Message from STLE’s president

Welcome to five days of world-class education, training and networking

Dear Members, Friends and Guests,

Welcome to STLE’s 64th Annual Meeting & Exhibition!

Two key STLE committees, the Annual Meeting Program Committee and the Education Committee, have assembled a challenging technical program featuring some 350 paper presentations. You can look forward to an outstanding week of professional development here in Lake Buena Vista, Florida.

In addition to the technical sessions, the meeting’s program includes 10 one-day education courses and many chances to network with and learn from your peers. I also encourage you to take time out of your schedule to visit companies displaying in the trade show. This is an opportunity to get an early look at the newest technologies the lubricants industry has to offer.

Remember, also, to take advantage of the social events, including the Welcoming Party Monday at 6:30 p.m. and the President’s Luncheon Tuesday at noon. You’ll reconnect with the entire STLE community and have a chance to recognize the many volunteers who generously donated their services in the last 12 months to create new programs for all of us involved in the science of tribology and best practices in lubrication engineering.

STLE continually strives to improve member services. Here in Florida we are demonstrating two new services at the Member Services Booth. First, you’ll see the first digital edition of TLT. This new product now extends the magazine’s reach further than ever and also will play a large role in STLE’s member-recruitment efforts. Also on display is the first of our educational Webinars. You’ll now have the ability to access world-class education from the industry’s top experts at a time that’s convenient for you.

By popular demand, we’ve brought back The STLE Lounge, adjacent to the trade show. The lounge is a great place to relax and conduct business with personnel from exhibiting companies.

I also urge you to take advantage of the Commercial Marketing Forum, where you can hear commercial presentations from the lubricant industry’s most innovative companies. The forum sessions are listed with the technical tracks in this program guide.

As you’ll see on the following pages, STLE’s 2009 Annual Meeting & Exhibition is a singular opportunity to discover technical concepts and make personal contacts that will help you better serve your employer and customers and advance your career. In just five days you’ll have access to a wealth of technical information that would take you months to find on your own.

If you see me in the halls or meeting rooms, please say hello. I’m looking forward to joining you on this journey.

Bob
PRACTICAL Oil Analysis & Cooling System Maintenance

TRAINING

Indianapolis
June 9-11, 2009

Edmonton
July 14–16, 2009
Laboratory Open House & Tour

Salt Lake City
September 14-16, 2009

Learn the fundamentals of Fluid Analysis Management & Cooling System Maintenance

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It's not just fluid analysis. It's what we do with it.

Mention this ad for a discounted rate!
## Daily Schedule-At-A-Glance

### Committee Meetings
- **TLT Editorial Advisory Committee**
  - 1 – 3 pm – Fiesta 2
- **CLS Committee**
  - 1 – 5 pm – Fiesta 1
- **Metalworking Fluids Certification Subcommittee**
  - 5 – 6 pm – Fiesta 1
- **ASME Research Committee on Tribology**
  - 5:30 – 6:30 pm – Fiesta 2

### Technical Committee Meetings
- **Practical Lubrication Solutions**
  - 4:30 – 5 pm – Coronado C
- **Special Session on Coatings**
  - 5:30 – 6 pm – Yucatan 2
- **Fluid Film Bearings**
  - 6 – 6:30 pm – Coronado E

### Technical Sessions (8 – 10 am)
- **1A Practical Lubrication Solutions – Coronado C**
- **1B Engine & Drivetrain I – Coronado D**
- **1C Fluid Film Bearings I: Modeling – Coronado E**
- **1D Lubrication Fundamentals I: ZDDPs and Other Anti-Wear Additives in Engine Oils – Coronado F/G**
- **1F Commercial Marketing Forum I – Fiesta 5**
- **1G Nanotribology I: Modeling and Simulation – Yucatan 1**

### Keynote Address: 10:30 am – Noon – “From Inspiration to Innovation” – Disney Institute – Coronado H

### Lunch: on your own – Noon – 1:30 pm

### Commercial Exhibits and Student Posters: Noon – 5 pm – Veracruz C

### Welcome Reception: 6:30 – 8 pm – Coronado H

## Exhibit Hours

**Hours for the 2009 STLE trade show in Veracruz Care:**
- **Monday:** Noon – 5 pm
- **Tuesday:** 9:30 am – Noon & 2 – 5:30 pm
- **Wednesday:** 9:30 am – Noon

## Sunday, May 17, 2009

**Registration:** 7 am – 6 pm – Foyer/Laredo 2

**Speakers Breakfast:** 7 – 8 am – Coronado F/G

### Education Courses
- **Metalworking 105**
  - 8 am – 5:45 pm – Coronado A
- **Synthetic Lubricants 203**
  - 8 am – 5:45 pm – Coronado B
- **Basic Lubrication 101**
  - 8 am – 5:45 pm – Fiesta 7/8
- **Condition Monitoring 101**
  - 8 am – 5 pm – Fiesta 9/10

### Committee Meetings
- **Section Leadership Training**
  - 5 – 6:30 pm – Yucatan 2/3
- **Section Leadership Reception**
  - 6:30 – 7:30 pm – Monterrey 3
- **IJTC Executive Committee**
  - 6 – 8 pm – Monterrey 2

## Monday, May 18, 2009

**Registration:** 7 am – 6 pm – Foyer/Laredo 2

**Speakers Breakfast:** 7 – 8 am – Fiesta 6

### Education Courses
- **Metalworking 125**
  - 7:30 am – 4:30 pm – Coronado A
- **Synthetic Lubricants 204**
  - 8:45 am – 4:45 pm – Coronado B
- **Basic Lubrication 102**
  - 7:30 am – 5:45 pm – Fiesta 7/8
- **Condition Monitoring 201**
  - 8 am – 5 pm – Fiesta 9/10

### Exhibit Hours

**Hours for the 2009 STLE trade show in Veracruz Care:**
- **Monday:** Noon – 5 pm
- **Tuesday:** 9:30 am – Noon & 2 – 5:30 pm
- **Wednesday:** 9:30 am – Noon
### Tuesday, May 19, 2009

**Registration:** 6:30 am – 5 pm – Foyer/Laredo 2  
**Speakers Breakfast:** 7 – 8 am – Fiesta 6  
**Committee Meetings**  
- Corporate Member Business Meeting  
  7 – 8 am – Fiesta 2  
- Editorial & Publication Advisory Board  
  8 – 10 am – Fiesta 1  
- Education Course Chairmen  
  10 – 11 am – Fiesta 2  
- Education General Committee  
  2 – 3 pm – Fiesta 2  
- Fellows Committee  
  3:30 – 5 pm – Fiesta 2  
- Awards Committee  
  5 – 7 pm – Fiesta 1  
- Non-Ferrous Pre-Planning Meeting  
  5 – 6:30 pm – Sonoma B  
- Metalworking Fluids Education Certificate Subcommittee  
  5:30 – 6:30 pm – Fiesta 2  
- Emerging Technologies Committee  
  6 – 8 pm – Sierra Room  
- ASME Tribology Division Executive Committee  
  7 – 9 pm – Fiesta 1  
**Technical Committee Meetings**  
- Engine & Drivetrain  
  4:30 – 5 pm – Coronado D  
- Metalworking  
  5 – 5:30 pm – Fiesta 3/4  
- Nanotribology  
  5 – 5:30 pm – Yucatan 1  
- Lubrication Fundamentals  
  5:30 – 6 pm – Coronado F/G  
- Synthetic Lubricants  
  5:30 – 6 pm – Coronado A  
- Environmentally Friendly Fluids  
  5:30 – 6 pm – Fiesta 7/8  
- Solid Lubricants  
  6 – 6:30 pm – Yucatan 2  
**Commercial Exhibits and Student Posters**  
9:30 am – 5:30 pm – Veracruz C  
**Technical Sessions (8 am – Noon)**  
- **3A** Hydraulic Fluids – Coronado A  
- **3B** Wear I: Panel Discussion “The Impact of Fuel Economy and Emissions Regulations on Wear of Engines and Drivetrains” – Coronado B  
- **3C** Condition Monitoring I: Mini Course and Papers: Mobile Oil Analysis Labs – Coronado C  
- **3D** Engine & Drivetrain III: Friction & Fuel Economy – Coronado D  
- **3E** Fluid Film Bearings III: Gas Bearings – Coronado E  
- **3F** Lubrication Fundamentals III – Coronado F/G  
- **3G** Metalworking I – Fiesta 3/4  
- **3H** Commercial Marketing Forum III – Fiesta 5  
- **3I** Environmentally Friendly Fluids – Fiesta 7/8  
- **3J** Nanotribology III: Nanoparticle Research – Yucatan 1  
- **3K** Special Session on Coatings II – Yucatan 2  
**President’s Luncheon/Business Meeting:**  
Noon – 2 pm – Coronado H/J  
**Technical Sessions (2–6 pm)**  
- **4A** Synthetic Lubricants – Coronado A  
- **4B** Wear II – Coronado B  
- **4C** Condition Monitoring II – Coronado C  
- **4D** Engine & Drivetrain IV: Fuel Impact – Coronado D  
- **4E** Fluid Film Bearings IV: Modeling – Coronado E  
- **4F** Lubrication Fundamentals IV – Coronado F/G  
- **4G** Metalworking II – Fiesta 3/4  
- **4H** Commercial Marketing Forum IV – Fiesta 5  
- **4I** Environmentally Friendly Fluids – Fiesta 7/8  
- **4J** Nanotribology IV: Carbon-based Materials (HOPG, CNT, DLC) – Yucatan 1  
- **4K** Special Session on Coatings III – Yucatan 2  
- **4L** Solid Lubricants (starts at 3:30 pm) – Yucatan 2  

