



CASE

CASE SCHOOL OF ENGINEERING



A Short Course in:

ROLLING-ELEMENT BEARING TECHNOLOGY

June 25-27, 2007

Cleveland, Ohio

Objectives:

To provide product engineers, machine designers, and manufacturing engineers with better appreciation for the design, application, life, and use of rolling element bearings.

Speakers Information:

Erwin V. Zaretsky, P.E.

Mr. Zaretsky is a noted speaker, writer, and consultant to both government and industry. He is currently Chief Engineer for Structures and Materials at the NASA Glenn Research Center, Cleveland, Ohio. He was formerly head of the NASA Bearing, Gearing and Transmission Section, responsible for most of the NASA mechanical component research for air breathing engines and helicopter transmissions. He has over 45 years of experience in Mechanical Engineering related to rotating machinery and tribology. He has performed pioneering research in rolling-element fatigue, lubrication and probabilistic life prediction. His work resulted in the first successful 3 million DN bearing and has received four I-R 100 awards. He is also a recipient of the NASA Medal for Exceptional Engineering Achievement. He has written over 190 technical papers and books and has lectured widely throughout North America, Europe, Asia and the Middle East. He has taught machine design as a member of the adjunct faculty at Cleveland State University.

He is a Fellow of both ASME and the STLE. He has also held national and local offices in these technical societies. Under his chairmanship, the Rolling-Elements Committee of the ASME authored the first *Live Adjustment Factors for Ball and Roller Bearings – An Engineering Design Guide*. In 1992 the STLE published an authoritative bearing text, *STLE Life Factors for Rolling Bearings* of which he was the editor and co-author. He is also the editor and co-author of the comprehensive text, *Tribology for Aerospace Applications*, published in 1997.

Speakers continued:

His broad experience, talents, and contributions have provided him with a rare combination to put together a comprehensive course related to ball and roller bearings.

Joseph V. Poplawski, P.E.

Mr. Poplawski, who is President of J. V. Poplawski and Associates has 39 years experience in mechanical engineering. He specializes in bearings and lubrication problems, finite element stressing, and thermal and dynamic analysis of mechanical equipment, and rotating machinery. His clients are from the aerospace, steel, cement, mining, manufacturing, utilities, and medical industries. He also serves as an expert witness in product liability litigation cases.

He is the developer of 3 internationally used commercial bearing codes widely used for industrial and aerospace applications.

Mr. Poplawski has lectured and taught rolling bearing technology throughout the U.S. and Canada. His early professional experience includes bearing analysis and design at United Technologies Pratt & Whitney, AVCO-Lycoming, and Bethlehem Steel Corporation. He holds a BSME from Penn State University and MS degree in Applied Mechanics from RPI. Mr. Poplawski is a member of ASME, STLE, and AISE and has served as session chairman, technical committee member, and on several meeting planning committees. As a member of the *STLE Life Factors Committee* he co-authored *STLE Life Factors for Rolling Bearings*, a comprehensive bearing text which was published in 1992.

Program Schedule:

First Day

8:00am Registration/Check-in
Nord Hall Conference Ctr., 310
Case Western Reserve University
10900 Euclid Ave.
Cleveland, OH 44106

8:20am Welcome
Robert L. Mullen
Chairman
Dept. of Civil Engineering
Case Western Reserve University

Each Day:

8:30-12:00 Lecture and Discussion
12:00 Noon Lunch
1:00-4:30 Lecture and Discussion

Final adjournment on last day at 3:30pm.

Breaks will be conveniently scheduled at mid-morning and mid-afternoon.

Outline:

Rolling Bearing Types and Applications

- Ball Bearings
 - Angular Contact
 - Deep Groove
- Roller Bearing
 - Cylindrical
 - Spherical
 - Needle
 - Tapered

Rolling Bearing Standards

- ANSI/AFBMA/ISO
- ABEC
- RBEC
- Metric v. Inch

Manufacturing Tolerances and Internal Clearances

- Dimensions
- Internal Radial (Diametrical) Clearance
 - Free or Bench
 - Mounting
 - Operating
- Fit-Up Studies and Significance

Failure Modes Related to Bearing Life

- Subsurface – Origin Spalling
 - Inclusions and Carbides
 - Subsurface Structural Changes
 - Subcase Fatigue (Case Crushing)
- Surface – Origin Spalling
 - Point Surface Origin
 - Geometric Stress Concentration
 - Microspalling
- Transverse Cracking (Cross-Section Fracture)
- True and False Brinelling
- Misalignment
- Excessive Thrust
- Lubrication
- Heat and Thermal Preload
- Roller Edge Stress

