Minghai Xu[1], Yogendra Joshi[2]
[1]China University of Petroleum, [2]Georgia Institute of Technology

10:30 a.m. – 12:10 p.m.   **Fir**
Parallel Session 3: Thermal Interface Materials
Session Chair: Jason Strader, Laird

10:30 a.m. – 10:50 a.m.
Mechanical Cycling Reliability Testing for Thermal Interface Materials for Semiconductor Test Requirements
David L. Saums[1], Timothy Jensen[2], Carol Gowans[2], Ron Hunadi[2], Mohamad Abo Ras[3]
[1]DS&A LLC, [2]Indium Corporation, [3]Berliner Nanotest und Design GmbH

10:50 a.m. – 11:10 a.m.
Liquid Metal Innovations for High Performance TIMs
Timothy Jensen, Indium Corporation

11:10 a.m. – 11:30 a.m.
High Performance Lightweight Ceramic Material for Thermal Management in Electronic Devices
Bei Xiang, Chandra Raman, Xiang Liu, Momentive Performance Materials Quartz, Inc.

Continued

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Vendor Workshops Parallel Sessions
Tuesday March 19, 2019 2:00 p.m. - 4:00 p.m.

2:00 p.m.   **Oak**

Mentor, a Siemens Business
Simcenter Flotherm 2019.1 Update: Transient Modeling, electro-thermal circuit simulation, accurate reduced order models, and more
Byron Blackmore – Mentor, A Siemens Business
Siemens PLM Simcenter portfolio includes a range of electronics cooling, CFD and multi-physics simulation software to meet the application modeling requirement of the electronics and semiconductor industry and the wide demographic of engineering software user skill level, experience and discipline. This presentation focuses on Simcenter Flotherm, the 30+ year industry leading electronics cooling software, latest release enhancements for 2019. Topics include:

- Transient modeling using power control
- Industry standard open file format support (using ECXML)
- Reduced order modeling speed and accuracy
- Thermal netlist extraction & electro-thermal circuit modeling
- And much more…

3:00 p.m.   **Oak**

t-Global
Development of Measuring Instrument of the Thermal Conductivity of Heat Pipes and Graphite Sheets Using Angstrom Theory
One thing needs to be noted is that when developing the measuring technology, some of the heat transfer path for the graphite sheet or graphene sheet is two-dimensional while the heat transfer path of heat pipe is one dimension. Based on the Angstrom method, this research designed a set of experimental instruments to measure the thermal diffusivity α of the material. The Thermal Diffusivity Measuring Instrument namely TDMI is calibrated by a pure substance such as copper, tin, aluminum etc., after the calibration is completed, the thermal conductivity of the heat pipe and graphite sheet can be measured. In this experiment, the repeatability errors are within 5%, while accuracy errors are within 10%.

3:00 p.m.   **Fir**

FK Kasei
Heat Release Coating Material RECRACK TMS series
RECRACK TMS is a coating that can dissipate heat by converting the heat energy to far infrared. Since our coating can release heat into the air, this can offer a new cooling or heating solution which can't be achieved by heat conduction alone. This paint can help improve the cooling effect or reduce the size/weight of thermal management systems by simply coating it with our product. We'll explain the heat release system of paints, and introduce the effect obtained by coating with an example during this vendor workshop.

Schedule of Events Tuesday March 19, 2019 Continued

11:30 a.m. – 11:50 a.m.   **Fir**
Performance of Durable High-Performance Polymer Composite TIMs Under Accelerated Aging Conditions
John A. Howarter, Michael D. Toomey, Hyungyung Jo, School of Materials Engineering, Purdue University

11:50 a.m. – 12:10 p.m.
Thermal Diffusivity Characterization of Thick Graphite Foils
Rick Beyerle, Martin Smalc, Rajath Kantharaj, Jonathan Taylor, Julian Norley, NeoGraf Solutions, LLC

12:20 p.m. – 2:00 p.m.   **Pine and Cedar**
Luncheon and Presentation:
The Future of Innovation - Fusing Art and Technology
Presenter: Domhnaill Hernon, Head of Experiments in Arts and Technology at Nokia Bell Labs

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

Continued

Teardown Session
Tuesday Afternoon, March 19, 2019 4:00 p.m.

Alternative Thermal Solution For A Wireless Home Router

Presenter:
Justin Dixon, Electronic Cooling Solutions, Inc.

In recent years the demand for faster internet speeds has been steadily increasing. As consumers rely more on the internet for shopping, streaming videos, gaming, personal communications, business, etc. the technology used to support these applications must advance to keep in step with demand. The market dictates that devices of this nature be small, silent and aesthetically pleasing while also meeting performance requirements. Currently, many wireless devices use vents and heatsinks to cool internal components which alters the external appearance and can reduce aesthetic quality.

This Teardown session will explore the possibility of removing the heatsinks and vents currently used for cooling in a high end wireless home router and replacing them with an alternative thermal solution using heat spreaders and conductive enclosure materials. Thermal analysis and thermal test data are presented and used to demonstrate the functionality of the alternative thermal solution. A "tear down" and evaluation of the current thermal solution are presented. The evaluation includes IR scans to determine hot spots and thermal test data to determine component temperatures under stressed loading conditions. Illustrations of system components and architecture and obstacles to designing a thermal solution are also discussed.

Justin Dixon has been a consulting thermal engineer at Electronic Cooling Solutions for 5 years. He has provided thermal analysis and testing services in the consumer electronics, telecommunications, automotive and medical devices industries. Recently he has consulted in the design for a number of consumer electronics devices such as routers, access points, cameras, LCD displays and more. He graduated, with honors, from San Jose State University with a degree in Mechanical Engineering and a focus on thermal fluids.

Schedule of Events Tuesday March 19, 2019 Continued

2:00 p.m. – 4:00 p.m.   **Oak and Fir**
Vendor Workshops Parallel Sessions

2:00 p.m.   **Oak**
Mentor, A Siemens Business

3:00 p.m.   **Oak**
t-Global

3:00 p.m.   **Fir**
FK Kasei

4:00 p.m. – 4:45 p.m.   **Bayshore Ballroom Foyer**
Tear Down Session: Alternative Thermal Solution for a Wireless Home Router
Justin Dixon, Electronic Cooling Solutions, Inc.

