HIGH-PERFORMANCE BRAKE SYSTEMS

DESIGN, SELECTION AND INSTALLATION

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Front Cover:
There is more to upgrading your brake system than just shopping for the best looking parts. While aesthetics certainly are important, consideration must also be given to system-level performance. Picking the right parts is usually more complicated than physically bolting them on–they have to work together. (Randall Shafer)

Title Page:
During track use, rotors are squeezed with thousands of pounds of clamp force, twisted by thousands of foot-pounds of torque, and heated to over 1,200 degrees F. Heavy cars with large engines such as these only make the demands that much more intense. (Wayne Flynn/pdxsports.com)

Back Cover, Top:
Designing a hot rod brake system from scratch may seem intimidating at first, but the fundamental concepts of gain and balance still apply. What really differentiates these brake systems are unique design and operating requirements that may require different compromises than would be appropriate for an all-out racecar. (Randall Shafer)

Middle:
Because experience is the best teacher, the final four chapters of this book are dedicated to sharing our years of upgrade know-how with you. Whether you are upsizing your front rotors for track use or converting your muscle car from rear drum brakes to rear disc brakes, grab your wrenches and head out to the garage with us. Just be sure to wear your safety glasses! (Randall Shafer)

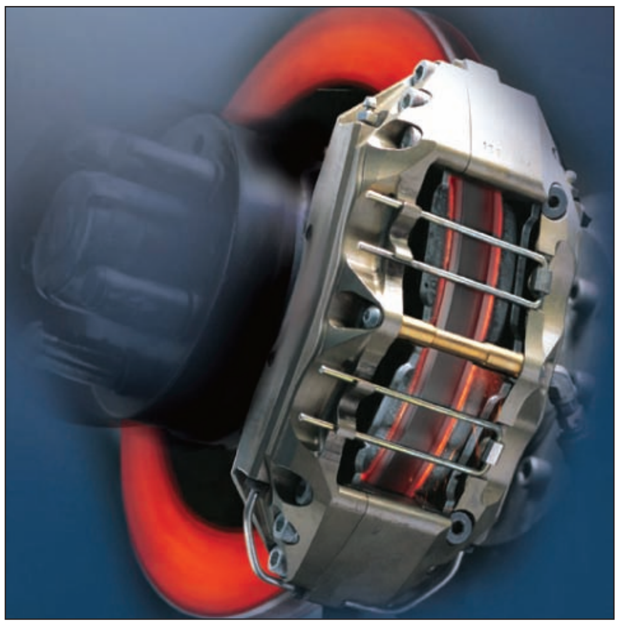
Bottom:
Motorsports can place extreme demands on your brake system, and if your hardware is not up to the task, performance can suffer dramatically. A solid understanding of brake system fundamentals greatly increases your likelihood of ending up in the winner's circle on race day. (Wayne Flynn/pdxsports.com)

ENERGY CONVERSION

If there's just one piece of information you should retain after reading this book, it's that the brakes don't stop the car. Contrary to popular belief, bright red calipers, cross-drilled rotors, and stainless steel brake hoses are not responsible for vehicle deceleration.

That's a pretty hard statement to accept, isn't it? This fundamental concept directly contradicts your own everyday driving experiences. You push on the brake pedal hundreds of thousands of times per year, each time expecting your vehicle to slow down. This is repeated more than one million times over the life of a typical vehicle. You're probably asking yourself right now, "How can those countless observations be wrong?"

Thankfully, the true purpose of brake systems is not based on particle string theory or quantum mechanics. All you need is solid understanding of the First Law of Thermodynamics and the rest will fall into place.



Regardless of their color, size, number of pistons, slots, holes, or sex appeal, the brakes don't stop the car. As you'll learn, they exist solely to convert energy from one form into another. A glowing rotor is a sure sign that the energy conversion process is in high gear. (Hawk Performance)

The Conservation of Energy

The First Law of Thermodynamics says that energy (the ability to do work) can neither be created nor destroyed. In other words, the amount of energy found in the universe is constant, and regardless of what you choose to do with it, you can't change the total amount.

