DEPARTMENTS

technology focus

This section was prepared by staff members from *Mechanical Engineering* magazine.

Instrumentation and Control

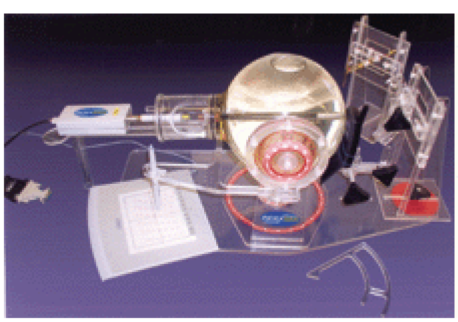
Technology Focus part 1

Talking Your Ear Off

by Jack Raplee

The proliferation of cellular phone use has raised public concerns about carcinogenic effects of electromagnetic radiation on human tissue, particularly the brain. Federal Communications Commission guidelines specify limits for human exposure to radio frequency emissions from handheld mobile phones in terms of a Specific Absorption Rate, or SAR, which is a measure of the rate of absorption of RF energy by the body. Compliance with this limit must be demonstrated before FCC approval is granted for marketing a cell phone in the United States.

IndeXsar of Newdigate, Surrey, U.K., manufactures a tool used to test new products from mobile device manufacturers for SAR compliance. The test device, called MapSAR, uses a calibrated SAR probe and range of simulating liquids to measure absorption into brain tissue from different mobile devices. The device uses a two-dimensional mapping technique supplemented by three-dimensional calculations to give volume-averaged results. It is claimed to be less costly than other measuring systems that use 3-D robotic systems.



MapSAR equipment is designed to measure how far radio frequency radiation from cellular phones absorbs into brain tissue.

IndeXsar used Micro-stripes electromagnetic analysis software, supplied by Flowmerics Inc. of Southborough, Mass., to calibrate its MapSAR product. The Micro-stripes model was used to test the device with a balanced dipole source transmitter to aid in the calibration. It was monitored at three communications frequencies: 900 MHz, 1,800 MHz, and 2,450 MHz. The testing had three objectives: characterizing the electrical field determination within MapSAR, investigating the effects on different head tissue substitute materials, and verifying the method that IndeXsar used for calibrating MapSAR.

The two companies said they were able to hone the model to give it consistently accurate results. These results showed that the 2-D base data could be extrapolated consistently and accurately to give 3-D penetration within MapSAR, and that radiation penetrated further into brain tissue at lower frequencies, according to Flowmerics. Overall, all three head tissue substitutes displayed a similar centerline decay profile.

Mike Manning, director of IndeXsar, said that the Micro-stripes analysis and theoretical validation of the MapSAR system have helped the company to back up its 3-D calculations in research.

Affordable Stress Test

by Paul Sharke

Smart parts that report their condition under stress are expensive. Sensortex Inc. of Kennett Square, Pa., claims that it has invented a cheaper way of detecting strain by depositing a magnetic film around a thin copper wire, and says its invention could lead to many opportunities to measure strain data from parts in service inexpensively.

The company said that its new Magstrain sensor promises a low-cost, noncontacting method of measuring shaft torque, which today is done with more expensive strain gauges or optical sensors. Sensortex said its sensors also can be embedded in structures and composites, where they could provide real-time, continuous monitoring data. In composites, for example, they could provide better cure control of the material during processing.

The sensors have magnetoelastic properties, which change their magnetic properties under stress, according to William Biter, president of Sensortex.

To make the sensors, Sensortex layers rings of magnetoelastic material around thin copper wires. In use, the wires carry low alternating current of 200 to 500 mA. Enough current is used to drive the magnetic rings into saturation, Biter explained. As the current reverses direction, the hysteresis loss at specific frequencies changes significantly under strain. The inductance of the wire changes, too, but much less measurably.

Sensortex developed the Magstrain sensor as an outgrowth of a project funded by the Ballistic Missile Defense Organization, now renamed the Missile Defense Agency. The company hopes to interest automakers that might have use for low-cost, high-sensitivity torque measurements. Other potential users include aeroframe and aerospace engine manufacturers, Sensortex said.

Negoti- ating the Strat- osphere

by Harry Hutchinson

An engineering company has developed a system that may offer some control over NASA's high-altitude weather balloons.

The control device, called StratoSail, consists of a spar from which an 8-foot rudder and an 18-foot wing hang. The developer, Global Aerospace Corp. of Altadena, Calif., has tested a miniature version from a tethered blimp. The company's president, Kerry Nock, said a full-size version has been built and may get a test sometime next year.

Balloons tend to ride with the wind, wherever it goes and about as fast as it goes. Sometimes that's away from the area of greatest interest. Sometimes it's over hostile territory.

A prototype of the StratoSail, from Global Aerospace, may get its first full-scale test next year.

The control plan works like this: A balloon operating at an altitude of 35 km would trail the StratoSail on a long tether—a full 15 km, or just over 9 miles. The difference in wind speed at the two altitudes, 35 and 20 km, will be considerable and will allow the StratoSail's wing to influence the balloon's flight. The rudder, controllable through computers on the ground, could direct the wing to tack across the wind.

The StratoSail also contains a battery of sensors, to inform controllers of azimuth, angle of attack, wind speeds, weather conditions, and so forth. An accelerometer keeps track of forces on the tether.

Cortland Cable Co. of Cortland, N.Y., makes the 15-km tether for Global Aerospace. Doug Bentley, design engineer, said the line is a multifilament braid with a diameter of about 1 mm. It is made of a material called Zylon, from Toyobo Co. Ltd. of Osaka Japan. The material has a density of 1.55 grams per cubic centimeter and a tensile strength of 5.8 gigapascals, or 840,000 pounds per square inch.

The entire 15-km braid weighs 26 pounds, or approximately a dozen kilograms. The StratoSail prototype that will hang from the line weighs 125 pounds, or just under 60 kg.

Streamlined Paper-making

by John DeGaspari

Last year, Paul Ridgway, a scientist at Lawrence Berkeley National Laboratory, and engineers at the Institute of Paper Science and Technology installed an ultrasonic laser sensor on a pilot paper-coating machine in a Mead Paper Co. mill in Ohio. The sensor, being developed as part of a U.S. Department of Energy program, is designed to measure the paper's flexibility as it courses through a production web at speeds of up to 3,900 feet per minute. It is intended to save the papermaking industry millions of dollars in energy costs.

Ridgway said the noncontact, nondestructive monitor measures the elastic properties of paper at manufacturing speeds. Elastic properties are important because they determine how paper runs through copiers, fax machines, and printing presses. The test was a step toward a mill trial on a papermaking machine, a much harsher environment.

Currently, paper is evaluated by taking a small sample from a roll and analyzing it manually. On thicker stock, an ultrasound head can be placed directly on the paper as it moves through the web to measure the paper's tensile elasticity in real time. In either case, if the sample does

not meet specifications,
it is scrapped or sold as inferior grade. To avoid this, manufacturers often over-engineer paper, using more pulp than is necessary, and in doing so, increase the energy load to turn out the paper. The researchers hope that their sensor will measure flexibility on the fly in real time. It would also conduct measurements without touching the paper, eliminating the chance of marring the surface.

The sensor works by measuring the time it takes ultrasonic shockwaves to propagate from a laser-induced excitation point to a detection point millimeters away. The time to travel from the ablation point through the paper to the detection point is theoretically related to two elastic properties, bending stiffness and out-of-plane rigidity.

The sensor takes samples 10 times per second, but this could be increased to at least 1,000 and possibly 5,000 times per second, Ridgeway said.
