CC/NUMBER 4
JANUARY 24, 1983

This Week's Citation Classic

Gloge D & Marcatili E A J. Multimode theory of graded-core fibers.
Bell Syst. Tech. J. 52:1563-78, 1973.
[Bell Laboratories, Holmdel, NJ]

When light transmission over miles of low-loss glass fiber became possible, the dispersion (breakup) of information pulses during propagation turned out to be a problem. This paper offered a simple, comprehensive theory that related this breakup to fiber structure and pointed the way toward control of the phenomenon. [The *SCI*® indicates that this paper has been cited in over 295 publications since 1973.]

D.C. Gloge
Bell Laboratories
Holmdel, NJ 07733

November 17, 1982

"This paper was the result of a meeting that I remember for two reasons. It was the first time that I found myself face-to-face with three levels of my line of management (I have since gotten used to this experience), and it was my first involvement in a far-reaching and important technology decision.

"I was a young member of a Bell Laboratories team at Crawford Hill, New Jersey, doing research on optical communications systems. The team had made rapid progress with a promising new kind of glass fiber, and the Bell System, as other telephone administrations, was contemplating commercial applications of these fibers in metropolitan networks. What was holding up full-scale development was a tenacious problem that seemed to occur in all the new fibers: short light pulses which contained the encoded information tended to break up during long-distance propagation.

"However, I had recently tested a new variety of fiber (we later termed it 'graded core') and found the breakup curiously absent. Since one of my bosses had an explanation for this absence,[1] I went into our meeting with confidence in my results.

"This confidence quickly faded under a barrage of questions concerning the validity of my measurements, the logic of the underlying concept, and the conclusions I drew from it. I slowly understood that a lot more than a singular measurement was needed to prepare this multimillion-dollar decision.

"When the meeting was over, Henry Marcatili, my friend and immediate supervisor, and I stayed around to chart the course. We needed a think tool that would rapidly build confidence in the technology by advancing a broad technical understanding and by providing cross-checks with measurements. We knew a computer analysis would be time-consuming and tedious. But others had tried it before[2] and we had little else to get started. Then, by a stroke of luck, some curious regularity in the computer results attracted our interest. These led to some daring conjectures that eventually resulted in a description in which everything fell into place. It was like finding the symmetry of a complex molecule. Once the structure became obvious, ideas of how to control, improve, or test the phenomenon appeared almost by themselves.

"We wrote the paper and published it as fast as we could. In the meantime, mounting evidence from a variety of measurements proved us right. Others later improved on the theory by incorporating certain materials characteristics.[3] Because of its simplicity and clarity, the theory has become a significant part of the optical fiber art and the engineering guidelines for optical communication systems.[4] Full-scale development of these systems began at the time our publication appeared and many of these systems are now in service in the US."

1. **Miller S E.** Light propagation in generalized lens-like media. *Bell Syst. Tech. J.* 44:2017-64, 1965.
2. **Streifer W & Kurtz C N.** Scalar analysis of radially inhomogeneous guiding media. *J. Opt. Soc. Amer.* 57:779-86, 1967.
3. **Olshansky R & Keck D B.** Pulse broadening in graded-index optical fibers. *Appl. Opt.* 15:483-91, 1976.
4. **Gloge D.** The optical fibre as a transmission medium. *Rep. Progr. Phys.* 42:1777-824, 1979.