THE 50th TIRE MECHANICS SHORT COURSE

In conjunction with the International Tire Technology Exhibition and Conference

September 14-18, 2020
John S. Knight Center in Akron Ohio, USA

This four-day educational and developmental course will provide engineers and scientists with an in-depth, intense study of the latest developments surrounding tire engineering. The course is designed for practicing engineers, chemists, and scientists who are concerned with tires and vehicles and who have an engineering or science background at the bachelor-of-science level.

The basic and practical aspects of the mechanics of pneumatic tires will be introduced by internationally renowned experts in tire mechanics. Extensive and detailed course notes prepared by each instructor will be provided for all participants along with a 700-page e-book, *The Pneumatic Tire*, edited by Professors A. Gent and J. Walter.

Those who complete this course will receive a **Tire Mechanics Short Course Certificate** from The University of Akron.

Monday, September 14, 2020
9:00-9:30
WELCOME AND INTRODUCTION

Dr. Benjamin T.F. Chung
Department of Mechanical Engineering
The University of Akron, U.S.A.

9:30-15:30 (Complimentary lunch 12-13:00)
THE TIRE AS A VEHICLE COMPOMENT

Dr. Gerald Potts
GRP Consulting
Akron, OH, U.S.A.

Today's pneumatic tire must serve four functions: (1) support a moving load;(2) generate steering forces; (3) generate driving and braking forces; and (4) provide isolation from road irregularities. In examining the complex mechanism involved in satisfying the four requirements, participants will study the tire's importance in

determining overall vehicle performance; for no matter what level of complexity is designed into a vehicle, its only communication with the road is through its tires, which must be tough and strong, yet flexible.

Participants will learn:

1. Basic Functions
2. Lateral Force Tire Models
3. Cornering Transients
4. Vehicle Ride Characteristics

Tuesday, September 15, 2020
9:00 – 16:00 (12:00-13:00 Complimentary Lunch)
TIRE MATERIALS AND MANUFACTURING

Dr. Joseph Walter, Department of Mechanical Engineering,
The University of Akron.
Presenter: Marc Borowczak, Research Center, The Goodyear Tire and Rubber Co.
Akron, Ohio. U.S.A.

The materials used in today's pneumatic tires are designed to act in concert with construction features to provide optimum durability and balanced performance for the expected service conditions. The proper combination of compound formulations and structural reinforcements is crucial for successful tire operation. These materials and constructions must then be processed efficiently within the tire factory beginning with mixing, continuing with extrusion, calendering, and component assembly, and ending with vulcanization prior to final inspection.

1. Tire Construction and Materials
2. Tire Polymers and Rubber Compounds
3. Textile and Steel Cord Reinforcement
4. Tire Manufacturing
   A. Rubber compound operations
   B. Tire component operations

16:00-17:30 Visit to the ITEC Exhibition

17:30-18:30 Complimentary Reception with ITEC Attendees

Wednesday, September 16, 2020
9:00 - 16:00 (12:00-13:00 Complimentary Lunch)
TIRE STRESS AND DEFORMATION ANALYSIS

Dr. Michael Trinko
Technical Center
The Goodyear Tire and Rubber Co.
Akron, OH. U.S.A. (Retired)

Several topics related to understanding tire behavior are covered to give a basic understanding of tire mechanics. The properties of the anisotropic cord rubber composite have primary control of the overall performance characteristics of pneumatic tires. In order to optimize a given tire performance, knowledge of the combined cord rubber composite material properties is necessary and will be covered in this part of the course. Finally, we will examine results of rolling tire analyses and how these were obtained.

Participants will learn:

1. Analytical Techniques, including:
   - Equilibrium tire design
   - Cord loads, belt loads, sidewall loads
   - Air diffusion calculation
   - Beads load, bead contact forces
   - Experimental Techniques
2. Composite Material Properties Calculation
3. Footprint Contact Behavior
4. Cord Loads for Traction, Cornering
5. Rolling Tire Modeling Approaches

16:00-17:30 Visit to the Exhibition

16:30-17:30 Complementary Brews & Bite

Thursday, September 17, 2020
9:00-16:00 (12:00-13:00 Complimentary Lunch)

IMPACT OF RUBBER AND REINFORCEMENT PROPERTIES ON TIRE FOOTPRINT MECHANICS

Dr. Mahmoud Assaad
Global Tire Performance Prediction, Computational Mechanics
The Goodyear Tire & Rubber Co.
Akron, OH. U.S.A.

