An Approach Toward Developing a Practical Friction Material Rating System

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A project supported by the U.S. Department of Transportation (DOT), National Highway Transportation Safety Administration (NHTSA).

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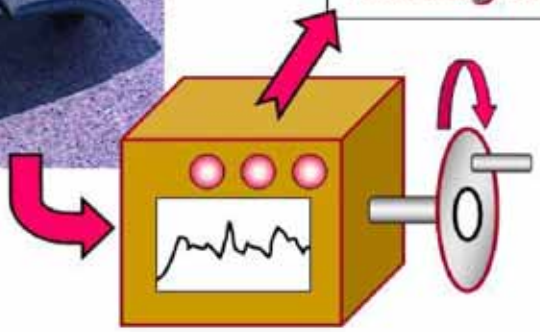
What we'd like to have …

Take a lining …

Simple, Useful Rating Number



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Major efforts have been expended to develop effective brake lining test methods

- FAST Test (SAE 1967)
- Chase Test (SAE J661a)
- SAE J160 (temp vs. dimens. chg)
- SAE J667 (cancelled)
- SAE J840 (shoe / lining bonds)
- SAE J866 (marking system/ J661)
- SAE J1652 (dyno test for discs)
- SAE J1801 (marking system)
- SAE J1802 (brake block test)
- TMC RP 628, FMV 121
- SAE J2115 (comm. veh. dyno.)
- SAE J2430 (dyno for disc tests)
- Private brake testing facilities
- Supplier and OEM test labs
- Gov't and university labs
- FMCSA 49 CFR Part 393 PBBT

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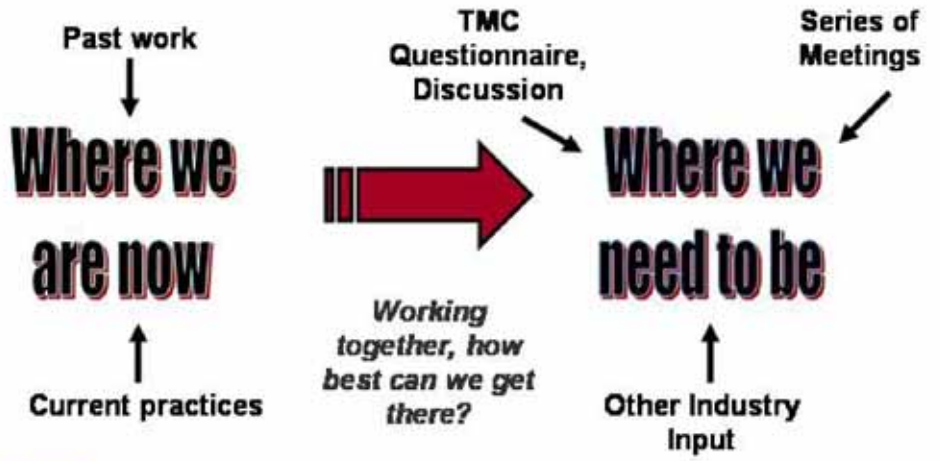
How NHTSA and ORNL are addressing this problem …



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Oak Ridge National Laboratory

- One of 16 Department of Energy labs
- Nation's largest energy R&D laboratory
- Located near Knoxville, Tennessee
- Operated by UT-Battelle LLC, the prime contractor to DOE.
- Staff: approximately 3800.
- $90 M in transportation-related research programs in FY 2002.

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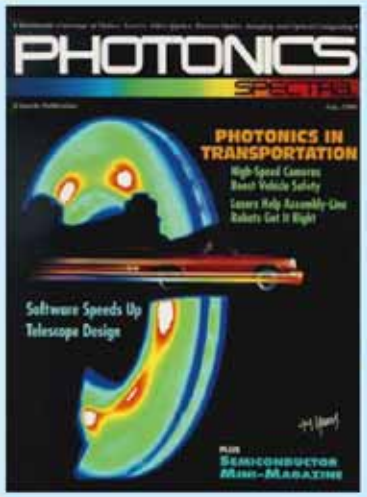
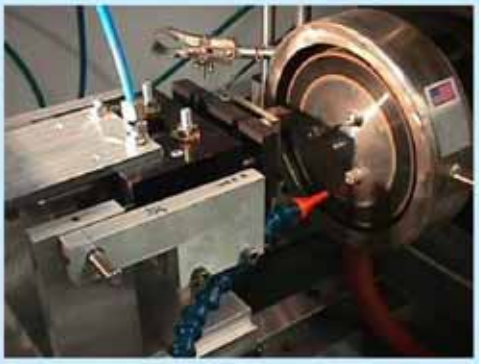
ORNL has been researching brake materials and components for over a decade

High-speed IR camera studies of hot-spots.





