Using Grease To Boost Perceived Quality

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When it comes to their cars, drivers expect smooth, quiet performance from the engine, under-chassis components, and cockpit accessories. In response, automakers have created engineering groups dedicated to tackling buzzes, squeaks, and rattles (BSR).

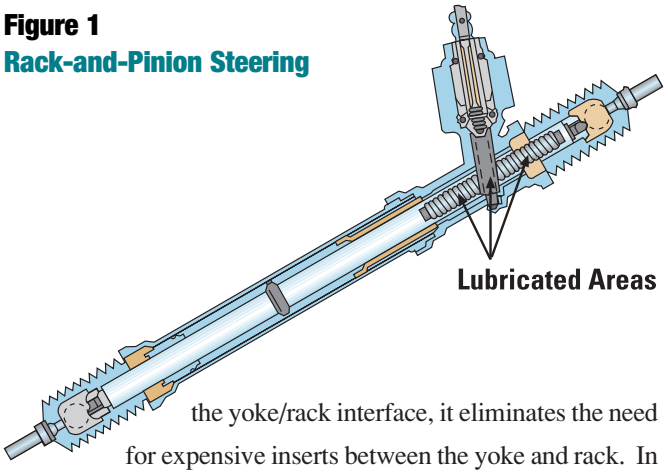
BSR engineers are learning that eliminating noise and vibration doesn't necessarily mean expensive redesign or tight engineering tolerances. Instead, putting the right lubricant in the right place often does the job economically. This article discusses several perceived quality problems that have been solved with custom synthetic lubricants, starting with Visteon Automotive Systems' rack-and-pinion steering. Functionally, the steering system consists of a toothed rack that mates to a pinion gear. When the steering wheel turns, the pinion gear rotates, which moves the rack to the left or right to steer the car (*See Figure 1*).

While Visteon wanted a grease to prevent wear and extend the operating life of the gear teeth, it was also concerned about a separate wear and noise problem. On the smooth side of the rack, a spring-loaded yoke is used to keep the rack teeth mated to the pinion gear. The yoke is inserted through a tapped hole on the rear of rack-and-pinion housing. A plug, screwed into the hole, compresses the spring and holds the yoke in place. Under mechanical shock — potholes or railroad tracks, for example — the rack would bounce and jar the yoke, which would cause a knocking sound and intensify wear.

Traditionally, many engineers handle this dilemma by inserting an expensive, composite plastic sleeve between the yoke and the polished side of the rack to help reduce wear on the rack and yoke. However, even plastic sleeves wear quickly if the proper amount of torque isn't applied to the yoke plug. Too much torque on the yoke plug accelerates wear due to excessive pressure; not enough torque accelerates wear because there is too much play between the yoke and the rack. The margin for error is thin and the tolerance can be too tight to ever know the exact measure.

Visteon found a solution with a custom-formulated, synthetic grease. The grease consists of a new, high-viscosity base oil, a lubricious thickening system, and a package of extreme pressure and antiwear additives. The viscous grease adheres to moving parts, so mating surfaces don't touch. They actually move within the grease itself. This not only eliminates noise at

Figure 1
Rack-and-Pinion Steering



the yoke/rack interface, it eliminates the need for expensive inserts between the yoke and rack. In addition, the grease allows for greater tolerances when securing the yoke plug.

When the grease was applied to the gear teeth and between the yoke and the smooth side of the rack, the rack-and-pinion unit passed gear and yoke wear tests without knocking — and Visteon reported a smooth, quality feel across the whole steering system. Visteon's quiet rack-and-pinion system will be in next year's Mazda. Rack-and-pinion systems for the Lincoln LS, Thunderbird, and Jaguar will also be lubricated with the new grease as soon as dispensing equipment on productions lines is converted. Notably, in addition to longer life and quieter performance, the Mazda rack-and-pinion system used only 12 grams of synthetic grease, compared to 50 grams of the petroleum grease formerly used on the device.

The new grease gave Visteon more than it bargained for. Visteon uses two yoke styles, the oval and the Y-shaped. After heat-treating the Y-racks, Visteon traditionally hand-buffed each rack to remove scaling and aspirates. Polishing the rack helped reduce wear. One of Nye's engineers suggested that Visteon wear-test unpolished racks that were lubricated with the synthetic grease. Results showed that unbuffed racks outperformed buffed racks — which enables Visteon to abandon the labor-intensive, rack-polishing operation for the more than 600,000 Y-racks it manufactures each year. Though this case is quite unique, it demonstrates that a custom-formulated grease can do a lot more than reduce wear and noise.