### Wednesday, May 20, 2009

**Registration:** 6:30 am – 5 pm – Lobby/Laredo 2  
**Speakers Breakfast:** 7 – 8 am – Fiesta 6  
**Committee Meetings**  
- Nominating Committee  
  8 – 9:30 am – Fiesta 1  
- Past Presidents’ Council Breakfast  
  9:30 – 11:30 am – Fiesta 2  
- IJTC Planning Committee Lunch  
  Noon – 1:30 pm – Fiesta 1  
- ASTM Meeting  
  2:30 – 4 pm – Fiesta 2  
- Certification Board Meeting  
  4 – 5 pm – Fiesta 2  

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**continued >**
64th Annual Meeting Program Guide

Daily Schedule-At-A-Glance

Technical Sessions (1:30 – 6:00pm)
6A Ceramics/Composites – Coronado A
6B Wear IV – Coronado B
6C Condition Monitoring IV – Coronado C
6D Seals II: Face Seal Materials Panel Discussion: Fundamental Review and Technology Outlook – Coronado D
6E Tribotesting II – Coronado E
6F Gears & Gear Lubrication – Coronado F/G
6G Metalworking IV – Fiesta 3/4
6H Commercial Marketing Forum VI – Fiesta 5
6I Rolling Element Bearings II – Yucatan 1
6J Nonferrous II: Biobased Applications in the Nonferrous Industry – Yucatan 2 – starts at 2 pm
6K Joint Session: Surface Engineering/Solid Lubricants II – Special Session: Tribological Coatings – Yucatan 3

Thursday, May 21, 2009

Registration: 7:30 am – 5 pm – Foyer/Laredo 2
Speakers Breakfast: 7 – 8 am – Fiesta 6
Certification Exams: 8:30 am – 12:30 pm – Fiesta 5

Technical Sessions (8 am – Noon)
7A Grease – Coronado A
7B Surface Engineering III – Coronado B
7D Seals III – Coronado D
7E Tribotesting III – Coronado E
7F Lubrication Fundamentals V – Coronado F/G
7G Metalworking III – Fiesta 3/4
7H Commercial Marketing Forum V – Fiesta 5
7I Rolling Element Bearings I – Yucatan 1
7J Nonferrous I: Sustainability in the Nonferrous Industry – Yucatan 2
7K Joint Session: Surface Engineering/Solids Lubricants I - Special Session: Tribological Coatings – Yucatan 3
7L Safety, Health & Regulatory Affairs – Coronado A – starts at 10:30 am

Technical Sessions (1:30 – 5:30 pm)
8B Surface Engineering IV – Coronado B
8E Tribotesting IV – Coronado E
8F Power Generation II – Coronado F/G
Committee and Council Meetings

Sunday, May 17, 2009
IJTC Executive Committee
6 – 8 pm – Monterrey

Monday, May 18, 2009
Committee Meetings
TLT Editorial Advisory Committee
1 – 3 pm – Fiesta 2
CLS Committee
1 – 5 pm – Fiesta 1
Metalworking Fluids Certification Subcommittee
5 – 6 pm – Fiesta 1
ASME Research Committee on Tribology
5:30 – 6:30 pm – Fiesta 2
Technical Committee Meetings
Practical Lubrication Solutions
4:30 – 5 pm – Coronado C
5:30 pm – 6:00 pm Special Session on Coatings
Yucatan 2
Fluid Film Bearings
6 – 6:30 pm – Coronado E

Tuesday, May 19, 2009
Committee Meetings
Corporate Members Business Meeting
7 – 8 am – Fiesta 2
Editorial & Publication Advisory Board
8 – 10 am – Fiesta 1
Education Course Chairmen
10 – 11 am – Fiesta 2
Education – General Committee
2 – 3 pm – Fiesta 2
Fellows Committee
3:30 – 5 pm Fiesta 2
Awards Committee
5 – 7 pm – Fiesta 1
Non-Ferrous Pre-planning Meeting
5 – 6:30 pm – Sonoma B
Metalworking Fluids Education Certificate Subcommittee
5:30 – 6:30 pm – Fiesta 2
Emerging Technology Committee
6 – 8 pm – Sierra
ASME Tribology Division Executive Committee
7 – 9 pm – Fiesta 1
Technical Committee Meetings
Engine & Drivetrain
4:30 pm – 5 pm – Coronado D
Metalworking
5 – 5:30 pm – Fiesta 3/4
Nanotribology
5 – 5:30 pm – Yucatan 1

Lubrication Fundamentals
5:30 – 6 pm – Coronado F/G
Synthetic Lubricants
5:30 – 6 pm – Coronado A
Environmentally Friendly Fluids
5:30 – 6:00 pm – Fiesta 7/8
Solid Lubricants
6 – 6:30 pm – Yucatan 2

Wednesday, May 20, 2009
Committee Meetings
Nominating Committee
8 – 9:30 am – Fiesta 1
Past Presidents’ Council Breakfast
9:30 – 11:30 am – Fiesta 2
IJTC Planning Committee Lunch
Noon – 1:30 pm – Fiesta 1
ASTM 34.50 Meeting
2:30 – 4 pm – Fiesta 2
Certification Board Meeting
4 – 5 pm – Fiesta 2
Metalworking Fluids Steering Committee
5 – 7 pm – Fiesta 2
Annual Meeting Program Committee
5:30 – 8 pm – Cancun
ASME Rolling Element Bearing Committee
6 – 8 pm – Fiesta 1
Technical Committee Meetings
Wear
3:30 – 4 pm – Coronado B
Condition Monitoring
2:30 – 3 pm – Coronado C
Tribotesting
4:30 – 5 pm – Coronado E
Ceramics/Composites
5 – 5:30 pm – Coronado A
Surface Engineering
5 – 5:30 pm – Yucatan 3
Nonferrous
4:30 – 5 pm – Yucatan 2
Seals
5:30 – 6 pm – Coronado D
Gears & Gears Lubrication
5:30 – 6 pm – Coronado F/G
Rolling Element Bearings
6 – 6:30 pm – Yucatan 1

Thursday, May 21, 2009
Technical Committee Meetings
Grease
11:30 am – Noon – Coronado A
Power Generation
4:30 – 5 pm – Coronado F/G
Personal Itinerary Planner for: _______________________________________
If found, please call: ________________________________________________

This new planning tool is brought to you by RohMax, your GF-5 low-temperature solutions provider.

To use this planner: Review all the events in this guide, particularly the technical sessions on pages 42-175 and the errata in your registration bag. Indicate each event and location on the grid. You will have your own personal itinerary indicating where you should be during every minute of STLE’s 2009 Annual Meeting.

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This new planning tool is brought to you by RohMax, your GF-5 low-temperature solutions provider.

### Monday, May 18

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*This new planning tool is brought to you by RohMax, your GF-5 low-temperature solutions provider.*

**Wednesday, May 20**

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Existing 95,000 square feet of meeting and function space:
- Largest hotel ballroom in the Southeast at 60,124 square feet
- 45 break rooms
- Permanent registration counters, dedicated Business Center and Meeting Planner offices
- High-speed wireless technology and fiber-optic cable throughout

Existing 86,600 square feet Exhibit Hall – divisible into three sections, featuring:
- Four dedicated Meeting Planner offices
- Power on 30’ grid plus air, water and drains in columns
- Six leading docks with three overhead doors in each section
- 23’ ceiling with structural truss hang points at 22’
Exhibit Hours

*Hours for the 2009 STLE trade show in Veracruz are:*
- **Monday:** Noon – 5 pm
- **Tuesday:** 9:30 am – Noon & 2 – 5:30 pm
- **Wednesday:** 9:30 am – Noon

Annual Meeting and Education Course Policies

- All attendees must register.
- A badge is required for admittance to any session or education course.
- Annual meeting registration includes admittance to the trade show.
- Education course registration includes admittance to the selected education course or courses, all technical sessions and admittance to the trade show.
- Handouts are not permitted in any technical session. Handouts will be given to education course attendees.

Recording Policy

Taping, either audio or video, IS NOT permitted in any of the annual meeting technical sessions. Audiotaping is permitted in the education courses with advance permission of the instructor. No video of any kind is permitted.

Photo Policy

STLE’s official photographer will be taking photographs of technical sessions, education courses, social events and the trade show on Tuesday. These images will be used in print materials promoting STLE’s 2010 Annual Meeting & Exhibition in Las Vegas. If you do not want your photo to appear in these materials, please step out of the picture fame or advise the photographer after your photo is taken.

No Smoking Policy

Smoking is not permitted in the technical sessions, courses, exhibits, registration area or any other areas of the facility involved with the STLE meeting.

Cellular Telephones

In order to not disturb speakers or follow attendees, please keep cellular telephones on vibrate and leave the session room to talk.

Registration Information

Attendees may register beginning on Saturday, May 16, from 3-6 p.m. at the STLE Registration Desk in Laredo 2 in Disney's Coronado Springs Resort. The STLE registration desk will be open daily thereafter through Thursday beginning at 7 a.m.

Registration for the annual meeting entitles you to attend the technical sessions, Welcoming Party on Monday evening, the trade show Monday through Wednesday, President's Luncheon on Tuesday and all other officially sanctioned events.

Registration for an educational course entitles you to attend the course, any of the technical sessions, Welcoming Party on Monday evening, the trade show Monday through Wednesday, President's Luncheon on Tuesday and all other sponsored events. It is not necessary to register for the annual meeting if you are already registered for a course.

Tickets are required for the President's Luncheon. Annual meeting and education course registrations include a ticket to the President's Luncheon. Additional tickets for the luncheon may be purchased at the registration desk for $50 each.

Attendance at business meetings of technical committees and industry councils is open to anyone who is registered for the meeting. See condensed schedule for time and location of individual technical committee and industry council meetings.
Social Events

Welcoming Party
Join your colleagues for light fare, entertainment and networking with hundreds of your industry peers. A great place to meet before embarking on your dinner plans, the Welcoming Party is a “can’t miss” annual meeting tradition. 6:30-8 p.m. in Coronado K.

