FIBER OPTICS MYTHOLOGY

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Signal transmission on a tiny glass thread is a technological development with vast implications for telecommunications. Fiber optics could even have as revolutionary an impact on the future of our society as solid state technology itself.

But if the cable television industry is to realize the very real promise of fiber optics technology in its special corner of the telecommunications universe, it must carefully distinguish between fact and fancy. The real facts are great enough; but opportunity could pass us by if we waste our time and capital on the dreams.

Five myths about fiber optics keep recurring, in the trade press as well as in magazines and newspapers of general circulation. The critical question for evaluating these claims of the superiority of fiber optics is:

"compared to what?"

MYTH NUMBER ONE.
Optical fiber has enormous, almost unlimited bandwidth.

Certainly, compared to a 4 kHz pair of telephone wires, an optical fiber does have "enormous bandwidth". But, optical fiber technology is presently limited to 4 or 5 TV channels because of dispersion in the glass, and non-linearity in the optical devices. FM is better than AM, but requires several times as much bandwidth per channel. Digital, PCM is almost impervious to dispersion and non-linearity, but requires very great bandwidth per channel.

So, compared to coaxial cables, capable of carrying up to 55 or 60 TV channels, the "enormous bandwidth" of fiber optics systems simply is not now a fact. Undoubtedly this will change, just as the channel capacity of coaxial cables increased dramatically from 27 up to 55 or 60; but it will be a long, long time before a single fiber can match the channel capacity of a single coaxial cable.

MYTH NUMBER TWO.
Low loss in optical fibers means very few amplifiers.

Optical fibers are routinely available today with certifiable losses of 0.18 dB per 100 feet (actually 6 dB per kilometer). This is equivalent to the loss in a 3-inch diameter coaxial cable at 400 MHz. With such low loss, repeaters with 20 dB gain could, in fact, be spaced 2 miles apart.

Unfortunately, since the fibers can only carry 5 TV channels, it would take 11 or 12 fibers to match the 55 or 60 channel capacity of coaxial systems. Each fiber would require its own photodetector, repeater, and laser or LED light source. Every 2 miles, then, there will be 11 or 12 repeaters; that is, an average of one repeater for every 880 to 960 strand feet. The old 412 cable would do better than that.

Of course, it is much easier to maintain 11 or 12 repeaters at one location than 8 or 10 repeaters at 8 or 10 locations. Moreover, the wide repeater spacing means shorter cascades. This is quite important because of the non-linearity of the light sources which must also be cascaded.

MYTH NUMBER THREE.
Optical fiber is cheap, and will greatly reduce the cost of systems.

Next to water, sand is probably one of the most plentiful and easily obtained materials on the face of the earth. However, only particular types and grades of silica sand are suitable for making optical fibers; and other, more expensive chemicals must be added to the silica to achieve the necessary refraction index. Moreover, fabrication of the hairlike fibers, with precise physical dimensions and optical characteristics is a sophisticated process that would not even be possible without elaborate computer control.

Thus, although sand is cheap, fiber fabrication isn't.

Because of limited channel capacity, 11 or 12 fibers are required to carry 55 or 60 channels. If one fiber costs 10 cents a foot, the bundle must cost more than $1 a foot, two and a half times as much as 3/4-inch coaxial cable. The fiber system requires more, not fewer, repeaters, than the coaxial system, and each repeater requires a photodetector and light source not necessary with coaxial cable.

Finally, because of the non-linearity, most fiber optics TV projects have been based on FM, baseband or PCM techniques. Each of these requires a single channel modulator and demodulator for each of the 55 or 60 channels, at a cost of $3,000 to $5,000 per channel. Such systems do perform much better than VSB/AM coaxial systems. But until VSB/AM becomes feasible for fiber optic systems, they will remain much more expensive, though better, than AM coaxial systems.

In fact, development may already have reached the stage where 4 or 5 VSB/AM channels can be carried as successfully on long fibers as on coaxial cable.

MYTH NUMBER FOUR.
Optical fibers are so small and light they can easily be installed anywhere.

Each optical fiber is, of course, very small and light in weight. However, each fiber must be loosely encased in its own protective plastic sheath, and for comparable channel capacity, 11 or 12 of these sheaths must be cabled together, with an overall outer jacket. In addition, special strength members must be included to relieve the tiny fibers of the mechanical stress of installation and other hazards. The resulting fiber cable may be only slightly smaller and lighter in weight than the customary coaxial trunk and feeder cables.

Even the inherently small size and weight of optical fibers are almost entirely offset by the practical requirements.

MYTH NUMBER FIVE.
Glass is a non-conductor, so fiber optics does not have to comply with electrical codes.

Glass is a non-conductor of electricity. It will not transmit lightning or power line surges. It does not present a shock hazard; and it cannot be short-circuited.

But the steel strength members required to protect the fibers are conductors, and present all of these hazards. Unless glass or plastic strength members are used instead of steel, and the optical fiber cable is installed on plastic messenger strand instead of galvanized steel, the non-conducting feature is of little value.

Most of the limitations of fiber optics today derive from the present limitations of the optical systems. Optical dispersion, which shrinks the bandwidth as the length of the fiber increases, has already been improved. Maybe it will get even better. The non-linearity of the light sources (not to mention their short life) is probably also subject to improvement.

These developments will be slow, however, unless a crash program is demanded by circumstances such as precipitated the recent 400 MHz development.

For the present, it appears quite safe to recognize that optical fiber is not a practical substitute for coaxial cable in the conventional tree-type distribution systems being built today.

However, fiber optics does have some valuable applications in today's cable television industry. A few channels transmitted over short enough distances that repeaters are not required, can provide higher technical quality and reliability than would be possible with coaxial cable, and at realistic cost. This is particularly useful for the critical TVRO and local off-air signals. FMTV provides exceptionally high transmission quality for hub interconnections, where the high cost can be widely shared. Fiber optics can be used in this application without unduly increasing the cost, and with the advantage of having fewer locations requiring maintenance of active devices.

These are only the sideshows, however. The main event really lies ahead when cable TV systems change from tree-type distribution to star-type, the "switched system" as it was called a dozen years ago. Instead of concentrations of only 4 or 8 or 16 or even 24 off-premises converters, each switching or processing center will serve 300 or 400 or maybe even 1,000 subscribers with fiber service drops, carrying one TV channel to each subscriber, perhaps as much as 2,000 feet or more away.

The small size of a bundle of 200 fibers, compared with the size of 200 RG-59 coaxial drop cables, makes this feasible. With only one channel, bandwidth and intermodulation are well within the capability even of the low-performance grades of fiber.

The set-top converter will be banished, forever. Scrambling will no longer be necessary. Three-fourths of the system will be passive--no power, no amplifiers, no splices, no leaky connectors. Perhaps even the teletext decoding, storage, and character generating facilities could be located in the switching or processing centers instead of expensive individual home terminals.

It is not ready yet; and probably a rather long evolutionary period will be needed to adapt present business practices, marketing methods, and personnel training to the new concepts, as well as to optimize the hardware configurations, installation techniques, and operational practices.

The advantages in maintenance costs, unlimited channel capacity, management flexibility, superior technical performance and reliability, especially in two-way systems are so great that it is bound to happen; but that is another story for another panel. In any case, it is only possible because of fiber optics.

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