Continued

Evening Tutorial
Tuesday March 19 2019, 7:30 p.m.

AI Is Helping Engineers Break Through The Barriers Of Thermal Design

Presenter:
Lieven Vervecken, Diabatix

Imagine what would happen if you explained the laws of thermodynamics to a hyperintelligent machine. With the capacity to think, imagine how that machine would optimally design cooling fins and cooling channels to precisely fit your needs. Would it decide to use parallel cooling fins, S-shaped cooling channels, or something new? Would it try to maximize the contact surface area, or not? Artificial intelligence is revolutionizing the way thermal engineers design cooling solutions. Discover how in a presentation by Diabatix.

Lieven Vervecken is CEO and co-founder of Diabatix, an engineering company specialized in advanced thermal design. Prior to founding Diabatix, Lieven received a PhD in mechanical engineering from the renowned University of Leuven, in the field of numerical simulations. Lieven incorporated his expertise into the advanced A.I. technology that lies at the heart of Diabatix. What started out as a small venture has become a fast-growing company serving multinationals all over the world.

Lieven is an experienced speaker at national and international conferences with a passion for the limitless possibilities of combining engineering with artificial intelligence technology. During his talk he will expound on the many doors the Diabatix technology can open.

Schedule of Events Tuesday March 19, 2019 Continued

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

7:30 p.m. – 9:00 p.m.   **Oak**
Evening Tutorial:
Breaking Through the Barriers of Thermal Design with A.I.
Presenter: Lieven Vervecken, CEO, Diabatix

Gold Sponsor:

SEMI-THERM 35

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

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

8:00 a.m. – 8:10 a.m.   **Oak and Fir**
Symposium Welcome Message
Program Chair: Pablo Hidalgo, Aavid

8:10 a.m. – 9:10 a.m.   **Oak and Fir**
THERMI Award Presentation
'Reflections on a Journey of Developing Means to Characterize Hot Spots in Cool Chips'
Peter E. Raad, Professor of Mechanical Engineering, Southern Methodist University

9:10 a.m. – 10:10 a.m.   **Oak and Fir**
Session 4: Automotive/Aerospace/Outdoor
Session Chair: Hussameddine Kabbani, Facebook

9:10 a.m. – 9:30a.m.
The Impact of Anodization on the Thermal Performance of Passively Cooled Electronic Enclosures Made of Die-cast Aluminum
Zhongchen Zhang[1], Michael Collins[2], Chris Botting[3], Eric Lau[3], Majid Bahrami[1]
[1]Simon Fraser University, [2]University of Waterloo, [3]Delta-Q Technologies

9:30 a.m. – 9:50 a.m.
Development of a 3D Printed Loop Heat Pipe
William G. Anderson[1], Joel Crawmer[1], Bradley Richard
[1]Advanced Cooling Technologies, Inc.

9:50 a.m. – 10:10 a.m.
Measurement of Thermal Resistance of Thermal Interface Materials with High In-Plane Thermal Conductivity Using Transient Thermal Based Structure Function Analysis*
Aloysius Davin Oetomo, Craig Green, Carbice Corporation
*Via Videoconference

10:10 a.m. – 10:30 a.m.   **Gateway Foyer**
Networking Break

10:30 a.m. – 12:30 p.m.   **Oak**
Parallel Session 5: CFD/Numerical Modeling
Session Chair: Taravat Khadivi, Qualcomm

10:30 a.m. – 10:50 a.m.
Design using Multi-Scale, Multi-Physics Analyses And Shape Optimization for Compact Heat Transfer Devices
Daniel Bacellar, Dennis Nasuta, Cara Martin, Reinhard Radermacher, Optimized Thermal Systems, Inc.

Continued

Monday, March 18, 2019

8:00 a.m. – 12:00 p.m.
                    San Jose, Santa Clara, Carmel, Monterey
Morning Short Courses
Session Chair: Marcello del Valle, Intel

Short Course 1
Statistical Analysis Methods for Dealing with Uncertainty in Thermal Testing
Instructor: Ross Wilcoxon, PhD, Principal Mechanical Engineer, Mission Systems, Collins Aerospace

Short Course 2
Design and Optimization of Heat Sinks
Instructor: Dr. Georgios Karamanis, Co-Founder and Senior Engineer, Transport Phenomena Technologies, LLC

Short Course 3
A Holistic Approach to Improve Mission Critical Facility Performance
Instructor: Kourosh Nemati, Application Engineer, Future Facilities

Short Course 4
Thermal Challenges in Automotive Electronics
Instructor: Tobias Best, Managing Director, Alpha-Numerics

1:30 p.m. – 5:30 p.m.
Afternoon Short Courses
Session Chair: Marcello del Valle, Intel

Short Course 5
Introduction to the Design and Implementation of Indirect Liquid Cooling for Electronic Systems
Instructors: Alfonso Ortega, Ph.D., Professor and Director, Laboratory for Advanced Thermal and Fluid Systems, Villanova University
Rahima Mohammed, Senior Principal Engineer, Intel Corporation

Short Course 6
Design of Experiments (DOE) for Thermal Engineering
Instructor: James Petroski, Principal Consultant, Design by Analysis Technical Consulting

3:30 p.m. – 6:00 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

Tuesday, March 19, 2019

7:00 a.m. – 7:45 a.m.   **San Jose**
Speakers' Breakfast
(March 19 Speakers and Chairs only)

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

8:00 a.m. – 8:10 a.m.   **Oak and Fir**
Symposium Opening and Welcome
General Chair: Adriana Rangel, Cisco Systems, Inc.

8:10 a.m. – 9:10 a.m.   **Oak and Fir**
Session 1: LEDs
Session Chair: Jim Petroski, Mentor, A Siemens Business

9:10 a.m. – 10:10 a.m.   **Oak and Fir**
Keynote Address: Challenges in the CPU and GPU Markets
Tom Dolbear, AMD

10:10 a.m. – 10:30 a.m.   **Gateway Foyer**
Networking Break

10:30 a.m. – 12:10 p.m.   **Oak**
Session 2: Two Phase Cooling
Session Co-Chairs: George Meyer and Sobo Sun, Celsia Inc.