The viscoelastic behavior of the rubber compounds and the reinforcing cords influences the stability of the tire footprint shape. Additional physical properties such as the strain dependency of both constituents and their thermal stability contribute to the contact pressure distribution. The resultant tire forces and moments transmitted to the vehicle are measured using tri-axial force pin transducers or pressure sensitive mats. The interaction between the materials behavior and the tire global response control the mechanics of tire abradibility and wear characteristics.

The following topics will be discussed:

1. Rubber viscoelasticity, static, dynamic, and fracture properties
2. Fibers and cords: load-displacement, creep, stress relaxation, and shrinkage
3. Footprint mechanics and tire forces and moments

Friday September 18, 2020
8:00 - 15:00 (12:00-13:00 Complimentary Lunch)
VIRTUAL TIRE MODELING for IMPROVED PERFORMANCE

Dr. Ronald Kennedy, Center for Tire Research (CenTire)
The University of Akron and Virginia Tech.
Blacksburg, Va. U.S.A.

Simulations are increasingly being used in companies' virtual design processes to more effectively and efficiently develop a tire with desired performance attributes. These simulation methods run the gamut from simple empirical or analytical models to highly detailed finite element models. These increasing levels of modeling will be described along with examples, with extended focus on the finite element modeling method. Various finite element modeling techniques will be shown as part of the tire performance simulation examples.

The lecture will cover:

1. Review of tire modeling methods, with examples
2. Introduction to tire finite element analysis (FEA)
3. Application of FEA to tire performance prediction
    - Tire/road contact
    - Rolling resistance
    - Tread wear
    - Durability
    - Hydroplaning

15:00 – 15:30
COURSE EVALUATIONS AND DISTRIBUTION OF CERTIFICATES

Dr. Benjamin T.F. Chung
Department of Mechanical Engineering
The University of Akron, Akron, OH. U.S.A.

FOR COURSE INFO:
Dr. Benjamin T. F. Chung
Department of Mechanical Engineering
The University of Akron
Akron, OH 44325-3903 USA
Tel: 330-972-7739
Fax: 330-972-2011
bchung@uakron.edu

FOR REGISTRATION INFO:
Ms. Sally Dietz
Assistant Events Manager
Rubber & Plastics News and Tire Business
Tel: 330-865-6112
sdietz@crain.com

Biographical Notes

Dr. Mahmoud C. Assaad

In 1983, Dr. Assaad earned his Ph.D. in Engineering Science and Mechanics with a minor in Applied Mathematics from Iowa State University. In 1979, he received a M.S. Degree in Structural Engineering from the same university. In 1990, he received a M.S. Degree in Polymer Science from The University of Akron. In 1983 he joined The Goodyear Tire & Rubber Company.

His current research interests include development of multi-physics simulation of tire performance including structural, thermal and oxidative response. He is a lecturer at the Goodyear Institute of Technology. He was an Adjunct Assistant Professor in the Civil Engineering Department at The University of Akron and was also a lecturer at The University of Toledo. He co-authored the composite segment of *The Pneumatic Tire e-book*, taught short courses on Plastics and Elastomers in Engineering Design in Italy, Luxembourg, and Germany. He was an invited speaker to the Gordon Conference on Fibers Science and to the 2009 "The Annual Workshops Materials" days at the University of Rostock in Germany.

Dr. Assaad was a recipient of the special Achievement Award from NASA for his meritorious accomplishments, dedicated work, and special efforts. He was the winner of the "2008 create the future design contest" in the machinery/equipment category and served as a technical chairman for the 26th Anniversary of The Tire Society Conference. Dr. Assaad holds over 60 U.S., European patents and trade secrets.

Dr. Benjamin T.F. Chung

Dr. Benjamin T.F. Chung earned his Ph.D. in Mechanical Engineering at Kansas State University. He joined The University of Akron as an Assistant Professor in 1969, served as Chair of Mechanical Engineering Department from 1984 to 1999 and was awarded the endowed Chair of the F. Theodore Harrington Professor of Mechanical Engineering in 1993. He has chaired the Tire Mechanics Symposium for the past 30 years.