Presidents Awards Luncheon and STLE 64th Annual Business Meeting
Salute 2009 STLE Award Winners, 2008-2009 President Robert W. Bruce and 2009-2010 President David K. Scheetz while you enjoy good food and participate in the business of STLE. The Presidents Luncheon is Tuesday, May 19, starting promptly at noon in Coronado H/J. Tickets to the luncheon are included with annual meeting or course registration. Additional tickets may be purchased for $50 per person at the STLE Registration Desk.

Speakers Breakfast and Briefing
7 – 7:45 am  ❆ Fiesta 6
Sunday, Monday, Tuesday, Wednesday and Thursday
Speakers and course instructors are invited to meet with the Session Chairs, Paper Solicitation Chairs and Session Monitors, Course Chairs, Course Vice Chairs and Course Monitors for a continental breakfast on the day of your presentation. This is an opportune time to review the session schedule and note any last-minute changes.

See the digital edition of TLT at the Member Services Booth
Starting with the June issue, STLE is publishing TLT digitally. For a preview of this new product stop by the Member Services Booth in the exhibit hall, Veracruz C, in Disney’s Coronado Springs Resort.

Certification Exams
Thursday, 8:30 am – 12:30 pm  ❆ Coronado A
The Certified Lubrication Specialist, Oil Monitoring Analysis Level 1, Oil Monitoring Analysis Level II and Certified Metalworking Fluids Specialist exams are given. Onsite registrations for the exams is available at the STLE Registration Desk.
The exams take approximately three hours to complete.
Fees:
  • First time taking exam: $315 Member, $420 Non-member
  • Re-take: $155 Member, $210 Member

Future STLE Meeting Dates
2009 International Joint Tribology Conference
October 19-21, 2009
Marriott Memphis Downtown
Memphis, TN

2010 STLE Annual Meeting & Exhibition
May 16-20, 2010
Bally’s Las Vegas Hotel & Casino
Las Vegas, NV

2011 STLE Annual Meeting & Exhibition
May 15-19, 2011
Atlanta Hilton
Atlanta, GA
Education Courses

Note: All courses are in the Disney Coronado Springs Resort.

Advanced Lubrication 301: Advanced Lubrication and Theory

Wednesday, May 20  8 am – 5 pm  Coronado A
This course is intended for people who have either taken the STLE's Basic Lubrication course and want to move on to a more advanced level or individuals who are knowledgeable about the lubricants business and want a more in-depth course on lubricant technology. A major emphasis is placed in this course on the concepts of oil rheology with discussions on how VI improvers function and the low and high temperature properties of lubricants. Also discussed are wear, wear mechanisms and how to diagnose wear problems from equipment failure. There is a detailed discussion on the types of additives used in lubricants, the mechanism of how they work and how they are formulated into additive packages.

Course Chairman: Scott Harold, Ciba Specialty Chemicals, Tarrytown, N.Y.

- Oil Rheology and Low Temperature Properties Of Lubricants
  Dr. Michael J. Covitch, The Lubrizol Corp., Wickliffe, Ohio
- Lubricant Additives
  Dr. Michael Hoey, Ciba Specialty Chemicals, Inc., Tarrytown, N.Y.
- Wear And Wear Mechanisms
  Dr. Vivek M. Palekar, Chevron Global Lubricants, Richmond, Calif.

Basic Lubrication 101: Fundamentals of Lubrication

Sunday, May 17  8 am – 5:45 pm  Fiesta 7/8
Basic Lubrication 101 is an introduction to lubricants, lubrication principles, base-oils, additives and compounded fluids. This course does not require the student to have a formal scientific degree or background, although many technical terms and concepts related to lubricant and their composition are covered. Basic Lubrication 101 is intended for a diverse group, including people involved in technical service, sales, marketing, manufacturing, maintenance and management who want to know more about lubricant products and how they work. The course is designed specifically for those new to the lubrication industry.

Chairman: Chair: John Sewell, ExxonMobil Lubricant & Specialties Co., Cape Elizabeth, MA
Vice Chair: Daniel G. Holdmeyer, Chevron Texaco Global Lubricants, North Royalton, OH

- Sting And Test Methods For Lubricants
  Raymond L. Thibault, LTC, Houston
- Fundamentals of Base Oils in Lubricants
  Steven A Holmes, Shell Global Solutions, Houston
- Additives For Lubricants
  Chris Schmid, Lubrizol Corp., Cleveland
- Metalworking Fluids
  Thomas F. McClure, TechSolve, Inc., Cincinnati
- Synthetic Lubricants
  Dr. Kenneth D. Hope, STLE, Chevron Chemical Company, Kingwood, Texas
- Grease: Chemistry/Formulations
  Paul Grives, ExxonMobil Lubricant & Specialties Co., Lumberton, Texas

Basic Lubrication 102: Fundamentals of Equipment Lubrication

Monday, May 18  7:30 am – 5:45 pm  Fiesta 7/8
Basic Lubrication 102 is primarily for the new person entering the lubrication field who needs a broad introduction to the fundamental concepts of lubrication, lubricated components in machinery, methods of application, and tips for maintaining those lubricants and the equipment. This course is also for persons not directly involved, but who need a broad overview of lubrication and its role in machine maintenance. This course does not require the course taker to have a formal scientific degree or background, although many technical terms and concepts are covered. Experienced people attend the course to be kept up to date on the latest developments especially in those areas not directly related to their job function or area of expertise. Thus, the Basic Lubrication 102 course is usually attended by a broad cross section of
people, such as technical, technical service, sales, marketing, manufacturing, maintenance, and management, who in some way are involved the industry. Attendees without chemistry or formulation knowledge of lubricants will want to attend Basic Lubrication 101 – Lubricants and Formulations, before attending this course.

Chairman: John Sewell, ExxonMobil Lubricant & Specialties Co., Ashburn, Va.
Vice-Chair: Daniel G. Holdmeyer, Chevron Texaco Global Lubricants, North Royalton, Ohio

- **Fundamentals Of Lubrication**
  Daniel G. Holdmeyer, Chevron Texaco Global Lubricants, North Royalton, Ohio

- **Bearings**
  Dr. Paul Shiller, The Timken Co. Canton, OH

- **Grease: Applications**
  Paul Grives, ExxonMobil Lubricant & Specialties Co., Lumberton, Texas

- **Seals**
  Steven Lemberger, American Electric Power, Bridgeman, Mich.

- **Gears And Their Lubrication**
  Tom Schiff, ExxonMobil Lubricants & Specialties Company, Fairfax, Va.

- **Synthetic Lubricants**
  Dr. Kenneth D. Hope, Chevron Chemical Company, Kingwood, Texas

- **Metalworking Fluids**
  Thomas F. McClure, TechSolve, Inc., Cincinnati

- **Hydraulics: Systems And Fluids**

### Condition Monitoring 101: Maintenance Strategies and Lubricants

**Sunday, May 17 ** 8 am – 5 pm  **Fiesta 9/10**

This new course helps prepare participants to implement, execute, evaluate and improve condition-monitoring programs for oil-wetted components. CM 101 begins with justification for condition-based monitoring, followed by an introduction to historically established maintenance strategies, providing understanding of the differences and benefits of each. We continue with an overview of the steps to implement and execute a program and conclude with information on lubricant functions and properties in the context of Condition Monitoring. Sampling procedures and testing instrumentation also are discussed.

**Chairman:** Jack Poley, Condition Monitoring International, LLC, Miami

- **Introduction to Condition Based Maintenance**
  Jack Poley, STLE, Condition Monitoring International, LLC, Miami

- **Machinery Failure Consequences and Maintenance**
  Chad Chichester, Dow Corning, Midland, Mich.

- **Overview of a Condition Based Monitoring (CBM) Program**
  Evan Zabawski, The Fluid Life Corporation, Edmonton, ALB, Canada

- **Lubricant Functions, Additives and Properties**
  Evan Zabawski, The Fluid Life Corporation, Edmonton, ALB, Canada

- **Instrumentation and Test Methods for Used Lube Analysis**
  Jack Poley, Condition Monitoring International, LLC, Miami

### Condition Monitoring 201: Failure Modes and Detection Methods

**Monday, May 18 ** 8 am – 5 pm  **Fiesta 9/10**

Condition Monitoring 201, an Intermediate course, begins with an introduction to machinery failure and causal analysis. A discussion on lubricant and machinery failure modes and condition indicators follows. Then various testing methods and techniques for identifying and quantifying such conditions, including potential or impending failures, are presented. CM 201 also provides insight into the pros and cons of on-line, on-site and laboratory analysis for different applications.

*continued >*
Education Courses

Condition Monitoring 201: Failure Modes and Detection Methods/continued from p. 19

A discussion on data interpretation, including concepts and case studies, then transitions to data management and integration to close the course.

Chairman: Jack Poley, Condition Monitoring International, LLC, Miami

- Introduction
  Jack Poley, Condition Monitoring International, LLC, Miami

- Machinery Failure and Causal Analysis
  Larry Toms, Larry A. Toms Technical Services, Pensacola, FL

- Failure Modes and Condition Indicators
  Allison M. Toms, Technical Director, GasTOPS Inc, Pensacola, FL

- Testing Strategies and Evaluation of Lube Analysis Data
  Jack Poley, Condition Monitoring International, LLC, Miami, FL

- Data Management and Integration
  Allison M. Toms, GasTOPS, Inc., Pensacola, FL

Grease: Synthetic Fluid Formulations and Applications

Wednesday, May 20 8 am – 5 pm  Fiesta 9/10

This course is a comprehensive overview of all aspects of lubricating grease. Grease formulation components are thoroughly covered, including base oils, the many different thickener types and grease performance additives. Manufacturing technologies are reviewed, as well as grease testing significance and methods. We'll discuss how to select the proper grease for an application and provide examples of both industrial and automotive applications.

Chairman: Dr. Chuck Coe, ExxonMobil, Herndon, Va.