10:30 a.m. – 12:10 p.m.   **Fir**
Parallel Session 3: Thermal Interface Materials
Session Chair: Jason Strader, Laird

12:20 p.m. – 2:00 p.m.   **Pine and Cedar**
Luncheon and Presentation:
The Future of Innovation - Fusing Art and Technology
Presenter: Domhnaill Hernon, Head of Experiments in Arts and Technology at Nokia Bell Labs

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

4:00 p.m. – 4:45 p.m.   **Bayshore Ballroom Foyer**
Tear Down Session: Alternative Thermal Solution for a Wireless Home Router
Justin Dixon, Electronic Cooling Solutions, Inc.

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

7:30 p.m. – 9:00 p.m.   **Oak**
Evening Tutorial:
Breaking Through the Barriers of Thermal Design with A.I.
Presenter: Lieven Vervecken, CEO, Diabatix

Wednesday, Mar[

7:00 a.m. – 7:45 a.m.
Speakers' Breakfast
(March 20 Speakers and Ch[

7:00 a.m. – 5:00 p.m.   **Bays[**
Attendee Registration

8:00 a.m. – 8:10 a.m.
Symposium Welcome Mess[
Program Chair: Pablo Hidalgo

8:10 a.m. – 9:10 a.m.
THERMI Award Presentation[
'Reflections on a Journey of D[
Characterize Hot Spots in Coo[
Peter E. Raad, Professor of Me[
Southern Methodist Universit[

9:10 a.m. – 10:10 a.m.
Session 4: Automotive/Aero[
Session Chair: Hussameddine[

10:10 a.m. – 10:30 a.m.
Networking Break

10:30 a.m. – 12:30 p.m.
Parallel Session 5: CFD/Num[
Session Chair: Taravat Khadivi[

10:30 a.m. – 12:10 p.m.
Parallel Session 6: Two Phas[
Session Chair: Pritish Parida, IB[

12:40 p.m. – 2:00 p.m.
Luncheon and Presentation[

1:30 p.m. – 6:30 p.m
Exhibits Open

2:00 p.m. – 5:00 p.m.
Vendor Workshops Parallel[

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

7:00 p.m. – 9:00 p.m.
How-To Sessions
How to Wright Whale… er, [
Ross Wilcoxon, PhD, Principal[
Mission Systems, Collins Aero[

Design of Liquid Cooled Sys[
Pablo Hidalgo, Senior Engineer,[
Division of Boyd Corp.

, March 20, 2019

Thursday, March 21, 2019

Friday, March 22, 2019

San Jose

and Chairs only)

Bayshore Ballroom Foyer

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Oak and Fir

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Oak and Fir

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Bayshore Ballroom

Oak and Fir

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Bayshore Ballroom

Oak

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

7:00 a.m. – 12:30 p.m. **Gateway Foyer**
Attendee Registration

8:00 a.m. – 8:10 a.m. **Oak and Fir**
Symposium Welcome Message
Program Chair: Pablo Hidalgo, Aavid

8:10 a.m. – 9:10 a.m. **Oak and Fir**
Session 7: Consumer Electronics
Session Chair: Mark Carbone, Intel and Angel Han,
Huawei

9:10 a.m. – 10:10 a.m. **Oak and Fir**
Embedded Tutorial:
Modeling Two-Phase Heat Transfer Systems,
Pumped and Passive Designs
Pritish R. Parida, Research Staff Member, IBM
Research; George Meyer, CEO, Celsia, Inc.; Sobo Sun,
General
Manager, Celsia, Inc.

10:10 a.m. – 10:30 a.m. **Gateway Foyer**
Networking Break

10:30 a.m. – 11:30 a.m. **Oak and Fir**
Session 8: Data Center Cooling
Session Chair: Marcelo del Valle, Intel

11:30 a.m. – 12:30 p.m. **Oak and Fir**
Thermal Hall of Fame Lifetime Achievement
Award Presentation
'From a Tiny University Lab to the World: the
MicRed Story'
Dr. Márta Rencz, Budapest University of Technology
and Economics

12:20 p.m. – 2:00 p.m. **Pine and Cedar**
Awards Luncheon
Harvey Rosten Award, Thermal Hall of Fame Award,
and THERMI Award

3:00 p.m. – 4:00 p.m. **San Jose**
Post SEMI-THERM Program Meeting

4:00 p.m. – 5:00 p.m. **San Jose**
Technical Advisory Board Meeting

5:00 p.m. – 6:00 p.m. **San Jose**
STEF Board Meeting

8:30 a.m. – 12:30 p.m. **Santa Clara**
JEDEC JC 15 Meeting

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

Plan on attending SEMI-THERM 36
at the DoubleTree by Hilton
in San Jose, CA, March 16-20, 2020.

Consider submitting an abstract
for a paper presentation at ST 36.

The Call for Papers (CFP) will be listed at
www.SEMI-THERM.org by April 1, 2019.

SEMI-THERM will be accepting abstracts
for both peer and non-peer reviewed
papers shortly thereafter, with a final
submission deadline on September 15,
2019.

SEMI-THERM 35

10:50 a.m. – 11:10 a.m.   **Oak**
Research on Package Thermal Resistance of Power Semiconductor Devices
Koji Nishi, Ashikaga University

11:10 a.m. – 11:30 a.m.
The Necessity for Thermal-Electrical Multiphysics for Board Heating in a Server Rack Unit
Jared Harvest, Wade Smith, Satyajeet Padhi, ANSYS, Inc.