FROM LEAF SPRINGS TO RADIO TUNERS

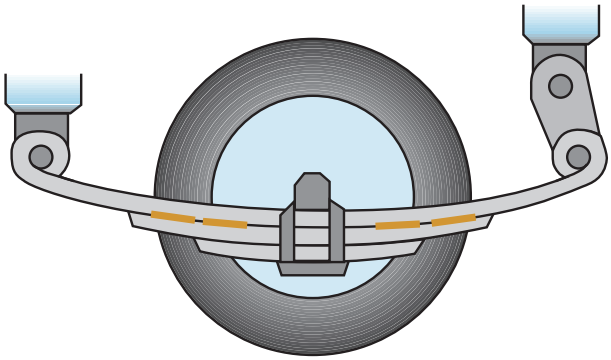
Leaf springs are one of the oldest and most reliable suspension systems in use today. Widely used in the heavy-car 60s and 70s, leaf springs are now usually confined to larger vehicles, pick-up trucks, and SUVs. Rugged, economical, and fairly inexpensive to repair, this steel-on-steel component has a predisposition for pesky BSR problems for service dealers and vehicle owners. In a marketplace that wants even its pick-ups quiet, DaimlerChrysler decided to tackle the problem head-on.

Generally, leaf spring squeaks are caused by friction. So, manufacturers have inserted plastic strips between the steel layers of some leaf springs to dampen metal-on-metal noise — and reduce metal wear (*See Figure 2*). But even with fortified-nylon inserts laced with slippery PTFE, squeaks happen.

Since friction is usually minimized with a lubricant, DaimlerChrysler wanted to test whether a lubricant would further dampen the noise. A leaf-spring lubricant would have to be a very heavy, sticky grease to stay in place on plastic inserts, especially under heavy load and shock conditions. It also would have to resist dirt, water, and salt-water washout. These operating conditions suggest an extremely viscous "damping grease."

Damping greases were first formulated about 50 years ago to build fine tolerances economically into microscopes, telescopes, and binoculars. Applied to focusing threads, they are responsible for the smooth feel, minimal backlash and coasting, and virtually silent operation of these devices. Damping greases work because they are formulated with highly viscous base oils. These oils give a damping grease a high internal shear resistance, so it requires some degree of force to move an object through it. This shear resistance is the quality that prevents backlash and coasting and ensures smooth, incremental motion.

Figure 2 **Automotive Leaf Spring**

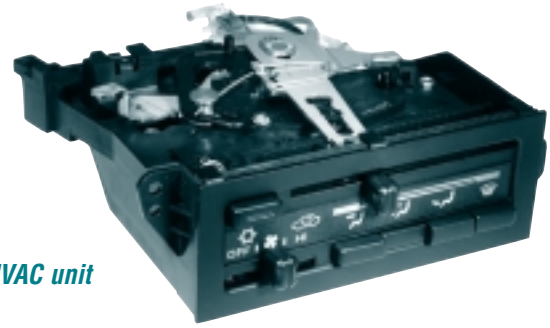


To achieve the "right feel" for a specific component, engineers can choose from various grease consistencies, from very light to ultra heavy. For example, the volume control on a radio would call for a lighter grease; the release mechanism on a parking break, a heavier grease. Because of their consistency, damping greases also do a good job of sealing out moisture, dust, and other pollutants, to extend component life.

In the mid 1980s, the first line of broad-temperature damping greases immediately caught the attention of automotive switch manufacturers. When damping grease is applied to detents, it suppresses the annoying click of plastic switches. It also imparts a certain tactile quality — a "velvet feel" — and makes possible very precise settings that could not otherwise be made by hand. Today, damping greases are used in more than 30 automotive parts (*See Table 1*) — including DaimlerChrysler's leaf spring suspension systems

DaimlerChrysler's tested an ultra-viscous damping grease fortified with molybdenum disulfide for improved load-carrying capability on its leaf springs. The grease resulted in an immediate noise reduction and a significant drop in leaf-spring-related warranty issues from the field. Ford specifies an ultra light version of this grease in HVAC and radio controls. General Motors uses a medium grade to quiet rattles in steering columns.

The right damping grease can likely solve other common noise and motion problems, including recoil speed of foot pedal parking brakes, temperature control cables that don't slide

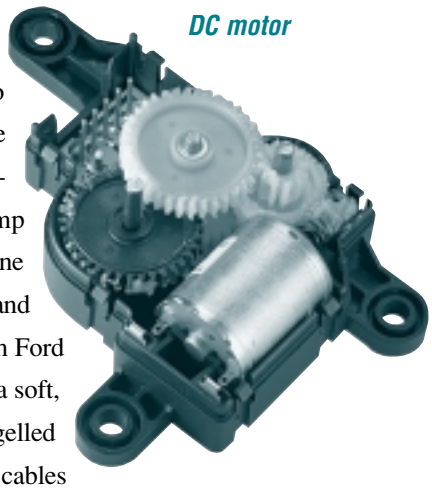


HVAC unit

smoothly, rear view mirrors that drift when the car is in motion, and shifter cables that carry vibration from the transmission to an operator's hand resting on the shift stick. While all of these components may be defect-free and meet manufacturer's life requirements, if they don't have the "right feel" they can be perceived by the vehicle owner as something less than a quality component. Damping greases are a way to design into the component the tactile and acoustic qualities consumers want.