- Course Overview and Introduction to Greases
  Dr. Chuck Coe, ExxonMobil, Herndon, Va., and Dr. Gareth Fish, The Lubrizol Corporation, Wickliffe, Ohio

- Base Oils
  Dr. Valentina Serra-Holm, Nynas AB, Canada

- Grease Manufacturing, Part I
  Dr. Chuck Coe, ExxonMobil, Herndon, Va.

- Grease Manufacturing, Part II
  David Turner, Shell Global Solutions (US), Houston

- Grease Testing
  Jaime Spagnoli, ExxonMobil Research & Engineering

- Grease Selection
  Dr. Paul Schiller, The Timken Co., Canton, Ohio

- Industrial Applications, Part I
  Chad Chichester, Dow Corning, Midland, Mich.

- Industrial Applications, Part II
  Chad Chichester, Dow Corning, Midland, Mich.

- Automotive Applications
  Dr. Gareth Fish, The Lubrizol Corp. Wickliffe, Ohio

- Application Problem Solving
  William Connor, TOTAL Lubricants USA, Linden, N.J.

Metalworking Fluids 105: Basics of Metal Forming

Sunday, May 17 8 am – 5 pm  Coronado A

This course is designed for those involved in developing, working with and using metal forming fluids in the manufacturing environment. In particular, the metal forming course is very useful for formulators, technical service representatives, shop floor people and coolant system managers who all need to know more about the fundamental concepts of metal forming fluids. This course is divided into modules covering metal forming operations metal forming fluid chemistry, metal forming fluid failure mechanisms, controlling contamination and microbial growth, waste
treatment and operator acceptance. By the end of the course, participants will have gained a good understanding of metal forming operations, formulation of metal forming fluids, tools for identifying and correcting metal forming fluid failures and waste treatment of metal forming fluids. This course will also help students understand key building blocks that can be used in preparation for the STLE Certified Metalworking Fluids Specialist certification. This certification meets a growing need for a professional credential that demonstrates knowledge and competency in this fast-changing segment of the lubricants industry.

**Chair:** Dr. Neil Canter, Chemical Solutions, Willow Grove, Pa.

- **Introduction to Processes, Applications and Fluid/Lubricant Requirements**
  Katherine Helmetag, Henkel Technologies, Madison Heights, Mich.

- **Metal Forming Lubricant Chemistry Basics: Stamping and Blanking**
  Dr. Neil Canter, Chemical Solutions, Willow Grove, Pa.

- **Metal Forming Lubricant Chemistry Basics: Rolling, Forging, Heading and Wire Drawing**
  Katherine Helmetag, Henkel Technologies, Madison Heights, Mich.

- **Metal Forming Failure Mechanisms: Lubrication, Concentration Control, Compatibility and Filtration**
  Dr. Neil Canter, Chemical Solutions, Willow Grove, Pa.

- **Metal Forming Failure Mechanisms: Water Quality, Corrosion, Foam, Emulsion Size, Residue and Cleanability**
  Richard Butler, Chemtool Inc., Crystal Lake, Ill.

- **Controlling Contamination and Microbial Growth in Metal Forming Fluids**
  Dr. Alan C. Eachus, Villa Park, Ill.

- **Waste Treatment of Metalworking Fluids**

- **Operator Acceptance and Final Q&A**
  Dr. Neil Canter, Chemical Solutions, Willow Grove, Pa.

### Metalworking Fluids 125: Basic MWF Health & Safety

**Monday, May 18 8 am – 4:30 pm Coronado A**

MWF 125 is a one day introductory course that discusses health & safety issues involved in the use of metalworking fluids. This course is designed for those new to the metalworking fluid industry from a chemical supplier, formulator, fluid maintenance and end user perspectives. Students will be informed about the reasons metalworking fluids can cause health & safety problems and ways to minimize them. Topics covering microbial contamination issues, metalworking fluid and additive toxicology, industrial hygiene and mist effects will give the student a good feel for the challenges facing metalworking fluid suppliers and end users. The course will be capped by student participation in a metalworking fluid mist case study. Students will be given an opportunity to solve an actual real world problem.

**Chairman:** Dr. Fred Passman, BCA, Inc., Princeton, N.J.

- **Course Introduction**
  Dr. Frederick J. Passman, BCA, Inc., Fellow, STLE, Princeton, NJ

- **Microbes In Metalworking Fluids**
  Dr. Terry Williams, Rohm and Haas Company, Inc., Spring House, PA.

- **Controlling Microbial Contamination**
  Dr. Alan C. Eachus, Villa Park, IL

- **Toxicology Of Metalworking Fluids**
  Dr. Richard Kraska, Kraska Consultants Inc., Bonita Springs, FL

- **Industrial Hygiene**
  Dr. Eugene White, Milacron, Inc., Cincinnati, OH

- **Metalworking Fluid Mist**
  Dr. John Howell, John Howell & Associates, Edinboro, PA

- **Health Effects Of Mwf Microbes**
  Dr. Frederick J. Passman, BCA, Inc., Princeton, NJ

- **Misting Case Study**
  MWF 125 Course Staff
Education Courses

**Synthetics Fluids 203: Non-petroleum Fluids and their Uses**

**Sunday, May 17 ★ 8 am – 5:45 pm ★ Coronado B**

The Synthetic Fluids courses are designed primarily for formulators and users of lubricating materials. The 203 course provides an overview of non-petroleum based lubricants, their comparison to each other and to petroleum oil. Each section covers the chemistry, and most importantly the strength and weaknesses of each material.

**Co-chairs:** Sandra Walker, Dow Corning, Plymouth, Mich., and Stephen C. Lakes, Cognis Corp., Cincinnati

**Vice Chair:** David Como, Dow Corning, Midland, Mich.

- **Polyalkylene Glycols**
  - Martin Greaves, Dow Chemical Corporation, Freeport, TX

- **Silicones**
  - David J. Como, STLE, Dow Corning Corporation, Midland, MI

- **Polyalphaolefins**
  - Jim Herman, Chevron Phillips Chemical Company, The Woodlands, TX

- **Esters**
  - Gene R. Zehler, STLE, Cognis Corporation, Cincinnati, OH

- **Fluorocarbons**
  - Greg Bell, STLE, Dupont Chemicals, Deepwater, NJ

- **Alkylated Aromatics**
  - Beth Winsett, ExxonMobil Chemical Co., Houston, TX.

- **Phosphates**
  - W. David Phillips, Great Lakes Chemical Corp., Trafford Park, Manchester, UK

**Synthetics Fluids 204: Synthetic Fluid Formulations and Applications**

**Monday, May 18 ★ 8:45 am – 4:45 pm ★ Coronado B**

The Synthetic Fluids courses are designed primarily for formulators and users of lubricating materials. The 204 course provides an overview of formulations and applications using API group IV and V, non-petroleum based base-stocks. The objective of this course is to give the participants a working knowledge of working with the various types of synthetic lubricants and their uses in a wide variety of applications.


**Vice-Chair:** David Como, Dow Corning, Midland, Mich.

- **Military Applications**
  - Carl E. Snyder, Jr., United States Air Force, Wright Patterson Air Force Base, Dayton, Ohio

- **Automotive Applications**
  - Stephen C. Lakes, Cognis Corp., Cincinnati

- **Industrial Applications-Compressors**
  - James N. Vinci, Lubrizol Corp., Wickliffe, Ohio

- **Metalworking Lubricants and Hydraulic Fluids**
  - Martin Greaves, Dow Chemical Corp., Freeport, Texas
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Keynote Session

‘Inspiration to Innovation’

Presented by the World-renown Disney Institute

Monday, May 18
10:30 am – Noon
Coronado H

Creativity and innovation are the keys to successful organizations in the 21st Century, and no group has been more successful at utilizing both qualities profitably than the Walt Disney Co.

In this fast-paced and thought-provoking 90-minute presentation, which has been tailored to the lubricants industry, a Disney Institute speaker shares the processes used by WDC’s acclaimed “imagineers” to breathe life into creative ideas.

This is your chance to hear state-of-the-art strategy advice from one of the world’s foremost consulting groups. STLE members will leave this unique workshop with ideas on how to boost the creativity and innovativeness in their organizations.

Program Objectives

1. Increase awareness of the process Disney uses to generate its innovations.
2. Achieve greater understanding of how Disney unleashes people’s imaginations.
3. Be able to describe Disney’s Eight-Step Inspiration-to-Innovation process.
4. Obtain a deeper knowledge of the efforts Disney uses to generate its unique guest experiences.
5. Improve awareness of how Disney designers and operators work.
6. Develop confidence to share and explore adaptations of Disney’s innovation strategies.

Program Agenda

• Welcome and facilitator introduction.
• Discussion of “the Disney difference.”
• Similarities between Disney and other organizations.
• Description of the Disney Chain of Excellence to position the session within a larger business foundation.
• Activity to provide a framework definition of “inspiration to innovation.”
• Video presentation on Disney’s history of innovation—the imperative and recognizable results.
• Program module overview: people as well as process plus details of the process, all intended to protect the integrity of innovations.
• “Blue Sky Brainstorming” with discussion of different types of brainstorming sessions.
• Concept development with explanation of how Disney balances business needs and creative goals.
• Feasibility with connections to market research and guest expectations.
• Detailed design with conceptual rather than engineering-based discussion.
• Production video and discussion of Disney’s project organization chart.
• Discussion of element installation plus test, adjust and “play testing.” Video presentation describing a Disney case study.
• Grand opening. How and why Disney plans this step from the first moment of a project.
• Show quality standards as the key to sustaining the initial vision and learning from and benefiting from in-use insights.
• Visual case studies of Disney examples.
• Video presentation and discussion about cutting-edge examples.
• Closing video and comments.
LOCAL SECTION LEADERSHIP WORKSHOP

Business Meetings that Work!

Presented by Dr. Jean K. Becker

Sunday, May 17
5 – 6:30 pm  Yucatan 2 & 3

The ability to plan and run an effective, productive business meeting is a cornerstone of success for STLE sections and in wider professional life. While every meeting chair has his or her own style, there are a lot of tips and tricks that can help you polish your skills when you are in charge.