11:30 a.m. – 11:50 a.m.
Temperature Profile of High Power Density (HPD) ASIC Device Mounted on Multi-Layered Diamond Enhanced Heat Spreader
Firooz Faili[1], Thomas Obeloer[1], Russell Mason[1], Daniel Twitchen[2]
[1]Element Six Technologies, USA, [2]Element Six Technologies Limited

11:50 a.m. – 12:10 p.m.
Practical Evaluation of Thermally-Conductive Plastics and Guidelines for Use
Dave Saums, DS&A LLC

12:10 a.m. – 12:30 p.m.
Optimization of an Array of Heat Sinks to Satisfy an Arbitrary Objective Function
Georgios (George) Karamanis, Marc Hodes, Transport Phenomena Technologies LLC

10:30 a.m. – 12:10 p.m.   **Fir**
Parallel Session 6: Two Phase Cooling
Session Chair: Pritish Parida, IBM

10:30 a.m. – 10:50 a.m.
CTE Matching Heat Pipe Thermal Ground Plane
Nelson Gernert, Mark North, Aavid Thermal Division of Boyd

10:50 a.m. – 11:10 a.m.
An Ultra-Thin Loop Heat Pipe with Long-Distance Heat Transport for Cooling of Small Electronic Devices
Shuto Tomita, Ai Ueno, Hosei Nagano, Nagoya University

11:10 a.m. – 11:30 a.m.
Evaluation of the Performance of Various Heat Pipe Mounting Methods with Various Thickness TIM's and Mounting Pressures
George Meyer, Sobo Sun, Rock Chin, Celsia Technologies TW, Inc..

11:30 a.m. – 11:50 a.m.
Relative Performance of Two-Phase vs Solid Conductive Heat Spreaders for High Heat Flux Applications
Joe Boswell[1], Corey Wilson[1], Daniel Pounds[1], Joshua Schorp[1], Bruce Drolen[2]
[1]ThermAvant Technologies [2]Consultant to ThermAvant Technologies

11:50 a.m. – 12:10 p.m.   **Fir**
The Impact of Heat Rejection Architecture on the Thermal Performance of a Pumped Two-Phase Cooling System*
Elizabeth Baker, Danah Valez, Timothy A. Shedd, Florida Polytechnic University
*Via Videoconference

Vendor Workshops Parallel Sessions
Wednesday March 20, 2019 2:00 p.m. - 5:00 p.m.

2:00 p.m.   **Oak**

Mentor, a Siemens Business
SiC Power Semiconductor Thermal Characterization and an Update on Thermal Model Calibration Techniques
Andras Poppe, Mentor A Siemens Business

A presentation on the latest in accurate, repeatable thermal characterization techniques utilizing Simcenter T3STER thermal transient test technology, combining thermal measurement with simulation and for reliability assessment studies. Topics:
- A proposed approach for SiC MOSFET power semiconductor module thermal measurement to generate accurate heat flow path analysis information in the form of structure functions
- IGBT & MOSFET thermal reliability: power cycling and thermal degradation tracking (Simcenter POWERTESTER update)
- Progress of DELPHI4LED project on multi-domain LED modeling incl. model calibration using thermal/optical measurement
- Automatic calibration of detailed IC package thermal models in Simcenter Flotherm and Simcenter FLOEFD software

3:00 p.m.   **Oak**

ANSYS

Automation and Customization for Electronics Thermal Management Simulation
Automating routine tasks and customizing workflows for specific applications enables significant time saving, productivity increases, and repeatability. In the electronics thermal management space, automation and customization benefits all stages of the CFD analysis, from model building to meshing, solving, and post-processing. Workflows can be automated for each stage or to combine all stages of the CFD electronics thermal simulation process.
This workshop will present an overview of the automation and customization tools ANSYS provides as part of its electronics thermal management simulation platform. It will highlight examples of customization for electronics thermal management and will provide an update on recent enhancements that improve users' ability to automate and customize their simulations. Attendees will have the chance to see how automation and customization could help improve their existing simulation processes, and possibly open the doors to new opportunities. The underlying goal of automation and customization is to enhance the productivity of engineers using simulation.

3:00 p.m.   **Fir**

CoolIT
Preparing to Liquid Cool Your Next Deployment
Whether you are an OEM or Hyperscale data center operator looking for products that enable your technology to perform at its peak, or a data center operator needing reliable products to reduce OpEx, CoolIT Systems modular Rack DCLC platform is equipped to support any server, rack configuration and data center environment. Utilizing Rack DCLC's three module approach, customers work directly with CoolIT's engineering experts to select components specific to their needs. In this workshop tutorial, we will be explaining the process of how we select and design direct liquid cooling components to meet required performance needs.

4:00 p.m.   **Fir**

Future Facilities
6SigmaET Ten Years Old and Still Developing Rapidly
6SigmaET was introduced to the electronics thermal industry at SEMI-THERM 25 in 2009. In 2019, we are celebrating the first 10 years of our state-of-the-art electronics cooling software. We'll take a short trip down memory lane to explore 6SigmaET's important philosophy of putting the user experience first, with real modelling objects rather than simplified, integrations with a wide range of ECAD/MCAD tools, and many more key usability features. We'll also explore the development of 6SigmaET's unique Multi-Level Unstructured Staggered Grid system, which allows complex models to be solved with minimal effort.The presentation will showcase the current release of 6SigmaET and will offer a sneak preview of some of our upcoming features.

SEMI-THERM 35

SEMI-THERM

12:30 p.m. – 2:00 p.m.   **Pine and Cedar**
Luncheon and Presentation
'The Origins of Silicon Valley: Why and How It Happened Here'
Paul Wesling, IEEE Life Fellow

1:30 p.m. – 6:30 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.   **Oak**
Mentor, A Siemens Business
SiC Power Semiconductor Thermal Characterization and an Update on Thermal Model Calibration Techniques

3:00 p.m.   **Oak**
Ansys
Automation and Customization for Electronics Thermal Management Simulation

3:00 p.m.   **Fir**
CoolIT
Preparing to Liquid Cool Your Next Deployment

4:00 p.m.   **Fir**
Future Facilities
6SigmaET Ten Years Old and Still Developing Rapidly

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

7:00 p.m. – 8:00 p.m.   **Oak**
How-To Session
How to Wright Whale… er, Write Well….
Ross Wilcoxon, Collins Aerospace

8:00 p.m. – 9:00 p.m.   **Oak**
How-To Session
Design of Liquid Cooled Systems
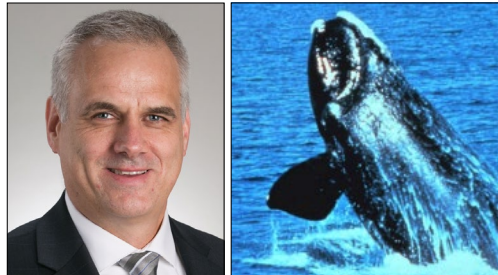Pablo Hidalgo, Senior Engineer, Aavid, Thermal Division of Boyd Corp.