Dr. Chung is a five-time recipient of the Outstanding Achievement Award from the Board of Trustees, a recipient of the Louis Hill Award from the College of Engineering, and the Outstanding Research Awards from both the College of Engineering and The University Alumni Association. His honors outside the campus include the Norbert Wiener Award from MCB University Press in London, Life Fellow from the American Society of Mechanical Engineers, Outstanding Alumni Award from the National Cheng Kung University, Taiwan, Outstanding Reviewer for the Journal of Heat Transfer, Contribution and Board Space Act Award from NASA Glenn Research Center, and the Lifetime

Achievement Award from Tire Technology International. Being an author and co-author of two book chapters, and 190 technical papers, Dr. Chung has directed 32 M.S. theses, 18 Ph.D. dissertations, and three post-doctoral fellows. He served as Associate Editor of the *ASME Journal of Heat Transfer* and Editorial Advisory Board member for John Wiley & Sons Inc. Currently, he is F. Theodore Harrington Professor Emeritus, an Editorial Board Member of *The Open Thermodynamics Journal, The International Journal of Applied Engineering Research, The Open Conference Proceedings Journal and Asian Journal of Engineering and Applied Technology.*

Dr. Ronald Kennedy

Dr. Ron Kennedy is currently the Managing Director of the Center for Tire Research (CenTiRe), an industry/university consortium involving Virginia Polytechnic Institute and State University, The University of Akron, and tire and tire-related companies.

Before joining CenTiRe, he worked for 37 years in the tire industry at Firestone, Bridgestone/Firestone, and Hankook Tire performing tire finite element methods development and software programming, simulation systems development, advanced tire design, and tire factory uniformity studies. His work has covered the range of tire performance areas, manufacturing, and design. Dr. Kennedy is currently an Associate Editor of the *Journal of Tire Science and Technology.* He has numerous technical publications and presentations and has been awarded the Arch T. Colwell Merit Award from SAE, the Tire Society Superior Paper Award and an Honorable Mention Award, the CEO Award and President's Award from Bridgestone/Firestone. Dr. Kennedy was the Plenary Speaker at the 2017 Tire Society Conference and gave the keynote address at the 2018 ACS Rubber Division Meeting. Ronald Kennedy received his B.S. and M.S. degrees in Engineering Mechanics from The University of Wisconsin, and his Ph.D. in Mechanical Engineering from The University of Akron.

Dr. Annette Lechtenböhmer

Annette Lechtenböhmer, citizen of Germany, finished her studies of chemistry at Westfälische Wilhelms-Universität Münster, Germany, with a Ph.D. in Physical Chemistry in 1981. After two post doctorates, she was employed at the Goodyear Innovation Center in Luxemburg, where she has been working since recently. During her career, she filled positions within compounding and compound testing. She achieved the position of Research Associate of Material Science. During her 35 years of experience in the rubber industry, she has accumulated profound knowledge of compound development, compound testing and test principles, viscoelasticity, compound processing, testing for material modelling and structure of tires, quality control and production. Her positions required close cooperation with other steps of tire development, production, tire design, construction, raw material suppliers, and scientific institutes and universities. She holds several patents and trade secrets.

In addition to her employment, she was a lecturer at Universität Hannover on tire technology for many years, she lectured on elastomer technology at Luxemburg University and acted as co-editor of the scientific paper *Tire Science and Technology*. She participated as a member of the Transport Advisory Board for Framework 7, a programme of the European Commission, from 2007 to 2012,

Dr. Joseph Padovan

Joe has developed his career as a balance of industrial, consultative, research and educational/teaching experiences. He earned a Ph.D. in Mechanical Engineering at the Polytechnic Institute of New York University. His direct industrial activities were with Curtiss Wright Corp - Aircraft Engine Division, United Technologies - Pratt & Whitney Aircraft Engines Division, and most recently at Goodyear Tire & Rubber Company as a Corporate RD&E Fellow. At Goodyear, he headed the Tire Physics/Mechanics group, one of whose special emphasis areas included tire dynamic performance, product fatigue life assessment, thermomechanochemistry of elastomeric composites materials, wear and traction, sensor development, new experimental methods, noise, hydroplaning and advanced FEA modeling.

