Friction & Wear Workshop

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Why Have a Workshop on Friction and Wear?

- **Optimization of tribological systems critical to achieve:**
  - Fuel Economy
  - Emissions Reduction
    - Better use of fuel
    - Implementation of emission reduction strategies
  - Reliability and Durability
    - Million-mile warranties
  - Safety
- **Friction & wear often addressed after-the-fact**
- **Lack of coordinated R&D efforts that address topics germane to a wide range of applications**
- **DOE/OTT/OHVT - Parasitic energy loss workshops**
  - Friction & Wear, Aerodynamic Drag, Thermal Management, Brakes & Rolling Resistance

Workshop on Research Needs for Reducing Friction and Wear in Transportation

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- **Objective(s):**
  - Obtain input from industry (OEMs end-users, and suppliers) on their critical needs to reduce friction and wear
  - Develop a multi-year R&D plan to address critical barriers that industry identified
  - Establish R&D teams to address critical needs
  - Increase governmental awareness of issues and needs

Workshop Agenda

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- **Keynote Presentations**
  - Effect of Friction & Wear on Fuel Efficiency
  - Role of Lube Oil on Nanoparticulate Emissions
- **Industry Needs**
  - OEMs, engine manufacturers, suppliers, end-users
- **Technical State-of-the-Art Updates**
  - Materials, Coatings, Lubricants, Design Methods, & Characterization
- **Breakout Sessions to Develop Research Agendas**
  - Materials, Coatings, Lubricants, Design Methods
- **Site Visits**
- **Multi-Year Program Plan - Final (December 1999)**

Issue - Solution - Barrier Approach

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Identify Customer Issues & Needs	Identify Potential Solutions & Approaches	Identify Barriers to Solutions	Develop & Implement R&D Program

Example: General Public

- secure fuel supplies	-reduce demand by use of alternative fuels -increase thermal efficiency of engine -reduce mechanical & parasitic losses	- low lubricity of alternative fuels - wear of high(er) pressure fuel system parts - wear with low(er) viscosity lubes - ....

Customer Needs/Issues

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Customer	Issue
General Public	- secure fuel supply - environment
Fleet Operators	- owning & operating costs - maintenance costs (oil change interval)
Truck Manufacturers	- cost effectiveness of vehicle - meeting emission standards
Off-Road Vehicles	- uptime - owning & operating costs - emissions
Engine Manufacturers	- emissions - fuel efficiency - durability/reliability - power density

Customer Needs/Issues cont'd

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Customer	Issue
Automobile Manufacturers	- fuel economy (CAFÉ) standards - performance - durability - alternative fuels - manufacturing costs
Suppliers	- ring, rod, camshaft frictional losses - low-sulfur fuel systems - high power-density bearings - low-friction, durable seals - high power-density transmissions
Lubricant Suppliers	- emissions - catalyst poisoning - extended life lubes - universal lubes - speciality/segmented lubes

Customer Needs/Issues cont'd

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Customer	Issue
Railroads	- operating costs - emissions - safety
Locomotive Manufacturers	- emissions - efficiency - durability

Common Research Topics

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- **Quantitative understanding of failure mechanisms**
  - A quantitative understanding of failure mechanisms such as wear, scuffing, and fatigue is essential both for the development of computational design codes to mitigate and possibly avoid those problems and for the development of bench-top tests to predict full-scale behavior. This will require combining the results of basic research into those mechanisms, applied research into how those mechanisms are manifest in an engine or drive train, testing to develop correlations between fundamental properties and component behavior, and analytical and computational approaches to codify the understanding

Common Research Topics (cont'd)

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- **Bench-top tests that are predictive of full-scale behavior**
  - While a quantitative understanding of the various failure mechanisms would be extremely helpful in designing bench-top tests, in the meantime it should be possible to develop better correlations between lab behavior and full-scale behavior by taking greater care to duplicate in the laboratory the essential conditions that prevail in an operating engine or drive train

Common Research Topics (cont'd)

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- **Affordable surface-modification technologies suitable for various components in various fuels or lubricants, and under various operating conditions**
  - For many situations where stresses, temperatures, or environments are becoming more severe, current bulk materials have reached, or soon will reach, their performance limits, and surface modification remains the only viable alternative for additional improvements. Surface-modification techniques for consideration include various coatings, thermal treatments (perhaps by lasers), ion implantation methods, and texturing or smoothing.
  - It is unlikely that any single surface-modification technique will be suitable for all applications. Therefore, a variety of techniques or coatings need to be characterized and, perhaps, further developed.

Common Research Topics (cont'd)

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- **Better understanding of the chemistry of lubricants and how additives affect their interactions with rubbing surfaces**
  - Formulation of additive packages is largely empirical. A more scientific understanding of the role of additives would form the foundation for developing new lubricants that will be longer lasting, environmentally friendly, capable of handling increased soot loadings for EGR, compatible with catalysts (probably with very low sulfur and phosphorous levels), and/or compatible with nonferrous materials.
  - Some question the validity of current protocols to evaluate catalysts. A fundamental understanding of how lubricant additives such as S, P, and Cl poison catalysts is needed.

Common Research Topics (cont'd)

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- **Advanced computer codes that model friction, wear, distribution of lubricants, and lubricant interactions with surfaces**
  A general friction/wear/lubrication model is needed along with more specific models of lubrication and vapor-phase lubrication.
- **Affordable high-performance steels to withstand the higher stresses resulting from increasing power density and fuel pressure**
- **Improved rotary-seal systems for longer life**
- **Improved brake systems to compensate for heavier loads and reduced aerodynamic drag**

Benefits of Improving Friction and Wear Performance

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- **Fuel Savings**
- **Emission Reduction - Quality-of-Life**
  - use less fuel
  - enabling emission reduction strategies
- **Reduced Downtime - higher productivity**
- **Reduced Maintenance Costs**
- **Improved Safety**

What do we do next?

Establish teams & projects

- National labs and universities to do initial research and materials evaluations
- Lubricant (and fuel), and additive supplier
- Suppliers to make prototype parts
- Vehicle and engine manufacturer for overall guidance and field tests

DOE Solicitation for R & D Projects

- Friction and Wear
- Aerodynamic Drag
- Thermal Management
- Brakes and Rolling Resistance

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