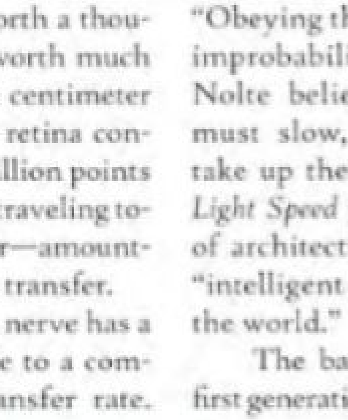
BOOK REVIEW

Photonic computing takes a quantum leap.

By Mark Williams

IS ONE PICTURE worth a thousand words? No, it's worth much more. A single square centimeter of image hitting your retina consists of more than a million points of light, all emitted together, traveling together, and arriving together—amounting to a massive parallel data transfer.

Accordingly, your optic nerve has a parallel data rate comparable to a computer hard drive's data transfer rate. Alas, David Nolte tells us in *Mind at Light Speed: a New Kind of Intelligence*, having as much as 7 Mbps of information flowing through our optic nerves is an advantage mostly lost on human beings. Our brains' neurons have inherent speed limits; human consciousness seems to be the final product of a process that filters data down to the minimum of what's "meaningful."



But our machines needn't have these limitations. Machines exploiting the light-speed parallelism of computation using photons—the quantum units of light energy—would obviously provide big gains over our own soggy grey matter. That's much better than laboriously shunting electrons around the silicon avenues of the tiny city-like structures that are our present-day microprocessors.

It's imperative that such an advance occur. Mr. Nolte, a physics professor at Indiana's Purdue University, points out that if Moore's law is projected to 2020, transistors in microprocessors would need to be so miniaturized that they would operate on only a single electron (see "The Light Brigade," page 40, and "Obeying the Law," page 46). Given the improbability of that scenario, Mr. Nolte believes, silicon's momentum must slow, and photonic computing take up the slack. Ultimately, *Mind at Light Speed* proposes, three generations of architectures of light will create an "intelligent optical fabric that will drape the world."

The basic elements of Mr. Nolte's first generation of optoelectronic machines already exist. Fiber optics, the only technology currently able to satisfy our demand for ever-greater Internet bandwidth, requires electronic systems to reamplify photonic signals that attenuate over hundreds of miles of cable. Such systems, translating optics to electronics and back to optics, autonomously route data and increasingly have intelligence built in.

Nevertheless, these optoelectronic systems impose speed limits. For one thing, electrons within silicon can be accelerated to just 0.03 percent of the speed of light. More significantly, electronics suffer badly in the comparison with the enormous parallelism inherent in light, since photons effectively provide an independent data-carrying variable with each photonic frequency or color. Thus, if we divided our visible spectrum alone into AM radio–wide bands, more than 35 billion separate channels would reside there. And each color could theoretically carry more than 200 terabits per second of information—a bus width of 35 billion bits, instead of the picayune 64 or 128 bits of current computers.

MIND AT LIGHT SPEED: A NEW KIND OF INTELLIGENCE
By David D. Nolte
256 pages, The Free Press, $26

So, as Mr. Nolte says, the next goal has to be an all-optical Internet without the bottlenecks that optoelectronic systems impose. In Mr. Nolte's second generation of photonic computer, light itself controls light: laser beams modulate other laser beams. Again, though the technical challenges are formidable, pure optical amplifiers have already replaced some optoelectronic systems. Given that, holography can replace silicon transistors.

Thereupon, other advantages will result. For one, unlike our current hardware, computers made of light could be rebuilt nanosecond by nanosecond into whatever is best suited to carry out each stage in a computation. For another, all those photons modulating each other are acting on the quantum level. Thus, Mr. Nolte foresees a third generation of photonic computer arriving in the second half of the 21st century: photonic computation looks to be the likeliest route for achieving quantum computing.

Mind at Light Speed explains it all as comprehensibly as you'll find anywhere, synthesizing explanations of converging fields, like holography, optical communications technology, and computational theory. Mr. Nolte's book is a good guide to a future in which the silicon microprocessor will likely go the way of the vacuum tube. It's a future that's practically upon us.■

Contributing editor Mark Williams *lives in Oakland, California. Write to letters@redherring.com.*