If people arrive at the meeting prepared to contribute, the length of the meeting can be trimmed, but participants will feel more satisfaction in what was accomplished. One of the secrets of the best meetings is the work the chair does before the meeting even starts. We will share a list of things the best chairs think about and do while creating the agenda and in contacts with other members of the board or workgroup.

The agenda is your roadmap for a successful meeting. We will expand on different types of agendas and the plusses and minuses of several ways of covering the necessary items. There is not any sacred way of ordering things on an agenda. By choosing what to include and where to put things on the agenda, a meeting leader can drastically alter the pace, climate and energy level of the meeting.

During the meeting itself, outstanding meeting chairs also have a set of behaviors that help everyone in attendance feel they have been heard and made a contribution. Advice and ideas from experienced leaders on how to keep things moving and how to reach satisfying decisions will be shared.

The secret to finding organized, enthusiastic volunteers for next year's board is to hold meetings that people who want to accomplish things look forward to rather than dread. This workshop will offer a potpourri of ideas how to make that happen in your section, with handouts to take back and share.

Time for questions and sharing of ideas from the audience will follow the presentation. At the end of the session, you will understand:

- Why and how to eliminate unnecessary meetings
- How to eliminate meetings with insufficient attendance to accomplish the goal
- How to prepare meeting participants so they arrive ready to do business
- The value of written records, and the pros and cons of different ways of recording
- How to decide what to put on an agenda, and what to leave off
- How to structure an agenda for optimal work flow
- How to run meetings that attract those who expect to accomplish things
- How to evaluate your current meetings, with ideas for change if you identify problem areas

Presenter is Dr. Jean K. Becker, owner and operator of The Emerald Frog, a management consulting firm providing training to for-profit and not-for-profit businesses. She is a former chair of American Mensa Ltd.
### Advisory Committee

#### Exhibit Hours

Hours for the 2009 STLE trade show in Veracruz, Mexico:
- **Monday:** Noon – 5 pm
- **Tuesday:** 9:30 am – Noon & 2 – 5:30 pm
- **Wednesday:** 9:30 am – Noon

STLE would like to thank the following individuals and their companies for being a part of the Exhibitor Advisory Committee, which establishes policies for the trade show. If you have comments or suggestions on how to improve the exhibit portion of the STLE Annual Meeting, please contact one of these individuals.

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<td>Marty Meyers</td>
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<td>Lauren Ereio</td>
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<td>Raj Shah</td>
<td>Koehler Instrument Co.</td>
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#### Exhibitors

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**Poster 1**  
**Tribological Characteristics of DLC Film-Coated Aluminum Alloy in CNT Ink Lubricant**  
K. Jang, H. Kim, S. Kim, Nanosystem and Nanoprocess Engineering, Pusan National University, Miryang-si, Gyeongnam, South Korea, H. Kim, Samho Precision Co., Busan, South Korea  
Tribological characteristics of diamond-like carbon (DLC) films were systematically investigated in the carbon nanotube (CNT) ink environment at the elevated temperatures. CNT ink was prepared with the total concentration of 1 wt% in aqueous solution. DLC films were deposited by radio frequency plasma enhanced chemical vapor deposition (RF-PECVD) method on Al6061 aluminum alloy. DLC film prepared in this study was verified to have very desirable surface characteristics, including high hardness, low friction coefficient, and good wear-resistance properties. The ball-on-disk tribotester for testing DLC film-coated Al6061 specimens was employed with the various operating conditions of a sliding speed of ~30 rpm, a load of ~2N, and surrounding various temperatures between 50C and 100C. After the series of tribological tests, the wear tracks and surface roughness of DLC film were analyzed by various techniques such as optical microscope, scanning electron microscopy (SEM), Raman spectroscopy, and atomic force microscopy (AFM).

**Poster 2**  
**Parameter Study of Offset Press Cylinders Based on Sliding Friction**  
H. Zhang, X. Chen, Institute of Printing and Packaging Engineering, Xi’an University of Technology, Xi’an, CHINA  
In the contact area of offset, a relative slide occurs between the surface of plate cylinder and blanket cylinder, which changes the size of print image and influences the printing quality. On the basis of research for the situation of relative slide in the cylinders rolling process, the principle on which cylinders' geometric parameters of offset press are defined is proposed. The results show that the relative slide reaches minimization on the condition that elastic cylinder radius is 0.2 times compression amount bigger than rigid cylinder radius. The deformation of print image and dot gain also reach minimization in the same condition. These results provide theoretical basis for accurate determination of offset press' cylinder radius.

**Poster 3**  
**Wear Properties of Oxide-Coated Metallic Matrix Composites Made of Silica Particles and Aluminum Alloy**  
Z. Peng, L. Han, X. Nie, Mechanical, Automotive & Materials Engineering, University of Windsor, Windsor, Ontario, Canada  
Plasma electrolytic oxidation (PEO) coatings have a high adhesion, hardness and wear resistance and in consequence were widely investigated and applied in industrial components as the wear and corrosion protective coating. There have been many investigations on the treatment of aluminum, magnesium and titanium alloy by PEO method. However, few investigations have been done on metal matrix composites (MMCs) using this method. In this work, by using a plasma electrolytic oxidation (PEO) technique, oxide coatings were fabricated on a set of MMCs that were prepared by mechanically adding silica sands (particles size 30-40 µm) of 5 wt%, 10 wt% and 20 wt% respectively into an Al-Si alloy (Al 383) melt before high pressure die casting. The coating microstructures were characterized by XRD analysis and SEM cross-sectional observations. Vickers hardness tests were conducted on the coating cross-sections. Tribological properties were examined using a pin-on-disc (POD) tribometer under boundary-lubricated conditions against steel counterface pins. Sliding distances were 500m, 750m and 1000m under a 5N and 10N normal load, respectively. Wear tracks profiles were determined by using a stylus surface profilometer. Scanning Electron Microscopy (SEM) and optical microscopy observations were also performed to investigate the morphologies of wear tracks on the coated samples. The effects of SiO2 particles on the coating microstructure and wear properties were analyzed and discussed.

**Poster 4**  
**A New Sensor for Integrated Friction Measurements In BRM Hip Wear Simulator**  
M. Spinelli, L. Tiberi, S. Affatato, Medical Technology Lab, Istituto Ortopedico Rizzoli, Bologna, Italy, S. Carmignato, Geometric and Industrial Metrology Lab, Padova University, Padova, Italy  
Conventional hip wear simulators give concrete results about wear performance of hip implants. A few simulators had been designed for friction studies but apart from wear tests, thus separating the study of these variables. A new friction
sensor was built and integrated in a biaxial rocking motion hip joint simulator. The study aimed at verifying the feasibility of an experimental set-up in which wear and friction factor measurements could be combined, without compromising the accuracy of a standard wear test. The integrated wear test ran for 1x10^6 cycles with three 28mm metal-on-polyethylene hip implants; during the test axial load and friction torque were synchronously recorded. The average friction factor varied in the range 0.08-0.15. Accuracy and repeatability among the sensors was assessed. The system was stable and reliable. Further investigations should prove the robustness of this new tool both on a longer cycling time and with different bearing materials.

**Poster 5**
**Systematic Molecular Dynamics Study of Load, Speed, and Temperature Effects on Atomic Stick-Slip Friction**

Z. Gao, A. Martini, Mechanical Engineering, Purdue University, West Lafayette, IN, R.W. Carpick, Mechanical Engineering and Applied Mechanics, University of Pennsylvania, Philadelphia, PA, V. Ivanov, Y. Mishin, Physics and Astronomy, George Mason University, Fairfax, VA

One of the primary challenges for the mechanical components design is that the moving interfaces often exhibit atomic stick-slip friction. In this work, we have performed a systematic study on the effects of load, speed, and temperature. We performed molecular dynamics simulation of an Ag tip sliding on a Cu substrate. The interactions between all atoms in the simulation were modeled using EAM potentials which were recently developed based on first-principles data and fitting to experiment. All simulations were performed using the IMD molecular dynamics simulation package. We performed simulations at sliding velocities of 1, 5, and 10 m/s, average normal stresses of 0, 100, 200, 300, 400, and 500 MPa, and temperatures of 10, 100, 200, 300 and 400 K. Then the average and maximum values of both the shear stress and the friction coefficient (shear stress / normal stress) as functions of velocity, load, and temperature were determined. At last, the common neighbor method (CNA) was used to show the crystal structure alternating between face center cubic (fcc) hexagonal close packed (hcp). From the above systematic study, we predict effects of the operating conditions, such as temperature, load and tip velocity, both individually and in combination to clearly explain the roles of these factors play in atomic stick-slip and provide a fundamental understanding of why these dependencies exist.

**Poster 6**
**Atomistic Simulation of Stick-Slip Using Parallel Replica Dynamics**

Y. Dong, A. Martini, School of Mechanical Engineering, Purdue University, West Lafayette, IN, D. Perez, A.F. Voter, Theoretical Division T-1, Los Alamos National Laboratory, Los Alamos, NM

Atomic Stick-slip friction of Cu AFM tips on Cu surfaces is studied at low scanning velocities using Molecular Dynamic simulation with the Parallel Replica Dynamic Method (ParRep). The time scale difference between experiment and simulation is around five orders of magnitude which hinders the possibility of quantitative comparison between them. ParRep allows the simulation to run on processors parallelized in the temporal domain so the scan velocity can be decreased. The preliminary results show that the ParRep method is accurate and efficient especially at low speeds such that we can further apply it to lower scanning velocities which can ultimately be accessed by AFM experiments. A logarithm dependence of the mean friction on velocity is observed at velocities from 0.001m/s to 0.1m/s. A physical interpretation in terms of the theory of Parallel Replica Dynamics and the modified Tomlinson model with thermal activation is presented.