Sub-scale friction material test system with water spray.

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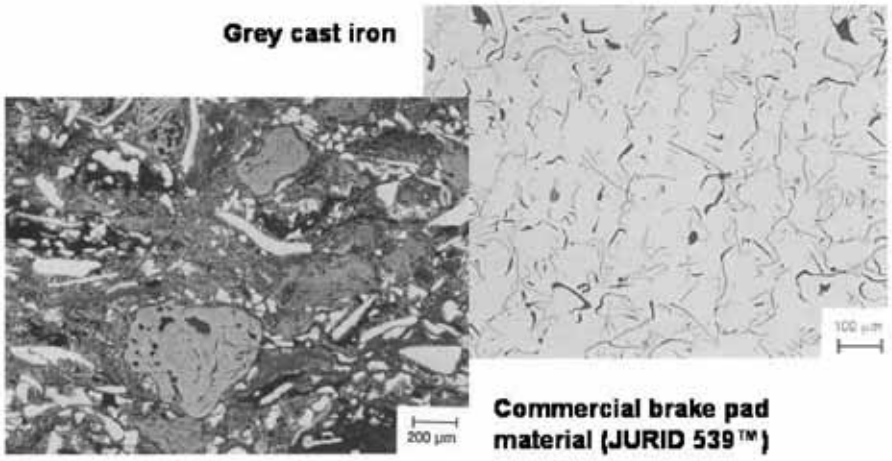
The properties of friction materials are determined by composition, microstructure, and processing



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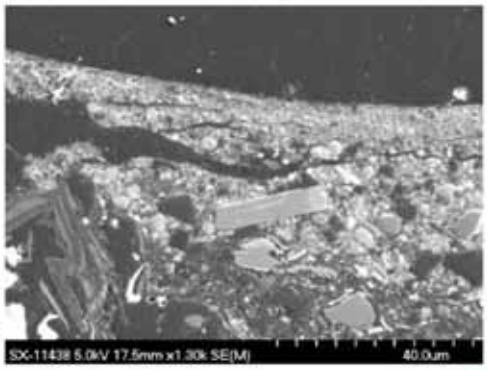
New materials are created on the brake surfaces and these, in turn, affect performance

Trailer brake shoe (4 yrs), *Courtesy Averitt Express*



Highly-magnified cross-section
(1,300 X original enlargement)

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An Important Distinction: Material Properties vs. Characteristics

- **A PROPERTY is a basic quantity that depends on the composition, structure, and processing of a material. [Examples: melting point, elastic modulus] Properties can be measured in different ways, but you should get the same value.**
- **A CHARACTERISTIC is the behavior of a material that depends on a combination of basic properties that react to the system in which the material is used. [Examples: friction coefficient and wear rate depend on a combination of basic properties, all combining to react to the conditions in a given machine.] Material characteristics depend on method of measurement.**

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Material Properties: A Question of Selecting from among Many Possible Choices

Just to name a few ...

- ❑ Density
- ❑ Gogan hardness
- ❑ Brinnell hardness
- ❑ Dynamic hardness
- ❑ Modulus o
- ❑ Shear modulus
- ❑ Flexural strength
- ❑ Yield strength
- ❑ Tensile strength
- ❑ Compressive strength
- ❑ Creep strength
- ❑ Torsional strength
- ❑ Impact strength
- ❑ Fatigue life
- ❑ Rupture strength
- ❑ Thermal expansion coefficient
- ❑ Thermal conductivity
- ❑ Thermal diffusivity
- ❑ Heat capacity
- ❑ Chemical stability (corrosion)
- ❑ Phase transition temperatures

TOO COMPLICATED!

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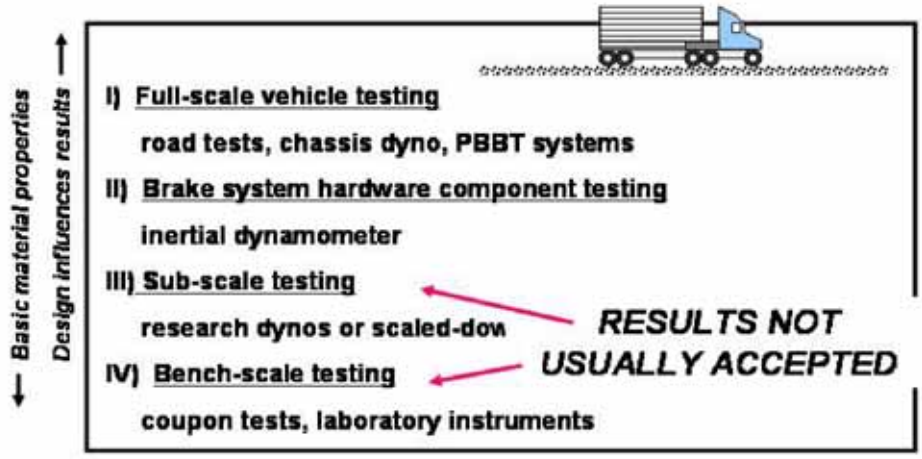
PROPERTIES AND CHARACTERISTICS CAN BE MEASURED AT DIFFERENT SCALES (AND RELATED COSTS)



