*Can You Imagine . . .*

. . . a family of low-cost, high-volume, production-rate inertial sensors for the automotive industry.

# NEW SENSORS TO ENHANCE VEHICLE OPERATION

ROCKWELL AND DRAPER LABORATORY EXPECT THE MINIATURE SENSORS TO PLAY MAJOR ROLES IN AUTOMOTIVE PASSENGER SAFETY AND INTELLIGENT NAVIGATION.

Previously ancillary, but now essential, sensors are involved in nearly every aspect of vehicle operation. Today's sensors keep a close watch on exhaust gas to minimize emissions, on deceleration to deploy air bags quickly in accidents, and on wheel motion to improve the reliability of antilock braking systems. In recent years, the number of sensors per automobile has quadrupled: In 1980, automobiles incorporated 10 to 30 sensors; in 1990, they contained 50 to 100 sensors.[1]

Car makers need new sensor technologies for future vehicle designs. Inertial sensors, for example, play major roles in passenger safety, vehicle dynamic control, and intelligent navigation systems. However, their cost—even when produced in large batches—limits their widespread use in the automotive industry.

Rockwell International (Anaheim, CA) joined forces with researchers at The Charles Stark Draper Laboratory, Inc. (Cambridge, MA), to develop a family of low-cost, high-volume, production-rate inertial sensors for the automotive industry. These sensors will owe much of their existence to Draper Laboratory's work for BMDO, which involved building miniature inertial sensor units to guide ballistic missile interceptors.

Inertial sensors measure rotation and linear acceleration and, in large systems, help guide moving objects or detect unwanted motion. Rockwell and Draper Laboratory see many uses for smaller, low-cost versions of these sensors in the automotive industry. A lateral skid detector, for example, requires sensing uncontrolled sideways movement to trigger a system to re-establish control. Such a device does not exist today, simply because no low-cost instrument accurately measures the kind of angular rate triggered by a skidding or sliding car.

The Silicon Micromachined Angular Rate Sensor, the first product being developed, provides single-axis angular rate data such as yaw, pitch, and roll. It can be used in sensing dynamic vehicle motion to help make antilock brakes safer, increase steering responsiveness, and improve driving comfort. The Rockwell/Draper Laboratory team plans to develop several other products, including gyroscopes and accelerometers for four-wheel steering, automatic braking, skid detection, and collision avoidance. Ultimately, the companies expect to develop a product that provides intelligent control, diagnostic, and navigation functions in a single package.

■ The Silicon Micromachined Angular Rate Sensor, pictured above, provides single-axis angular rate data, such as yaw, pitch, and roll.

## ABOUT THE TECHNOLOGY

Rockwell and Draper Laboratory are developing low-cost, miniaturized inertial systems that contain accelerometers, gyroscopes, and information processors in dedicated units. These systems will measure 2 x 2 x 0.05 cm, require less than one milliwatt of power, and be accurate up to 100 degrees per hour. Further development could lead to devices with accuracies as high as 10 degrees per hour, while still keeping costs under $100 per unit. In general, inertial systems tend to drift. For inertial sensing applications, lower drift rates increase unit precision.

Draper will fabricate the sensors using an innovative micromachining process that employs a controlled isotropic chemical etch of silicon to form up to 10,000 devices on a single silicon wafer. This mass production keeps the device portion of the inertial sensor's total cost minimal.

[1]Abachi, Raida. 1996. An overview of automotive sensors. *Sensors*. April, 82–85.