BRAKES AND STARTERS

Silicone greases have good track record in extending the life and eliminating noise in push-pull cable applications. While oil is still used for some lightly loaded cables with high efficiency needs, a grease's stay-in-place capability mitigates leakage problems associated with oil. Greases also prevent wear better than oils. Formulated by gelling a base oil with a thickener system, greases act like a sponge of oil, slowly releasing oil throughout the life of the cable and ensuring an adequate supply of lubricant during cycling. PTFE is a popular gellant for cable greases. It creates a surface with a very low coefficient of friction and aids in supporting medium and heavily loaded cables to reduce wear. Because grease is a less mobile form of lubrication it can also damp mechanical vibration from one end of the cable to the other and deliver a "quality feel." Both Ford and General Motors specify a soft, high-viscosity silicone fluid gelled with PTFE for parking brake cables in light trucks. DaimlerChrysler specifies a medium silicone-based grease for parking brake cables — and adds a tube of the grease to its Mopar BSR kit.



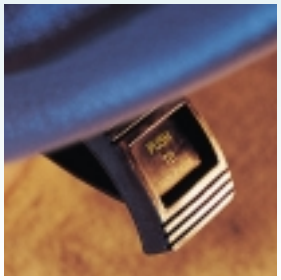
DC motor

Gearbox manufacturers are expected to quiet noise and extending gear life. They often use a gear oil because of its wet-ability. But there is another option — a very soft grease, which helps quiet the gearbox and allows a manufacturer to avoid the design and manufacturing costs associated with oil seals. Delco Remy starters rely on just such a grease: a unique blend of lithium soap and synthetic hydrocarbon and ester oils with an operating temperature range of -40°C to +135°C. It softens to the consistency of soft butter as it is churned by the gears. As it softens, its wetting ability increases to retard friction and wear, while its gel-like consistency helps to reduce noise. The grease has an EP additive package, including molybdenum disulfide, making it ideal for metal-on-metal and high-load gearboxes. Importantly, the grease does not "chan-

Table 1

Where and Why Damping Greases Are Used in Today's Autos

SWITCHES *Quality "Feel"* *Quiet Operation*	INTERIOR COMPONENTS *Improved Tactile Quality*	GEARBOXES *Noise Reduction*	CABLES *Smooth Operation*	OTHER *Motion Control*
Multifunction	Window Visors	Door Lock Actuators	Parking Brake	Seat Tracks
Headlamp	Visor Vanity Mirrors	Power Side View Mirrors	Shifter	Starter Selenoids
Ignition	Rear View Mirror	Folding Side View Mirrors	Temp Control	Suspension System
Climate Control	Control Knobs/Buttons	Convertible Roof Gearboxes		CV Joint Clunking
Power Window	HVAC Air Flow Vents	Sunroof Motors		
Power Seat	Retractable Cupholders			
Power Door Locks	Ashtrays			
Power Mirrors	Slide-out Storage Trays			
Rear Defrost	Shifter mechanisms			
Hazard	Glovebox Latches/Hinges			
Map Lamp	Steering Column			
Truck Release	Lumbar Adjustment Knob			



nel" — an important characteristics for greases intended for gearboxes. Many OEMs who switch from oil to grease in the gearbox often opt for the same grease used to lubricate the bearings of the gearmotor. However, bearing greases are designed to "channel" that is move out of the way of the rolling element, so it rotates freely on a thin layer of oil. While that works for bearings, it's disastrous for gears. If a gear grease channels, metal-on-metal contact, noise, and premature failure are the result.

THE SQUEALING MOTOR

Sometimes, it takes more than a lubricant to get rid of noise. A Tier One supplier wanted an oil for powdered metal bearings in an HVAC motor. More than preventing wear, they wanted an oil to silence the squeal when the car heater down to –40°C. Squealing actually started at around +10°F. The customer sent "dry," that is, unlubricated bearings to Nye for pre-application testing. Through a soxlet extraction process, Nye engineers removed oil from the "dry" bearings — not lubricating oil, but residual process oil used in the manufacture of the sintered bearings. Process oil left in the bearings can pose two problems. First, it takes up space, thereby reducing the amount of lubricant the bearing can hold. Worse, if the lubricant of choice is a polyalphaolefin, ester, or polyglycol, the process oils, with their poor thermooxidative stability, exacerbate degradation of the lubricant.

Nye, therefore, recommended more than a lubricating oil for the sintered bearing. It recommended a complete impregnation process: extract process oils; use a perfluoropolyether (PFPE) oil to assure good low temperature performance; ensure a full complement of oil within the bearing by impregnating in a vacuum chamber for 24 hours @ 100'C. The result: the low-temp squeal was squelched and the operating life of the motor was extended.

While PFPE lubricants offer the widest operating temperatures of any synthetic lubricant — -90°C to +250°C — they are also used frequently in the passenger compartment, where PFPEs inertness makes it a popular choice. PFPE lubricants do not crack, craze, discolor, or dissolve plastics. Nor do they cause natural rubber or elastomers to swell, shrink, or become brittle. They have no adverse effect on metal. As a result, PFPE grease is used on automotive assembly lines. On weather-stripping it eliminates squeaking dry rubber. It is also used on plastic control knobs, plastic hinges, and many other last-minute squeaks. Because it is inert, PFPE lubricants can be used confidently — without the time and expense of prequalification and life-cycle testing. ■