Silver Sponsor:

NOVARK ™
TECHNOLOGIES

How-To Sessions
Wednesday March 20, 2019 7:00 p.m. - 9:00 p.m.

**7:00 p.m.** **Oak**

How to Wright Whale… er, Write Well….
Ross Wilcoxon, PhD, Principal Mechanical Engineer, Mission Systems, Collins Aerospace

Whether you are selling an idea to management, proposing work to a customer, or presenting the results of your research, the ability to communicate well through your writing is critical. This presentation gives an overview on a few things to keep in mind to improve your technical writing abilities. It will provide some insight into effective writing from an engineer who has authored and reviewed numerous publications and has also contributed to multiple proposals for external funding.

Dr. Ross Wilcoxon is a Principal Mechanical Engineer in the Collins Aerospace Advanced Technology group. He conducts research and supports product development related to component reliability, electronics packaging and thermal management for communication, processing, displays and radars. He has 30 US Patents, dozens of journal and conference publications, and is an associate technical editor of Electronics Cooling magazine. Prior to joining Rockwell Collins in 1998, he was an assistant professor at South Dakota State University.

8:00 p.m. **Oak**
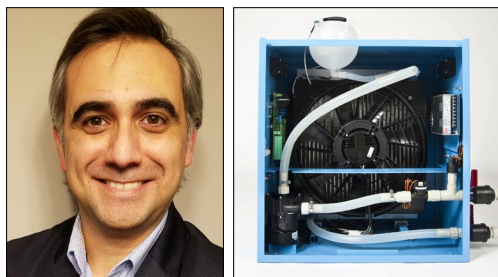
Design of Liquid Cooled Systems
Pablo Hidalgo, Senior Engineer, Aavid, Thermal Division of Boyd Corp.

Automating routine tasks and customizing workflows for specific applications enables significant time saving, productivity increases, and repeatability. In the electronics thermal management space, automation and customization benefits all stages of the CFD analysis, from model building to meshing, solving, and post-processing. Workflows can be automated for each stage or to combine all stages of the CFD electronics thermal simulation process.

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Pablo Hidalgo is a Senior Thermal Engineer at Aavid working on the development of new products for the military and aerospace industries as well as consumer products, data centers and medical applications. Currently his primary focus is on the development of a new line of products within Aavid for consumer electronics. 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 flow control and aerodynamic techniques. His professional experience and interests are single and two-phase cooling, heat pipes, vapor chambers, R&D, flow control and fluid/structure interactions.

SEMI-THERM 35

SEMI-THERM®

Schedule of Events Thursday , March 21, 2019

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

7:00 a.m. – 12:30 p.m. **Gateway Foyer**
Attendee Registration

8:00 a.m. – 8:10 a.m. **Oak and Fir**
Symposium Welcome Message
Program Chair: Pablo Hidalgo, Aavid

8:10 a.m. – 9:10 a.m. **Oak and Fir**
Session 7: Consumer Electronics
Session Chair: Mark Carbone, Intel and Angel Han, Huawei

8:10 a.m. – 8:30 a.m.
Analysis of Natural Frequency Dependency on Temperature Variation of MEMS Vibratory Gyroscope
Jacek Nazdrowicz, Andrzej Napieralski, Lodz University of Technology

8:30 a.m. – 8:50 a.m.
Battery Discharge Capacity Calculation by Temperature Measurement
Jeevan Kanesalingam, Khoo Li Lian, Motorola Solutions

8:50 a.m. – 9:10 a.m.
Exploring Heatpipe Configurations for Package On Package (PoP) Cooling
Sankarananda Basak[1], Ryota Watanabe[2]
[1]Intel Corporation, [2]Lenovo (Japan) Ltd.

9:10 a.m. – 10:10 a.m. **Oak and Fir**
Embedded Tutorial
Modeling Two-Phase Heat Transfer Systems, Pumped and Passive Designs
Pritish R. Parida[1], George Meyer[2], Sobo Sun[2]
[1]IBM Research, [2]Celsia, Inc.

10:10 a.m. – 10:30 a.m. **Gateway Foyer**
Networking Break

10:30 a.m. – 11:30 a.m. **Oak and Fir**
Session 8: Data Center Cooling
Session Chair: Marcelo del Valle, Intel

10:30 a.m. – 10:50 a.m.
Simulation-Based Optimization of Data Center Cooling Performance Using Performance Indicators
John Petrongolo[1], Kourosh Nemati[2], Kamran Fouladi[1]
[1]Widener University, [2]Future Facilities

10:50 a.m. – 11:10 a.m.
Transient Analysis Overshoot in Temperature for High Power Thermal Solutions
Javier Avalos , Enrique Barreto, Intel Corporation, Zapopan, Mexico.

Continued

SEMI-THERM 35

Embedded Tutorial
Thursday March 21, 2019
9:10 a.m. – 10:10 a.m.

Modeling Two-Phase Heat Transfer Systems, Pumped And Passive Designs

Presenters:

George Meyer	Pritish R. Parida	Sobo Sun
Celsia	IBM Thomas J Watson Research Center	Celsia

Two-phase heat transfer systems utilize the latent heat property of a coolant fluid to transfer heat loads to regions or components where it could be efficiently dissipated to the ambient environment. The development of two-phase cooling for both two-dimensional (2D) and three-dimensional (3D) integrated circuits using pumped dielectric coolant and passive designs such as heat pipes, vapor chambers, thermosyphons, etc., has gained recent attention due to the ability to manage high heat densities, compatibility with electronics and above ambient temperature operation to achieve very low cooling energy usage. Development of this approach requires high fidelity and computationally manageable conjugate thermal models both at the device level as well as at the system level.