Consulting activities have been for a variety of industries and government agencies, i.e. Automotive, Aerospace, Biomedical (joints, heart pumps, wiring leads, and Orthotic devices), Chemical-Material, Steel / Bearings, Tire and Rubber/Plastics, as well as NASA (Glenn, Langley), The Air Force, The Army and Navy. From these sources, a multitude of Federal (NSF, NASA, and Military), State (ODOT, EPIC) and industrially funded research projects have been undertaken. His teaching activities were at The University of Akron where he was a Distinguished Professor of Mechanical & Polymer Engineering.

Additionally, Joe gives numerous short courses (Tire Mechanics, FEA, Wear and Fatigue, Elastomeric Materials) on site, at conferences or through University Extension services, i.e. UA and The University of Wisconsin. Overall his work has led to over 220 refereed journal publications, over 210 conference presentations, several patents and over 50 Ph.D. and over 50 MS advisees. He received a 2014 Tire Technology International Lifetime Achievement Award.

Dr. Gerald Potts

Dr. Gerald Potts obtained his Ph.D. degree in Mechanical Engineering from Kansas State University. Upon graduation in 1970, he joined the Firestone Tire and Rubber Co. as a Research Scientist and Group Leader of the Dynamics Research Laboratory. In 1978, he became the Manager of Tire/Wheel Testing Systems at MTS Systems Corporation where he led the initial development of the Flat-Trace â tire test machine. Two years later, he was employed by the General Motors Institute as an Associate Professor of Mechanical Engineering teaching Vehicle Dynamics and Mechanical Vibrations. In the meantime, he established his own company, G.R. Potts Associates, Inc.

From 1984 to 1991, then becoming President of TMSI specializing in tire high speed uniformity test systems, tire rolling resistance testers, On LEVEL tire test systems and vehicle crash testing. In 2013 he sold TMSI to MESNAC Americas, LLC, and remains as President of TMSI LLC. Dr. Potts has traveled and lectured to engineering groups, world-wide, having delivered a Plenary Lecture at the 2006 Indian Rubber Institute Conference in Cochin, India. He holds ten patents, has been an Adjunct Professor of Mechanical Engineering at The University of Akron since 1974, and was awarded a Lifetime Achievement Award by Tire Technology International at the 2014 Conference and Exhibition in Cologne, Germany.

Dr. Michael Trinko

Dr. Michael Trinko holds his Ph.D. in Engineering Mechanics from the University of Wisconsin. He has devoted three decades (1972-2003) of his career to tire analysis and tire development for the Technical Center of the Goodyear Tire & Rubber Company where he served as a Research and Development Associate. While at Goodyear, he initiated, developed and led Technical Leadership Courses for the technical staff.

Dr. Trinko holds two patents relating to tire technology and has authored a section of *The Pnuematic Tire* published by NHSTA. He has presented numerous papers, all related to tire mechanics, in government sectors, at universities and professional societies. He served as the Chairman of the Industrial Advisory Committee of the NASA Tire Modeling Program, Session Chair for SAE meetings and Program Chair for the Tire Society Conference, Treasurer for The Tire society, and Associate Editor of the *Journal of Tire Science and Technology*. Dr. Trinko was recognized with Lifetime Achievement Award at the 2014 International Tire Technology Conference.

Dr. Joseph D. Walter

Dr. Joseph D. Walter is presently a member of the faculty of The University of Akron where he teaches graduate and undergraduate courses in both the Mechanical and Civil Engineering Departments. Prior to joining academia, Dr. Walter was the Managing Director of Bridgestone's Technical Center Europe in Rome, Italy, and served on the Board of Directors of Bridgestone Europe. He has served as a Mechanical Engineering evaluator for the Accreditation Board for Engineering and Technology, (ABET), and has also served on several committees of the National Academy of Sciences addressing fuel efficient cars (1992) and energy efficient tires (2005).

Dr. Walter received his Ph.D. from Virginia Polytechnic Institute and State University and an M.B.A. from The University of Akron. He is a member of several professional organizations, including the Society of Automotive Engineers and the Rubber Division of the American Chemical Society.