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'Strawman #1' had <u>both</u> material properties and characteristics, but was felt to be too complicated

FCS	0.43 / 21.0	Ave COFs / % var in n applies
FCT	0.42 / 0.45 / 0.32	Ave COFs at 25 / 200 / 400 C
FWR	1.8	Time to recover COF after wet (seconds)
WR	3.2	Lining wear loss (mm)
TC	45.0	Thermal conductivity (W/m-K)
TE	15	Coefficient of thermal expansion(10^{-6}/K)
FLX	650	Flexure strength (MPa)
IS	20.5	Impact energy (N-m) at room temperature

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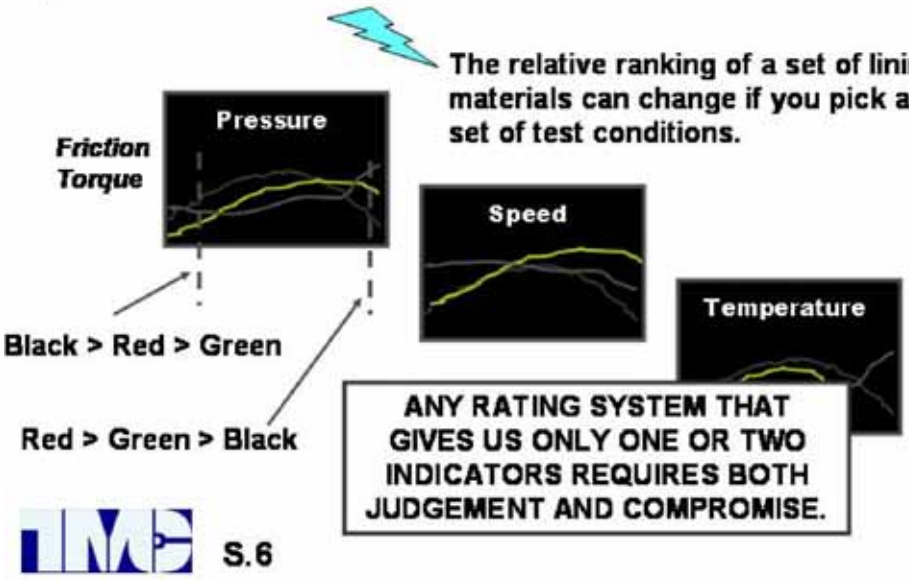
A Major Challenge is faced by Test Developers



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A fleet operator survey was conducted at this TMC meeting

Only yellow-badged registrants received the survey.

Background questions: fleet size, type of operation, whether do own brake maintenance or not.

Opinion questions:

Importance of various brake related problems: electrical, wear, noise, stopping distance, lubrication, out of adjustment, breakage of parts, air system, parking brake…

Relative importance of various causes for brake problems: training, basic brake design, maintenance issues, lining quality

How do you select linings? Familiar with RP 628? Use it?

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WHAT's NEXT?

1) **CONSIDER RESULTS OF GROUP DISCUSSIONS, QUESTIONNAIRE, OTHER INPUT (HDBMC, TMC, SAE, other organizations)**

2) **DEFINE TARGETS: How many parameters, Applicability to S-Cam and/or Air Disc, etc.**

3) **PREPARE A NEW STRAWMAN RATING SCHEME(s) and SEND OUT FOR INDUSTRY REVIEW. (Late spring 2003)**

4) **DETERMINE WHETHER MODIFIED CURRENT PROCEDURES OR NEW TESTS WILL BE REQUIRED TO MEET THE TARGETS.**

5) **ORNL to PREPARE SUMMARY REPORT AND RECOMMENDATIONS TO NHTSA. (Summer 2003)**

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THIS AFTERNOON ---
Your chance to sound off on brake lining issues.

NHTSA People Saving People www.nhtsa.dot.gov

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