Bearing Life and Reliability

- Lundberg-Palngren Theory and Application
- Weibull Analysis
- ANSI/AFBMA Standards
- Life Factors
- Manufacturers' Catalogue Methods
- Restored and Refurbished Bearings and Bearing Reuse
- Warranty Considerations

Bearing Loads and Stresses

- Hertz Contact Stress
- Subsurface Stress and Critical Depth
- Line, Point and Elliptical Contact
- Heavy Load and Distortion
- Misalignment
 - Ball Bearings
 - Roller Bearings
- Residual and Hoop Stresses
- Axial Loads on Cylindrical Roller Bearings
- Rotordynamic Loads
- Centrifugal Loads
- Static Capacity

Bearing Lubrication

- Type of Lubrication
- Lubricant Selection
 - Liquid
 - Grease
- Elastohydrodynamic (EHD) Lubrication
- Effect of Contaminants
 - Wear Particles
 - Water

Materials and Processing

- Bearing Materials
 - Through-Hardened Steels
 - Corrosion-Resistant Steels
 - Nonferrous Materials
 - Ceramic Bearings
 - Ceramic Hybrid Bearings
- Material Processing
 - Melting Practice
 - Metal Working
 - Heat Treatment
 - Material Hardness
 - Carbide Effects
 - Compressive Residual Stress
- Coatings

Bearings Kinematics

- Low Speed v. High Speed
- Skidding
- Time Transient
- Characteristic Frequencies
- Speed Limitations

Multi Bearing Systems

- Statically Indeterminate
- Fixed Bearings
- Floating Bearings
- Load Sharing
- Three Degrees of Freedom
- Five Degrees of Freedom

Computer Aided Design of Rolling Bearings

- Typical Bearing Codes
- Design Variables

Computer Optimized Ball and Roller Bearing Applications

- Introduction to Computer Bearing Analysis (COBRA)
- Single Bearing and Multi Bearing Analysis
- Bearing Types
 - Iterative Nature
 - Sign Convention
 - Example

Special Topics*

- Industrial Application
- Aerospace Application
- Specialized Lubricant and Lubrication Requirements
- Application Problems and Solutions

*Based upon attendees' needs and interests

Who Should Attend:

This course is intended for engineers involved in product design, materials selection, failure analysis, product endurance testing, and process control.

Course Materials:

The STLE Text "Life Factors for Rolling Bearings" will be used as a reference and is included in the price of the seminar. An extensive set of notes is also provided in a three-ring notebook along with a 3½" demonstrator disk containing a Rolling Element Bearing program.

CWRU reserves the right to amend the program should circumstances warrant such action.

In the event of course cancellation, Case Western Reserve University will refund course fees. Liability for course cancellation is specifically limited to the amount of pre-paid course fees and excludes any incidental or consequential damages.

General Information

Enrollment: *Course enrollment is limited.
Please reserve your place now!*

Registration Deadline: June 8, 2007

Online: www.oai.org/cwru/

Fax enrollment form to: (440) 962-3057 or mail enrollment form to address below.

Fee Covers: Notebook, program materials, break refreshments and lunches. Lodging and other meals **NOT** included. A Certificate of Participation is presented to each registrant. Proceedings are not published.

Refunds and Cancellations: There is a \$50 administrative fee for any registration cancellations. To cancel, you must call our department at (440) 962-3024 *seven (7) working days prior to the program start date* to obtain a cancellation number. If cancellation is less than seven (7) working days prior or the above procedure is not followed, you will be liable for the full fee. Enrollment substitutions may be made at any time.

Location: This program will be held at:
Case Western Reserve University
Bingham Bldg., Room 103
10900 Euclid Ave.
Cleveland, OH 44106

Lodging: Please make your own lodging arrangements at the facility of your choice. Local hotel information can be found at <http://www.cwru.edu/menu/lodging/>. Please advise us at the time of registration if you are physically challenged and require special accommodations. All requests will be kept confidential.

Suggested Attire: Casual business dress is appropriate. Please be prepared for a moderate temperature variation in the seminar room.

*Discount available if three or more
enroll from one company.
Call 440-962-3024 for more details.*

For up-to-date information visit our website at www.oai.org/cwru/

To Enroll: Please go online to register or if no web access, please mail or fax enrollment form.

Enrollment Form

MAIL TO:

Ohio Aerospace Institute
Attn: Christina Klamer
22800 Cedar Point Road
Cleveland, OH 44142

Fax Registration 440-962-3057

Please enroll me in the following course:

Rolling-Element Bearing Technology

June 25-27, 2007

Fee: \$1,395

Cardholder Name _____

Check made payable to OAI MasterCard Visa

Credit Card Number _____

Expiration Date _____

Last Name _____

First Name _____

Company _____

Title _____

Address _____

City _____

State _____ Zip _____

Telephone _____

E-mail _____