This talk will describe a few modeling methodologies demonstrating the process of design and development of both passive and pumped two-phase heat transfer systems.

George Meyer is a thermal industry veteran with over three decades of experience in electronics thermal management. He currently serves as the CEO of Celsia Inc., a design and manufacturing company specializing in custom heat sink assemblies using heat pipes and vapor chambers. Previously, Mr. Meyer spent twenty-eight years with Thermacore in various executive roles including Chairman of the company's Taiwan operations. He holds over 70 patents in heat sink and heat pipe technologies and serves as a chairperson for the SEMI-THERM thermal conferences in the San Francisco area.

Pritish R. Parida received the B.Tech. degree in mechanical engineering from IIT Guwahati, Guwahati, India, in 2006, the M.Sc. degree in mechanical engineering from Louisiana State University and Agricultural and Mechanical College, Baton-Rouge, LA, USA, in 2007, and the Ph.D. degree in mechanical engineering from the Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA, USA, in 2010. He is currently a Research Staff Member at IBM T. J. Watson Research Center, Yorktown Heights, NY, USA, where he develops new techniques and innovative solutions, offering fundamental breakthroughs in the state of the art to provide market differentiating technology for IBM's portfolio of products and services in the field of information technology. He addresses the thermal challenges in computer systems to achieve highly energy-efficient thermal designs to reduce the cooling energy used by computers in data centers. He has co-authored over 50 peer-reviewed publications and holds over 40 issued patents.

Sobo Sun is a 20 year thermal industry veteran with 80 patents in this field and expertise in heat sink modeling and design for manufacturability.
Prior roles include various senior management positions with Coolermaster and Thermacore. Masters Mechanical Engineering, National Chung-Hsing University and PhD. ME candidate, National Chiao Tung University.

Schedule of Events Thursday March 21, 2019 Continued

11:10 a.m. – 11:30 a.m.   **Oak and Fir**
Airflow Management Using Active Air Dampers in Presence of a Dynamic Workload in Data Centers
Sadegh Khalili[1], Ghazal Mohsenian[1], Anuroop Desu[2], Kanad Ghose[2], Bahgat Sammakia[1]
[1]Department of Mechanical Engineering, Binghamton University-SUNY, NY, USA
[2]Department of Computer Science, Binghamton University-SUNY, NY, USA

11:30 a.m. – 12:30 p.m.   **Oak and Fir**
Thermal Hall of Fame Lifetime Achievement Award Presentation
'From a Tiny University Lab to the World: the MicRed Story'
Dr. Márta Rencz, Budapest University of Technology and Economics

12:30 p.m. – 2:00 p.m.   **Pine and Cedar**
Awards Luncheon

Harvey Rosten Award
'Compact Cooling-System Model for Transient Data Center Simulations'
Jim VanGilder, Chris Healey, Wei Tian, Michael Condor, Quentin Menusier

Thermal Hall of Fame Award
Dr. Márta Rencz

THERMI Award
Dr. Peter E. Raad

3:00 p.m. – 4:00 p.m.   **San Jose**
Post SEMI-THERM Program Meeting

4:00 p.m. – 5:00 p.m.   **San Jose**
Technical Advisory Board Meeting

5:00 p.m. – 6:00 p.m.   **San Jose**
STEF Board Meeting

Schedule of Events Friday, March 22, 2019

8:30 a.m. – 12:30 p.m.   **Santa Clara**
JEDEC JC 15 Meeting

Thursday March 21, 2019 12:30 p.m.

The 2018 Harvey Rosten Award
Sponsored by Mentor, A Siemens Business

Compact Cooling-System Model for Transient Data Center Simulations
Jim VanGilder, Chris Healey, Wei Tian, Michael Condor, Quentin Menusier
Schneider Electric
For Outstanding Work in the Field of Thermal Analysis of Electronic Equipment.

Jim VanGilder received a BS from the University of Maine (1992) and an MS from Duke University (1993) in Mechanical Engineering. He joined Flomerics in 1997 where he initially focused on CFD for traditional electronics thermal applications and later on building-scale applications and, ultimately, data centers. He joined Schneider Electric (APC at the time) in 2003 where he focused on developing practical and fast tools to assist the thermal design and operation of data centers; Jim currently directs CFD development and related research. He has authored over 50 technical publications and holds more than 30 US patents related to data-center and electronics cooling. Jim is a long-time member and former chair of ASHRAE TC 4.10, Indoor Environmental Modeling, and a frequent contributor to the ASME InterPack and IEEE ITherm conferences. Jim is also a licensed professional engineer in the state of Massachusetts.

Chris Healey is a graduate of the College of William and Mary (2005, BS Math) and Georgia Institute of Technology (2010, PhD Industrial Engineering). He is a Data Science Team Leader in Schneider Electric, working in thermal analytics and data science in the goal of efficiency and reliability of data center systems through optimal design, efficient control, and predictive maintenance. He has authored or co-authored seven journal papers and numerous conference proceedings.

Michael Condor received a BS from Bucknell University (2000) in Computer Science. Michael has nearly 20 years of experience developing software for data center management technology (DCIM) as well as thermal analytics software. Michael is currently the lead software engineer for the Thermal Analytics team in Schneider Electric.

Wei Tian received a PhD in Civil Engineering from the University of Miami. He is currently a research engineer at Schneider Electric, working in developing numerical models and tools to analyze thermal performance of data centers. His research interests include computational fluid dynamics, energy system modeling, and dynamic simulation and optimization. Wei has authored over 20 technical papers.

Quentin Menusier received an MS from ENSMM (2018), a French Engineering School in Computational Mechanics. He had the opportunity to work in Schneider Electric as a Computational Fluid Dynamics intern. He currently works in France as an Engineering Consultant.