**Poster 7**
**The Effect of Triglyceride Molecular Structure on Frictional Properties of Fats**

H. Gylfadottir, A. Martini, School of Mechanical Engineering, Purdue University, West Lafayette, IN

Fats and oils, consisting of triglyceride molecules, influence texture, mouth feel and flavor of food products. Molecular dynamic simulation is applied in order to better understand how fats enhance food texture. Four types of triglyceride molecules that commonly occur in fats and oils (monosaturated, disaturated, trisaturated and triunsaturated) have been modeled to investigate their properties. By grouping the triglycerides into nanoscale clusters the dynamic properties such as the diffusion constant and viscosity can be evaluated. The clusters are also sheared in order to determine their frictional behavior. The simulation results show how molecular structure affects friction in triglycerides.
**Poster 8**  
**Molecular-Scale Characterization of Thin Film Lubrication**

A. Vadakkepatt, Mechanical Engineering, Purdue University, West Lafayette, IN

In this work, molecular dynamics (MD) simulations are employed to characterize fluid flow in nanoscale lubricated interfaces which typically operate in the thin film lubrication (TFL) regime. The model configuration consists of n-hexadecane (fluid) molecules confined between two structured Alumina walls. Two broad cases of Couette flow are generated: 1) by moving one of the walls and keeping the other stationary; 2) by moving both walls in opposite directions. The COMPASS force fields govern both the non-bond intermolecular and intramolecular interactions including bond, angular, torsional and out of plane potentials. Various flow parameters such as slip, shear strain rate, shear stress, friction coefficient and volumetric flow rate in flow and transverse directions are calculated for various shear rates. These parameters are used to characterize the system for various wall velocities. Next the simulations are performed to explore the hydrodynamics of nanoscale fluid film on the application of load. This is done by moving one of the walls laterally and applying normal load to the other. On the application of load, the film achieves an equilibrium thickness proportional to load after the steady state is reached. During the transience, we observe that the loaded wall oscillates about the equilibrium film thickness with a frequency and a decay rate proportional to the applied load. This transient and steady state analysis of nanoscale films on the application of load would give some key insights about the TFL system which could be exploited for various nanoscale applications.

**Poster 9**  
**Confidence Ranking of Monte Carlo Simulated Fatigue Data based on a Weibull-Johnson Methodology**

N.S. Murray, Mechanical Engineering Technology, Georgia Southern University, Statesboro, GA

Statistical and probabilistic models of fatigue lives were used to determine whether data sets were significantly different. Monte Carlo simulations based on Weibull-Johnson parameters were used to simulate fatigue lives. These lives can be for bearings, shafts, gears, or any component that fails as a result of fatigue. The Monte Carlo simulation is repeated one hundred times to determine a confidence number. Linear approximations of Leonard Johnson's Confidence Number curves were used to calculate separate confidence numbers, and were compared to those generated by the Monte Carlo simulations. This work contributes to the validation of the linear approximations used, which expand greatly on the limited cases published by Johnson. A known experimental data set was also used to validate the Monte Carlo simulations, validating the relative ranking of fatigue data sets with variations due to test conditions, material variations, differences between batches and heat treatments, and vendors.

**Poster 10**  
**Anisotropic Frictional Behaviors of Micro Scale Laser-Textured Surfaces**

C. Yu, Q.J. Wang, J. Cao, Mechanical Engineering, Northwestern University, Evanston, IL, G. Liu, Mechanical Engineering, Northwestern Polytechnical University, Xian, Shaanxi, China

Anisotropic frictional behaviors can arise from strongly oriented surfaces topography like grooves. Examples of orientation dependent frictional responses are found in anti-adhesive cutting tool, magnetic recording disk, fiber-reinforced materials and even snake skin, etc. Micro scale grooves with different geometry characteristics were fabricated on copper, stainless-steel and tungsten carbide surfaces by a pico-second laser ablation system. Frictional properties were investigated by means of a stainless-steel ball with a radius of 800 µm sliding on textured surfaces under normal loads of 10, 30 and 100 mN with a sliding speed of 1 m/s. Friction coefficients in two orthogonal sliding directions were compared in order to investigate the anisotropic frictional behaviors. Orientation dependent friction coefficients were observed in all three sets of measurements respectively under the same condition. The trends for those anisotropic behaviors, however, were found to be dependent on material, which needs to be further studied.
**Poster 11**
Effect of Particulate Additives on the Properties of a Diesel Engine Oil


A fully formulated 15W40 diesel engine oil, and base stock, were tested with and without additives (tricresyl phosphate, hexagonal boron nitride (h-BN), graphite, MoS2, and a commercial boric acid-containing additive at weight percentages of 3.8%, 9.1%, and 16.7%) to determine their effectiveness at preventing scuffing damage. To do this, oil mixtures were evaluated using an increasing step load machine; a Society of Automotive Engineers (SAE) 01 tool steel block was pressed with increasing force against an SAE 4620 hardened steel ring rotating at selected speeds (750rpm, 1000rpm, 1500rpm) until scuffing (a sudden catastrophic failure of a sliding lubricated contact characterized by a sudden rapid rise in friction, temperature, and noise/vibration) occurred. All additives were found to increase the oil’s load capacity. The presence of additives typically increased scuffing loads from 400-650N to 800-1200N with h-BN being most effective.

**Poster 12**
A Voronoi Finite Element / Damage Model for Life Scatter in Rolling Contact Fatigue

B. Jalalahmadi, F. Sadeghi, School of Mechanical Engineering, Purdue University, West Lafayette, IN

It has been recognized that the microstructure of bearing materials can significantly affect their rolling contact fatigue (RCF) lives. Therefore, micro-level topological features of materials will be of significant importance to RCF investigation. In this work, damage mechanics modeling approach is incorporated into the Voronoi finite element method (VFEM) developed by Jalalahmadi and Sadeghi[1] to determine fatigue lives of bearing elements and account for the effects of topological randomness of bearing materials. Contrary to most of the life models existing in the literature for estimating the RCF lives, the current model considers micro-crack initiation, coalescence and propagation stages. The proposed model relates the fatigue life to a damage parameter ‘D’ which is a measure of the gradual material degradation under cyclic loading. It is observed that fatigue lives calculated and their Weibull slopes are in good agreement with previous experimental studies and analytical results. Also, introducing inhomogeneous material properties and initial flaws within the material domains decrease the fatigue lives and increase their scatter.[1] Jalalahmadi, B., and Sadeghi, F., 2009, “A Voronoi Finite Element Study of Fatigue Life Scatter in Rolling Contacts”, ASME Journal of Tribology, Vol. 131(2), pp 022203-1 – 022203-15.

**Poster 13**
Tribological Behavior and Surface electrochemistry in Tantalum Electrochemical Mechanical Planarization (ECMP)

F. Gao, H. Liang, Mechanical Engineering, Texas A&M University, College Station, TX

The tribo-electrochemical performance of tantalum was studied using a specially assembled test system combining tribotesting and electrochemical analysis. This system is able to carry out studies in electrochemical-mechanical polishing (ECMP). Results showed that the friction coefficient was a function of five major factors, such as anodic reactions, cathodic reaction, oxidation by H2O2, mechanical abrasion, and local concentration of abrasive particles. The potentiodynamic and electrochemical impedance spectroscopy (EIS) indicated that the electrochemical reactions were influenced by mechanical parameters such as the down force and the rotating speed. Further analysis of the polished surface found that the tantalum surface was passivated during ECMP. There was an evidence of friction induced electrochemical reactions. The present research demonstrated an effective methodology to observe friction and electrochemical properties of the tantalum surface simultaneously. Being able to pinpoint the reactions of mechanical versus electrochemical is beneficial to understand ECMP and will lead to its process optimization.
Poster 14
Role of Diesel Soot and Carbon Black on Wear of Ferrous Surfaces

M. Patel, P.B. Aswath, Material Science and Engineering, University of Texas at Arlington, Arlington, TX

EPA has adopted stringent emission standards with the aim to of reducing emission to 0.2 g/bhp-hr for NOx and 0.01 g/bhp-hr for particulate emission by 2010 for on road diesel engines resulting in a need to develop cleaner technologies. To achieve these emissions limits, OEMs are using various techniques like Exhaust Gas Recirculation (EGR), exhaust after treatment devices such as catalytic converters etc. Using techniques like EGR brings the exhaust gases back to combustion chamber resulting in soot accumulation in the oil. In this study we have mixed 1 and 3% by weight of carbon back to simulate the presence of soot in oil. The anti-wear additives ZDDP were used and the resulting oil has been evaluated using both a Ball on Cylinder wear tester as well as 4-Ball wear tester. Diesel Engine Soot extracted from used diesel engine oil has also been used to compare the experimental results obtained from carbon black. In addition, particle size of the carbon black and its surface area also have influence on wear, hence, various carbon black with different particle size and surface area have been studied. The wear surfaces are examined by Scanning Electron Microscope (SEM) and Electron Dispersive X-Ray Spectroscopy (EDS). The wear debris generated from the wear test was examined in Transmission Electron Microscope (TEM) and Nano mechanical properties of the tribofilms were examined using a Hysitron Triboindentor.

Poster 15
Development of a High Performance Grease using Design of Experiments

A. Suresh, P. Aswath, R. Mourhatch, Materials Science and Engineering, University of Texas at Arlington, Arlington, TX

With the aim of devising advanced and better performance greases while suppressing undesirable properties, additives that can improve the different parameters of the grease must be considered since these additives can mutually interact synergistically by assisting each other or antagonistically. To construct a useful predictive model of all the critical response measures of process efficiency and product efficacy, a statistical model, Design of Experiments (DoE) is recommended. DoE helps identifying critical factors, revealing interactions (whether antagonistic or synergistic) and finding ideal process conditions that accomplish the targeted responses with little or no additional experimentation. In the present study, the interactions between the following factors, Zinc dialkyldithiophosphate (ZDDP), molybdenum disulfide, graphite, polytetra fluoro ethylene and carbon black, were observed. The wear behavior was evaluated using the four-ball wear tests by modifying the ASTM Standard D 2266 to study the behavior of the grease chemistries under various conditions of temperature, load and duration. ASTM D2596 was the standard used to evaluate the extreme pressure properties of the grease using the Four-ball wear tester.

