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**IN THE LAB**

## This Professor Has a Little Boy's Dream Job — Dropping Costly Equipment to See If It Bounces

By JOHN J. KELLER
*Staff Reporter of* THE WALL STREET JOURNAL

MURRAY HILL, N.J. — Suresh Goyal seems like a clumsy guy. Dozens of times a day, he drops expensive gadgets to the floor—and gets paid for it.

Dr. Goyal, a mechanical engineer at AT&T Bell Laboratories, searches for just the right combination of sturdy design and high-impact material that will protect future AT&T portable computers and other mobile gizmos of tomorrow.

His work at **American Telephone & Telegraph** Co.'s giant research arm is sort of the flip-side of the 1960s Disney flick, "Flubber." Unlike that goofy professor, who invented super-bouncy rubber, Dr. Goyal is looking for rubber that *won't* bounce.

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**Suresh Goyal**

The right mix — a "dead rubber" that will absorb all the impact of a blow rather than let the force rattle the product's innards—will let AT&T make ever-smaller, ever-tougher gear. Dr. Goyal is trying to figure out whether the right mix even exists, or whether Bell Labs will have to invent it.

Wielding special balls of dead rubber and a high-powered computer, Dr. Goyal spends his days chucking, banging and bumping expensive wares in his lab and taking computer readings on the blows, with software of his own design. In the future, AT&T can use the software to create the housings of its portable gear.

As computers get more mobile and their users become obsessed with mobility, durability is becoming a crucial feature. Pocket computers and flip-open phones will house electronic components that will let roving pedestrians exchange electronic scribbles and phone calls and, perhaps, even place a lottery wager or two.

In Dr. Goyal's lab, these multimedia doohickeys have to take a real lickin' to keep on tickin'. These products "will have to be extremely rugged," the researcher says. "If they're not and kids carry them. . ." He wiggles his eyebrows and laughs. "Watch out."

Dr. Goyal, a 33-year-old scientist with a Ph.D. from Cornell who joined Bell Labs four years ago, works with visco-elastic polymers (some of which are dead rubber), as well as with new gunk that isn't even for sale yet.

On a recent day, he displays two black rubber balls about an inch in diameter. One would delight a child. It takes a lively bounce as Dr. Goyal drops it on the floor; he has to crawl after it before it disappears under a desk.

Normal rubber has a natural tendency to bounce because it returns to its original shape after denting on impact. Dr. Goyal speaks of its "deformation phase" and "restitution phase." "It's completely elastic and gives the energy back," he says.

The dead rubber ball has no bounce. It hits the floor like a plummeting cat on its ninth life. The ball has high "hysteresis": after impact it loses all energy.

First discovered in the late 1960s, dead rubber has a vastly different molecular structure from, say, the pink "Spaldenes" on New York City stickball courts. Regular rubber contains monomers (groupings) of carbon and hydrogen atoms linked in

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## A Little Boy's Dream: Dropping Machinery To See If It Bounces

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molecular chains. The ball bounces because the chains are so tightly knit.

In dead rubber, the molecular chains are loose and constantly slip against one another, coiling and uncoiling. This "relaxation" allows dead rubber to soak up and dissipate the impact from a blow. The friction from the chains' movement also causes heat. That is why dead rubber can lose its anti-bounce properties when cooled.

Dr. Goyal demonstrates this phenomenon. He drops a steel ball on a dead rubber pad cooled in an ice bucket. It bounces surprisingly high. "We need to find a material that absorbs a lot of impact, but which will work as well in Phoenix as it does in a Minneapolis winter," he says.

High-speed video cameras, snapping images at 12,000 frames a second instead of the usual 30 frames, tape each downward plunge. Each machine is wired with electronic sensors, and Dr. Goyal's computer records every shock, letting him know just how far he can go before the rubber-encased prototypes he's beating on finally give up their ghosts.

The impact itself is simulated and plotted on a Silicon Graphics workstation loaded with Dr. Goyal's special software, which tracks the force and deformation on the object as it hits the floor. Dr. Goyal is designing software that will eventually let him simulate all of this in three dimensions without having to destroy actual products. He can then make calculations on the stress that internal components absorb when an object is dropped.

On this day, the victim is a prototype of a new pen-based computer that AT&T's NCR Corp. won't introduce until sometime next year. He drops the gadget, which is coated in dead rubber, from five feet, picks it up and drops it again, betraying no signs of pleasure at being allowed to break something so obviously delicate and costly.

Turning to his computer, he sees an animated, three-dimensional picture on his screen showing the tiny computer as it hits the hard floor. He carefully notes the different angles of impact. In the right-hand corner of his screen, numbers run rapidly as the computer records the "contact forces."

The more an object bounces upon impact, the more likely it is to be damaged—not solely because of the first blow, but also because of the second one. Dr. Goyal runs an animated picture of a pencil dropping: The entire pencil falls at the same velocity, but when one end hits first, the follow-up blow on the other end can occur at up to twice the speed. That's because the end that hits first bounces back at the same velocity, thereby doubling the speed of the opposite end.

When a product is dropped, the faster its casing absorbs the blow and does away with it, the better off the components inside are. "Some materials will dissipate energy in a few milliseconds" — which is good — "while others take much longer," Dr. Goyal explains.

Lately, however, he has been wondering whether the ultimate answer may lie in the shape, as well as the makeup, of a product. Today's cellular phones, for example, are all sharp corners and flat surfaces — bad geometry for avoiding the impact of a nasty fall. They would stand a better chance of survival if they were rounded or oval, Dr. Goyal says.

Hence, the pocket communicator of tomorrow may feel like dead rubber — and look something like an elongated egg.

**Behind-The-Scenes**

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