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

SEMI-THERM 35

Thursday March 21, 2019 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 2019 THERMI Award to:

Dr. Peter Raad
Southern Methodist University

Dr. Raad will be giving a presentation:
'Reflections on a Journey of Developing Means to Characterize Hot Spots in Cool Chips'

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. During that time, he also founded and directed The Guildhall at SMU, a first of its kind, graduate program in digital game development. Raad has received over $2.8 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 55 journal articles and given more than 100 conference and invited talks. He holds U.S. and international patents in thermal metrology and computational characterization of multiscale integrated circuits. He is a Fellow of ASME and a Senior Member of IEEE. He received his BSME (with honors, 1980), MS (1981), and PhD (1986) in mechanical engineering from the University of Tennessee - Knoxville.

SEMI-THERM®

We are proud to sponsor:

The SEMI-THERM Educational Foundation
Thermal Hall of Fame

Lifetime Achievement Award

Presented To

Márta Rencz

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

Márta Rencz received the Electrical Engineering degree, the Doctor in Engineering Degree and the PhD degree from the Budapest University of Technology and Economics, where she has also obtained the Habilitation. She has received the Doctor of Science degree from the Hungarian Academy of Science in the field of Microelectronics. She is a professor at the Budapest University of Technology and Economics. Between 2005 and 2013 she served as the Head of Department of Electron Devices. She has participated in numerous international research projects, mostly in the field of investigating, measuring and modeling multi-physical effects in electronics. She has published her theoretical and practical results in more than 300 technical papers.
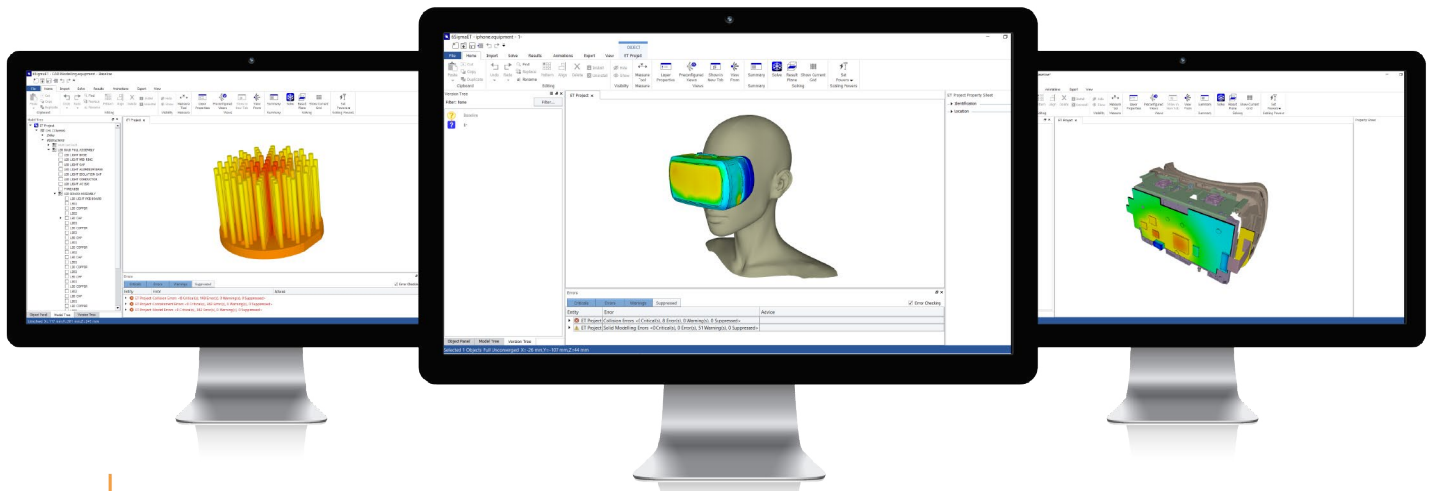
She has been the guest editor of over 10 special issues of various scientific Journals in the fields of thermal investigations and thermal management in electronics. She is regularly reviewing scientific papers and international research proposals. She was a co-founder and CEO of Micred Ltd that is now part of Mentor, a Siemens business, where she still holds a research director position.

She initiated in 1992 the THERMINIC EU research project that has led to the THERMINIC workshops, dealing with thermal issues in electronics, giving a forum for thermal management experts. Today she is the chair of the steering committee of THERMINIC.

She holds various awards of excellence, among others Harvey Rosten award (2001) and the Allan Krauss thermal management award of ASME (2015). In 2013 she has received the Doctor Honoris Causa degree from the Tallinn University of Technology in Estonia.

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DOUBLETREE SAN JOSE FLOOR PLAN

GATEWAY BALLROOM: SESSIONS

PINE | CEDAR | FIR | OAK

SECOND FLOOR

SILICON VALLEY ROOM

ZINFANDEL | RIESLING | BOARDROOM | CHARDONNAY

SAN SIMEON | SAN MARTIN | SAN JUAN | SAN CARLOS
SAN JOSE | SANTA CLARA | CARMEL | MONTEREY

SHORT COURSES

EXECUTIVE ROOM

SIERRA | CASCADE | SISKIYOU | DONNER

BAYSHORE BALLROOM: EXHIBITS

LOBBY LEVEL

CONVENTION ENTRANCE

SPENCER'S FOR STEAKS AND CHOPS

Sprigs

LOBBY LOUNGE

Sushi

UPS

MAIN ENTRANCE

10th ANNIVERSARY

6SigmaET by Future Facilities

Accelerate Your Thermal Design

For more information visit ww.6sigmaet.info

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

www.analysistech.com

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

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.

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.

EXHIBITOR LISTINGS

AOS Thermal Compounds developed the first non-silicone thermal interface materials for AT&T in the 1960's. Today we manufacture the lowest thermal resistance and pump-out resistant thermal greases, unique Micro-Faze thermal pads, and a high performance and economical line of Sure-Form gap fillers.

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.

Binghamton University
S3IP brings together teams of experts from industry and academia to address pressing real-world problems in the systems integration and manufacturing of electronics. Our research centers focus on topics related to electronics packaging, flexible electronics, energy-efficient data centers and energy harvesting and storage. Binghamton University, the premier public university in the Northeast, is home to S3IP. Our PhD-level staff members and affiliated faculty are ready to assist companies in New York State and beyond with collaborative problem solving. S3IP, which recently celebrated its 10th year as a New York State Center of Excellence, and its constituent research centers have contributed more than $1 billion in economic impact to New York State since 1996.