Poster 16
Shear Driven Pocket Flow Investigation Using Micro Particle Image Velocimetry

C. Wang, Mechanical Engineering, Purdue University, West Lafayette, IN

This investigation demonstrates the hydrodynamic mechanism responsible for enhancing the lubrication. The lubricant flow due to the ring passing over the pocket was treated as a typical phenomenon, shear driven pocket flow. A test rig was designed, developed to experimentally investigate shear driven pocket flow. In this test rig, a steel belt was driven by a variable-speed motor. The belt contacted with a specimen that contained a 1.0 mm wide pocket. Micro particle image velocimetry was applied to visualize the shear driven pocket flow and generate the streamline contour of the flow field. Two different sets of experiments were conducted to test the important factors which affect the flow field, including the aspect ratio of pocket and the shear driven speed. The second set of experiments was designed to observe the important fluid flow phenomena including the extraction and stagnation of the fluid above and below a critical pocket depth.
**Poster 17**  
**Development and Characterization of Thermal Films on Ferrous Substrates from Antiwear Additives**  
B. Kim, P. Aswath, Materials Science and Engineering, University of Texas at Arlington, Arlington, TX  
Tribofilms formed at contacting surfaces protect the surfaces by creating a layer whose chemistry and properties are dependent on the chemistry of the additives used in the lubricant as well as the tribological conditions responsible for the formation of the tribofilms that include temperature and shear stress. Many studies have shown that a thermal route to form films provide a valuable insight into the mechanism of formation of tribofilms. In this study a thermal approach was used to study the kinetics of thermal films formed on ferrous substrates for a variety of antiwear chemistries that include Zinc Dialkyl Dithiophosphate (ZDDP), short and long chain ashless dialkyldithiophosphates, amine phosphate, and ashless thio-esters. The thermal films were deposited on ferrous substrates by immersion in oil containing these additives at a nominal concentration of 0.1 wt.% phosphorous for durations ranging from 1 to 60 minutes. The chemistries of the films were analyzed using X-ray absorption near edge structure spectroscopy (XANES). The nano-mechanical properties for the thermal films were characterized using nano indentation, nano scratch, and nano wear tests.

**Poster 18**  
**Energy Efficient Hydraulic Fluids**  
A.D. Kimball, K. Burgess, Fluid Power Institute, Milwaukee School of Engineering, Milwaukee, WI  
Friction and internal leakage reduce the starting and low-speed torque output of hydraulic motors to a fraction of their theoretical capacity. By applying high pressure rheology and boundary lubrication science within the disciplinary area of tribology, the low-speed and starting performance of three common hydraulic motors are studied. The effects of viscosity index (VI), piezoviscosity, and boundary lubrication are investigated with a conventional hydraulic fluid, a high VI mineral oil, and a high VI synthetic ester. The HVI mineral oil is shown to increase torque efficiency, thus increasing the minimum torque output of hydraulic motors.

**Poster 19**  
**Friction-Induced Formation of Silver Nanochains**  
K. Wang, S. Kundu, H. Lee, H. Liang, Materials Science and Mechanical Engineering, Texas A&M University, College Station, TX  
We demonstrate a new approach fabricating nanochains made of Ag and a polymer under friction. The Ag acted as nodules linked by polymeric chains. The silver nanochains (Ag-NCs) was generated through a simple sliding using crown ether as a template. The average size of the Ag nodules was 50 nm and the separation distance between each nodule was around 10 nm. The conductivity of the Ag-NCs behaved like a semiconductor with a threshold of 9 volts at the room temperature. Molecular dynamics simulation and experimental results revealed that the formation of Ag-NCs involves three competing paths: formation of Ag nanoparticles through wear; breaking of crown ether ring; and chain formation (oxidation). In the poster, we discuss details of this tribo-fabrication process.

**Poster 20**  
**Fretting of WC/a-C:H and Cr2N Coatings Under Grease Lubricated and Unlubricated Conditions**  
B. D. Leonard, F. Sadeghi, School of Mechanical Engineering, Purdue University, West Lafayette, IN, R.D. Evans, G. L. Doll, P. J. Shiller, The Timken Company, Canton, IN  
The fretting phenomenon was investigated experimentally in contacts between coated and uncoated steel rod and ball specimens generating a circular Hertzian contact. A fretting wear test rig equipped with a video camera was used to observe the effects of fretting on coated steel surfaces in both grease lubricated and unlubricated environments. Tungsten carbide reinforced amorphous hydrocarbon (WC/a-C:H) and chromium nitride (Cr2N) coatings were tested and compared. Fretting wear volumes and surface profiles are presented for both grease lubricated and unlubricated conditions. Videos of a coated ball fretting against a transparent sapphire flat were recorded and screen captures are presented. The role of normal load, lubrication, frequency, and amplitude of motion on the fretting wear of coatings is discussed. Lubricant released from the grease was observed to flow through channels in the stick zone of the fretting contacts. Both coatings were found to reduce fretting wear. WC/a-C:H was more effective at reducing wear under unlubricated conditions. WC/a-C:H decreased fretting wear more than Cr2N when delamination was avoided in grease lubricated contacts.
Poster 21
Temperature and Friction Measurement at the Polymer-Metal Interface: A Tribometer Design

N.T. Daniels, Division of Engineering and Physics, Wilkes University, Wilkes-Barre, PA

Dry ( unlubricated) sliding of two solid bodies in contact generates heat. The friction-generated heat dissipates though solid bodies, while in polymer-metal contact the friction generated heat is confined to a thin layer at contact surface due to the low thermal diffusivity of the polymers, which results in temperature rise. The temperature increase greatly affects the tribological properties of the polymer such as friction and wear. Hence there is a need to identify pressure and sliding speed conditions under which a given polymer will operate satisfactorily for a designed lifetime in tribological applications. This design and development of a tribometer and accompanied data acquisition system is presented in this poster. The design is based on a thrust washer configuration in which the polymer/composite specimen is rotated against a stationary metal anvil. The software is being developed to read, analyze, and plot the friction coefficient and temperature change as functions of time.

Poster 22
Effects of Surface Defects on Rotor System Dynamics

A. Ashtekar, F. Sadeghi, Mechanical Engineering, Purdue University, West Lafayette, IN, L. Stacke, SKF Engineering & Research Centre, SKF, Göteborg, Sweden

The scope of the present study is to develop a rotor system model to study dynamic instabilities due to bearing defect. An elasticity model was developed and used to investigate the force deflection relationship for a spheroid, with a defect, in contact with a semi-infinite domain. An examination of the resulting pressure distribution for a surface containing a bump revealed that the pressure distribution is nearly the superposition of a smooth Hertzian contact pressure plus the pressure distribution for a bump contact. Comparison of the pressure distributions of a dented contact with that of a surface containing a bump further revealed that the effect of a dent and bump on pressure distribution is inverse of each other, i.e. a dent can be modeled as a bump with negative pressure distribution). The principle of superposition was also found to be valid for the case of a surface containing multiple defects within the contact area, e.g. spalls. The effects of race defects were then incorporated in the rotor dynamic model by replacing the Hertzian relationship by the new approach to calculate contact forces. Large race defects (i.e. spalls) were modeled by modifying the race shape in the defect zone. The results indicate that surface defects significantly affect the bearing motion and force, which were further transmitted to the rotor. Small defects, such as dents, result in impulses which excite a broad range of frequencies as compared to frequencies excited by large defects (spalls). These effects are appreciably more severe for high-speed applications.

Poster 23
Effects of Fretting Wear on Rolling Contact Fatigue Life of M50 Bearing Steel

A. Warhadpande, B. Leonard, F. Sadeghi, Mechanical Engineering, Purdue University, West Lafayette, IN

The study presents the results and effects of fretting wear on rolling contact fatigue (RCF) life of M50 bearing steel. A fretting wear test rig was designed and developed to induce fretting scars on the surface of standard M50 rods commonly used in a three ball and rod rolling contact fatigue testing machine. The fretting scars were developed at a Hertzian contact pressure of 1.1 GPa, in the presence of MIL-L-23699 lubricant at a frequency of 10 Hz, slip amplitude of 21 µm for different number of fretting cycles (500, 1000 and 5000 cycles). The fretted rods were then evaluated at a contact pressure of 1.7 GPa and 3.4 GPa in the three ball and rod rolling contact fatigue tester to determine the effect of fretted scar on rolling contact fatigue life. The results indicate that fretting scar can reduce the rolling contact fatigue life at 3.4 GPa by an average of 30%. Fretted rods operating at 1.7 GPa behave similar to an unfretted rods operating at 3.4 GPa signifying that fretting scar acts as stress riser and leads to premature spalling.
Poster 24
Tribological Mechanisms of Cockroach Wax coated on a Glass Surface

A. Rocha, R.A. Cooper, H. Liang, Mechanical Engineering, Texas A&M University, College Station, TX

We have recently reported that the cockroach wax was effective in reducing friction and it has similar frictional behavior compared to motor oil. In the present study, we explore the mechanisms of this wax in tribological properties as well as an anti-corrosion coating. In this work, we investigated the effectiveness of the coating onto a glass (for control) and various metallic surfaces in terms of adhesion, surface wetting angle, and resistance to a fluid shear. The chemical components and their interactions with the surfaces are discussed here.