(Note here that Albert Einstein later proved that isn't necessarily the case, but exceptions only occur when traveling at the speed of light. Since the vehicles you drive are most certainly *not* traveling at the speed of light, you can ignore Einstein's accurate but irrelevant observations without worry.)

These vehicles are sitting on the grid, ready to head out on the track. Even if they all were to attain the same top speed on the main straight, they would all have different amounts of kinetic energy because of their differences in weight. (Wayne Flynn/pdxsports.com)

While complex in design and operation, the internal combustion engine only exists to convert the stored chemical energy of gasoline into vehicle kinetic energy. The higher the rate of energy conversion, the more power (and acceleration) the vehicle is capable of producing. Turbochargers certainly add to the excitement. (Randall Shafer)

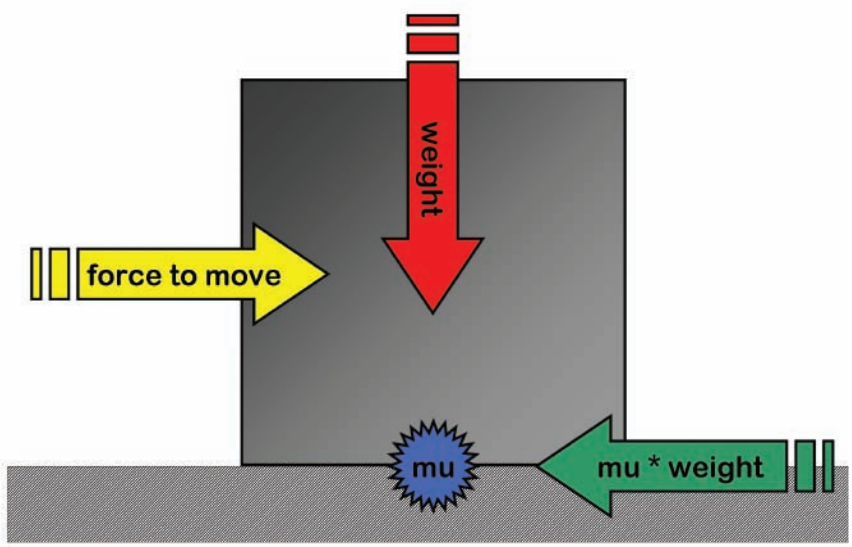
While the law as stated refers to the universe as a whole, the focus of automotive enthusiasts is quite a bit narrower. From this perspective, *the universe* can be replaced with *the vehicle* and the law still holds true.

In summary, the amount of energy in and around your vehicle is constant, and while you can't change the total amount, you *can* influence which forms that energy takes.

Where Energy Comes From

The primary source of energy in most vehicles comes from the *chemical energy* stored in the bonds holding together molecules of gasoline in the gas tank. The internal combustion engine is a device which takes this stored chemical energy and converts it into a variety of other energy forms with the intended effect of accelerating the vehicle to a given speed and maintaining that speed as long as the driver intends—or until the gas tank is empty.

In this regard, the most useful form of energy coming from the internal combustion engine is *kinetic energy*—the energy of the vehicle in motion. Unfortunately, this only accounts for about 25 to 35 percent of the total energy stored in the fuel. The remaining 65 to 75 percent is converted into relatively useless *thermal energy* (such as heat) lost to the cooling system and stored in the exhaust gasses.



The force due to friction (green arrow) is equal to the coefficient of friction, or mu (blue star), multiplied by the object's weight (red arrow). This is equal to the force required to move the object along the surface (yellow arrow). As a result, the lower the coefficient of friction, the easier the object will be to move.

Friction

Since friction is discussed at great length in this book, it makes sense to define it now. In simple terms, friction is the resistance to movement that occurs between any two objects that are in contact with one another. More specifically, any time you attempt to generate relative motion between two objects, there will be a force generated which resists the motion you are trying to achieve. This force is called the *frictional force*.

The simplest example is a block of wood sitting on a table. In order to move the block along the surface of the table, you need to push it with a certain amount of force. The force required to get the block to move is equal to the weight of the block multiplied by the amount of