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.

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.

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.

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EXHIBITOR LISTINGS

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

Delta Fan and Thermal Products Group

The Delta Fan and Thermal Products Group designs and builds innovative cooling systems that perform to the highest standards – even in harsh environments.

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

Our Delta-exclusive patented design and innovative structure boosts cooling performance and reduces system noise. Delta fans and thermal products are sold globally, serving an array of industries and organizations. Highly efficient cooling solutions can be customized to suit 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.

Dynatron Corporation, an industry leader in thermal solutions spanning a wide spectrum of consumer to enterprise products. With missions of CPU coolers sold worldwide since 1995. Dynatron has established its reputation over the years and continues to reinforce it with world class support and inventive ways to keep critical systems operating.

It is also the first company to invent a uniquely designed radiator equipped with a built-in pump into the liquid cooler. Coupled with an integrated Skived fin and its proprietary Vapor Chamber technology into a heatsink, has raised the standard in liquid cooling.

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.

Electronics Cooling

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EXHIBITOR LISTINGS

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.

Fujikura Kasei Co. Ltd. is the global supplier of coatings for automotive and electronic parts with its history reaching 80th anniversary this year.

We have developed thermal radiation clear-coating which can easily increase the emissivity of substrates by applying the coating. Since its paint film has higher emissivity than anodized aluminum, our coating can offer strong support for advancement in performance of heat emitting materials.

With its advantage being in a form of coating, we can also offer flexible solution for various shape and substrates as well as physical property needs.

For anyone who is looking for some countermeasure for thermal issues, please visit our booth as we can propose optimal coating choices.

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.

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.

Jones Tech

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.

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EXHIBITOR LISTINGS

LISAT

LISAT, manufacturer of Thermal Interface Material & EMI products. HQ in U.S., LISAT have operations in Asia. In U.S., we provide Thermal Management Solution to customers & work with R&D Engineers at Design Centres. We provide technical support & samples to our customers to test our materials. Our Asia operations provide manufacturing, converting, technical & sales to customers' worldwide. Our products : TIM Pad, Insulator, Silicon Free TIM, Gel, Grease, Mylar, Graphite, Conductive Plastic, Conductive Elastomer, Fabric-Over-Foam, Microwave Absorbing Material, Metal Finger Stock, EMI Shielding Solution, Switching Power Supply, Desktop & Wall Mount Adaptor, Metal Core PCB, Ceramic PCB.
Email alan@lisat.net

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.

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.

Mentor, A Siemens Business

Siemens PLM Simcenter portfolio includes a range of simulation software and test equipment solutions to aid development of a virtual digital twin of a product for improved design and lifecycle management. This portfolio now includes 30+ year industry leading Simcenter Flotherm electronics cooling software product family and Simcenter T3STER thermal test hardware solutions from Mentor, A Siemens Business.

Find out about the latest in enhancements to Simcenter Flotherm and Simcenter Flotherm XT at SEMI-THERM, and seek more information on other simulation tools in the portfolio incl. multi-physics simulation software (Simcenter STAR-CCM+), CFD for designers (Simcenter FLOEFD), …

In semiconductor thermal measurement, characterization and thermal reliability, find out the latest on Simcenter T3STER test solution family. This includes latest developments in thermal measurement to support automatic thermal simulation model calibration and LED multi-domain models, TIM material testing, and power semiconductor thermal reliability testing (SIMCENTER POWERTESTER range).

MSC Software

Software Cradle 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, Software Cradle has joined MSC Software Corporation, the worldwide leader in the field of multidiscipline simulation.

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EXHIBITOR LISTINGS

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.

Netzsch Instruments
https://www.netzsch.com/us/

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.

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.

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.

Solid State Technology

Solid State Technology is part of the Semiconductor Manufacturing and Design Network which includes the SemiMD portal, www.semiMD.com. Solid State Technology reaches the largest, most qualified community of decision makers for semiconductor and electronics manufacturing through the magazine, email newsletters, website, webcasts and The ConFab Conference & Networking event which will be held at The Hotel del Coronado in San Diego May 14th – 17th, 2017. Topics covered include Advanced Packaging, MEMS, LEDs, Displays, and Materials as well as current trends in the industry. Visit us here www.solid-state.com.

EXHIBITOR LISTINGS

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.

TCPoly, Inc.
TCPoly has developed high thermal conductivity plastics for use on low cost 3D printers. The 3D printing materials have thermal conductivity up to 50X higher than traditional plastics (10 W/m-K) and when combined with the design freedom of 3D printing, can be used to make high performance heat transfer products including plastic heat exchangers, heat sinks, coldplates, and heat conductive cases and enclosures.

t-Global Technology
T-Global Technology is dedicated to the development, manufacture and research of total thermal solution and materials including heat sink, heat pipes, vapor chamber, thermoelectric cooling chip, fan, TIMs and thermal simulation service.
We provide our customers with rapid sampling, customized manufacturing and professional technical support. With rich experience in research and development, T-Global is already become the designated and direct supplier of over 2,500 enterprises worldwide.
Over 15 years, T-Global keeps on providing customers with high quality products by using own innovation which is already become a total thermal solution expert now.

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.

ThermAvant Technologies, LLC
ThermAvant Technologies, LLC designs, develops and delivers custom thermal solutions to improve size, weight, performance and/or costs of advanced energy and technology platforms. The leading provider of Oscillating Heat Pipe products, ThermAvant also offers custom Cold Plates, Ejector Refrigerators, and Design & Engineering services.

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.

W. L. Gore & Associates
W. L. Gore & Associates is a global materials science company dedicated to transforming industries and improving lives. Founded in 1958, Gore has built a reputation for solving complex technical challenges in the most demanding environments.

Student Scholarships

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

Annual
P.K. Mulay Memorial Scholarship
$1,500
Best Student Paper at SEMI-THERM

Annual
Celsia, Inc.
$1,000
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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