Poster 25
The Effect of Mesh Density on the Modeling of Real Surfaces

O. Kwon, M. Thompson, Civil and Environmental Engineering, KAIST, Daejeon, South Korea

Traditionally, surfaces were modeled analytically by simplifying the surface geometry or by ignoring the surface details. Numerical contact simulations began to enter tribology as contact technology evolved. However, the geometric assumptions used in the analytical models have followed into the numerical models primarily because the computational costs associated with solving increasingly complex geometries were considered to be prohibitive. This work examines the effect of the finite element mesh density on real measured surfaces in ideal contact. The mesh convergence of a variety of results parameters is used to determine the minimum number of elements per surface asperity required to obtain representative results. It is shown that only one finite element per asperity is needed to obtain accurate results which are dependent on real area of contact, average/maximum contact gap, or average contact pressure. Additional refinements to the finite element mesh result in only small (4 ~ 10%) changes in results despite many orders of magnitude difference in solution time. Maximum contact pressure is shown to be an unreliable results parameter for convergence analysis because it is hyper-sensitive to local surface peaks and contact element area.

Poster 26
Testing of Nanoengineered Lubricant Additive in Internal Combustion Engines

T.J. Bailey, D. Demydov, A.P. Malshe, MMRL, University of Arkansas, Fayetteville, AR

This poster focuses on the use of MoS2 nanoparticle additives [1] in engine oil. MoS2 is a great solid lubricant because of its lamellar crystal structure. Its layers slide very easily against each other, thus reducing friction between them. The particles under load spread out across the surface to form a sacrificial tribo film which protects the surface from wear. It is readily used commercially in micro-sized particles; however, the MMRL has developed a method to mill the particles to the 100 nm range. This will allow the particles to fit into the texture of the surface further improving their effectiveness. With the high fuel prices and environmental issues there is a need to increase the efficiency of today’s car engines. Many address this issue with lowering the weight of the vehicle or optimizing the combustion process; however this poster for the first time proposes the use of nanolubricants as a means to reduce the parasitic losses due to friction. By decreasing the frictional losses in the engine, power and fuel efficiency would both increase as well as the longevity of the engine. Laboratory tests have shown that nanoengineered MoS2 added to base oil will decrease friction and wear under boundary lubrication [3]; from these findings a test vehicle was developed in order to test these results in real world conditions, a test engine. This was achieved by connecting a 6.5 Hp single cylinder OHV engine to a 2600W generator, which was loaded by a bank of 150 power resistors. The voltage, current, and rpm were gathered to plot a power vs. rpm curve. From these measurements it could be determined if the output of the engine was increased due to a decrease in the parasitic losses of friction. In addition, a load cell measured the weight of the 16 gallon fuel tank vs. time so that fuel efficiency can be evaluated. Also, a thermocouple has been placed in the crankcase oil to measure the temperature of the oil throughout the test. The oil temperature should decrease with friction due to less energy converted into heat. The engine was then run for a period of time filled with regular formulated oil to get the baseline measurement. Then it was filled with oil using the nanoengineered additive and ran for the same period of time. Since the tests were not conducted at the same time readings could change due to atmospheric conditions, so ambient air temperature, pressure, and humidity were monitored during the test to make sure any changes found were due to the additive and not the environment. From the six tests performed so far the nanoengineered additive has shown a 5.8% increase in power from an increase of 0.2% efficiency due to the improved lubrication over the baseline oil. As well as, a two degree Celsius decrease in engine oil temperature. These tests were done on a 196cc single cylinder engine with promising results, but it
is possible for the additive to perform even better if added to a multi cylinder engine. During the power stroke of one cylinder it is hindered by the friction in the other cylinders, so there are more interfaces to reduce friction which would show higher gains. The findings from these tests could greatly impact the world of transportation. With the increased power a smaller engine could replace a vehicle’s current engine reducing the overall weight, which would further increase fuel economy.

Poster 27
Tribo-Chemistry of Lubricated Coatings (DLC) for Engineering Components Under Extreme-Pressure Conditions @ University Of Leeds (UK)

K. Mistry, A. Neville, A. Morina, Institute of Engineering Thermofluids, Surfaces and Interfaces (iETSI), University of Leeds, UK, Corporate Strategic Research, ExxonMobil Research and Engineering Company, Annandale, NJ

Diamond like carbon (DLC) coatings are currently one of the most interesting surfaces used for the tribological applications. DLC coatings provide low friction, low wear characteristics and are chemically inert which makes them corrosion and oxidation resistant. Reports on low friction and low wear coefficients are largely restricted to dry/inert conditions. Conventionally most tribological applications are in lubricated conditions hence it is very important to investigate DLC performance in lubricated conditions. In the present work the tribological performance and the tribochemical interactions of WC-DLC (tungsten-carbide doped DLC) was investigated under dry conditions as well as lubricated extreme-pressure conditions. An extreme-pressure lubricant was tested on WC-DLC surface to evaluate the tribological performance and tribochemical interactions. In addition a comparison was made with same lubricant interacting at a conventional surface (steel). The topographical characterisation of the tribofilm was carried out using scanning electron microscopy (SEM) and atomic force microscopy (AFM) furthermore, the chemical characterisation of the tribofilm was carried out using energy dispersive X-ray spectroscopy electron (EDX) and X-ray photoelectron spectroscopy (XPS). Moreover, DLC undergoes graphitisation under wear-induced dry sliding condition hence, Raman spectroscopy was carried out on the tribofilm to investigate possibility of the formation of a graphitic nano-crystalline carbon layer under lubricated conditions. Thus, the current study gives an insight of the role of WC-DLC surface on tribological performance and tribochemical interactions under extreme-pressure contact conditions.

Poster 28
Studies on an Oscillating Water Column

J. Edwards, Department of Mechanical & Manufacturing Engineering, The University of the West Indies, St. Augustine, Trinidad & Tobago

With the exception of Trinidad, all the English speaking Caribbean countries depend on imported oil to meet their energy demands. High oil prices can therefore be detrimental to the economy of the Caribbean. Additionally, the burning of fossil fuel contributes extensively to global warming. These factors have led to the development of alternative energy sources. One such source is wave energy. The energy concentration in waves is about 8 times higher than in wind and 10 – 20 times the energy concentration in solar energy. In this work, the existing modes of harnessing ocean wave energy were investigated, with particular emphasis on the appropriate choice of device for the Caribbean region and its climatology. A prototype oscillating water column wave energy converter was designed and tested under simulated Caribbean conditions. An oscillating water column is a hollow structure that is partially submerges in sea water. It is open to the sea below the water line, enclosing a column of air on top of a column of water. Waves cause the water column to rise and fall, which alternately compresses and expands the air column. The trapped air flows to and from the atmosphere through a Wells turbine, which can turn in the same direction no matter which way the air flows.

Poster 29
Characterization and Applications of Shape Memory Alloys

C. Jarvis, Department of Mechanical & Manufacturing Engineering, The University of the West Indies, St. Augustine, Trinidad & Tobago

The need to continuously find alternative means to carry out any process or function, improve efficiency and utilize the knowledge and materials available to us is of great importance in the field of Engineering. Technological advances and the development of new materials allow for alternative solutions to existing engineering problems. One such advance or development is the production of materials known as Shape memory alloys (SMAs). These alloys display two key physical
characteristics; pseudo-elasticity and temperature induced transformations. The pseudo-elastic nature of SMAs allows for relatively large amounts of strain at almost constant applied stress without damage. This behaviour allows SMAs to be used in the field of vibration isolation. Temperature induced transformations also called the Shape Memory effect is the ability of the alloys to change or alternate between shapes upon exposure to specific temperature ranges. This property can be applied to actuation type applications. Other useful characteristics of SMAs include corrosion resistance and biocompatibility which make them feasible for use in various engineering applications. The purpose of this study is to investigate the use of Shape Memory alloys in engineering applications, thus providing alternatives to the way we do things with materials available to us. It included the design, construction and testing of a thermal actuator and a heat engine. The thermal actuator was able to perform the functions required, i.e. sense a temperature change, provide a displacement indicative of the temperatures sensed and actuate a control valve. The time taken for the actuator to achieve a steady state condition is acceptable, 6-32 seconds. This shows that the system can sense temperature and take corrective action in a reasonably short time. The thermal actuator offers advantages such as; simple design, no need for pneumatics, hydraulics or other external actuation system and so can be used in remote locations where the use of such systems are impractical or unavailable. The Heat engine was able to convert low quality heat into work. The heat engine can operate with relatively low Heat source temperature, as low as 580°C. The engine shaft speeds obtained were dependent on the heat source and sink temperatures.

**Poster 30**

**Tribological Performance of X(=Si, F) Incorporated DLC Films**

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In this study, we investigated the tribological performance of three kinds of diamond-like carbon (DLC) films on Mg-alloys. Si-incorporated DLC film, F-incorporated DLC film layer and non-modified DLC film was top-coated after an interlayer by Hexamethyldisilane (HMDS) gas was deposited to enhance adhesion with the top-coating. Tribological tests were done in open air (15-20% humidity) below 2N normal load using Al2O3 ball on disk. The test results showed that the wear loss of the specimen with Si-DLC film was a much lower compared to other DLC films. After tests the wear tracks of DLC film were analyzed by optical microscope, scanning electron spectroscopy SEM and Raman spectroscopy. The surface roughness and 3-D images of wear track were also obtained by an atomic force microscope (AFM).

**Poster 31**

**Spatial Evolution of Friction of a Micro Device**

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At the micrometer scale, contact kinetics between mechanical interfaces in micro devices becomes very significant. Understanding the predominant issues, such as stiction and friction is critical for further development. The objective of this research is to develop a methodology to study the tribological performance and surface properties of micro devices such as micro-electromechanical systems (MEMS). In this poster presentation, we demonstrate a simple method for in situ, spatially resolved, wear induced, evolution of the coefficient of friction. Tribological experiments are performed on a sample consisting of a silicon patterned wafer of various materials. Instantaneous friction values are used to develop a friction map. The map shows an increase in coefficient of friction as a function of friction cycle. Effects of geometry on friction and wear are clearly seen. Surface characterization through XPS identified transferred elements due to pin sliding. The high friction value was found to be related to the onset of wear debris. In this poster we discuss about mechanisms of spatially resolved friction and wear and their importance in Microsystems such as MEMS.
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