Introduction

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In 1980, just 20 years after the first laser was demonstrated and about 10 years after the way to make low loss optical fibers was discovered, two miracles took place: one that lots of people noticed and that some recall and another that few noticed and that changed the course of human history. At the Winter Olympics at Lake Placid, New York, the Miracle on Ice in which the U.S.A. men's hockey team beat the much vaunted Soviet Union team was seen by tens of millions on television—lots of people noticed. However, the television broadcast of the Olympic Games, including the hockey match, was transmitted over an optical communications system using diode lasers and fiber optics. Virtually no one noticed this miracle at the time, but many billions would be affected by the technology. Optics changed the world and communications would never be the same. This section presents the pivotal events and technologies leading to optical fiber communications becoming practical.

Perhaps a few people in the mid-1970s could have foreseen that ultra-low-loss optical fibers and diode lasers would enable optics to take over the world as the dominant means of communications. Optics did just that. Not only are billions of kilometers of fiber optics communication cables in use with diode lasers as the light sources but progress continues as the demand for more and more information-carrying capacity continues to grow. New techniques for multiplexing are still being developed to enable higher throughput.

The invention of the laser and the demonstration of nonlinear optics spurred a greatly renewed interest in optics. In the period 1975–1990 that interest blossomed into many major applications and scientific breakthroughs. Nonlinear optics benefited from demonstration of excellent new materials for use in both the visible and the infrared. Periodically poled nonlinear material had been described as early as 1962 but was finally demonstrated in this period. It turned out that the periodically poled material was often a more efficient harmonic generator than its single-crystal index-matched version. These materials and greatly improved engineering made optical parametric oscillators and amplifiers available for applications requiring wavelength tunable sources. Nonlinear optics also made possible achieving ultrashort pulses, 6 picosec in this period (today 67 attosec) and supercontinuum pulses with spectral content exceeding an octave in frequency.

The list of applications of optics that developed in this period is too long to list in its entirety here. However, a few are worth mentioning because they are so common that the outstanding optics and optical design that makes them possible can be easily overlooked. They are the bar code scanner, the CD/DVD player, the laser printer, the laser pointer, the laser cut, the drilled or welded part of a finished product, the laser-marked product, the variable-focus spectacle lens, self-darkening spectacle lenses, soft contact lenses, the optical mouse, and the remote control for an appliance, as well as the display screens of televisions, computers, and mobile phones.

Between 1975 and 1990 developments of new lasers and their applications spurred demonstration of new medical innovations. The LASIK technique for vision correction based on the use of an excimer laser was developed and has now been used on ~30,000,000 patients. Optics and fiber optics have made detecting pathologies in patients more reliable and less invasive. Laparoscopic surgeries are performed today with minimal cuts because fiber optic endoscopes or miniaturized cameras can be inserted to give the surgeon vision of the problem that must be dealt with. Photodynamic therapy in which a laser is used to excite a dye that

preferentially locates in tumorous tissues is another area in which optics and medical treatment have come together.

During this period spectacular progress was made in optical astronomy. The Hubble Space Telescope was launched and, after its optics were repaired, it performed spectacularly. It provided data on the content of the universe such as the number of galaxies and the presence of dark matter surrounding galaxies. Ground-based telescopes were designed and built that took advantage of adaptive optics to build large-aperture, segmented-mirror instruments that can minimize atmospheric distortions and provide superb images. These telescopes could be much larger than space telescopes and could gather more light from distant objects. Using image processing techniques and modern computers, it is now possible to link optical telescopes to greatly enlarge their effective aperture.

Whenever the field of optics is mentioned to non-optics people in the field of optics, they immediately think of their eyeglasses or contact lenses. And why not? Almost everyone will use spectacles or contacts at some point in his or her life and if they live long enough will have an implanted lens as part of cataract surgery. Progress in these areas has been remarkable. Contact lenses were invented that allow air to pass through, enabling long periods of comfortable wearing. In addition, contact lenses can now provide astigmatic correction. Spectacle lenses with continuously variable strength eliminated the need for bifocal lenses with a sharp delineation between near and distance viewing sections. Then photochromic lens materials became available enabling the wearer to no longer need different spectacles indoors and outdoors; the lenses would lighten and darken according to the ambient light environment.

By 1990 optics included light sources from continuously operating very stable lasers to lasers producing pulses as short as a few picoseconds (now a few tens of attoseconds). Optics included components small enough to be swallowed to 30-meter-diameter segmented telescope mirrors. Displays were getting so small as to be worn in a head-mounted device or so large as to be seen by 100,000 people in a stadium. Most interesting and important was that applications of optics beyond those that aid vision had become part of everyday life and so ubiquitous that most went unnoticed.