Introduction: Early Technology

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This section of our centennial history of optics addresses two tasks: setting the stage by describing the situation at the beginning of our highlighted period, and then summarizing the changes that occurred. The beginning and end of our period are both quite special years in political and economic history. The United States was just entering the Great War, as World War I was called in 1916; and in 1940 it was on the inevitable path leading to its entry into World War II. It is not an exaggeration to say that the course of civilization was dramatically altered by each of these events, and the course of optical research and technology was no less altered.

In a very real sense modern instrumental optics began in a series of developments in Germany led by Carl Zeiss, Ernst Abbe, and Otto Schott. In his essay Jeff Hecht reviews these and other earlier developments that formed the basis for the rapid developments in our field in the first half of the twentieth century. The dawn of the new century found Germany recently unified and growing quickly in industrial output, Great Britain at the peak of her imperial era, and the United States, fresh from its victory in the Spanish–American War, rapidly becoming the world's leading industrial power. Technical inventions such as a practical light bulb, the telegraph and telephone, phonograph, motion picture camera, and projector changed the way people lived. There was a great deal of optimism looking forward to the new century of continued progress. There were a series of world's fairs and exhibitions in which the latest inventions were touted. Perley G. Nutting, the prime mover in the founding of The Optical Society, apparently constructed the very first neon sign and exhibited it at the Louisiana Purchase Exhibition in 1904, proudly proclaiming "NEON" in glowing light.

It was in this heady environment that optics entered the twentieth century. Optics was centrally involved in two scientific revolutions that shook confidence in the foundations of the old Newtonian science that had served the science and industry of the nineteenth century so well: Einstein's relativity and quantum mechanics. Patricia Daukantas reviews the advances in spectroscopy up to 1940 and their importance to the development of quantum theory and astronomy. Today it is difficult to imagine carrying out precision spectroscopic measurements without a laser, a computer, or a photomultiplier or photodiode. Photographic plates had to suffice, unless you used Albert Michelson's technique of calibrating dark-adapted students. That proved adequate for him to resolve the 1.7 GHz ground state hyperfine splitting of sodium by measuring the drop-off of the visibility of the fringes in his interferometer illuminated by fluorescence from sodium. By 1940 the new quantum theory was in place, and Paul Dirac and Erwin Schrödinger had developed a quantum version of electrodynamics. The basic ideas underlying modern quantum optics were in place awaiting the development of optical technology that would allow controlled experiments one atom and one photon at a time. As we will see in later chapters in this volume, these technological developments followed in the second half of the twentieth century following the development of the laser.

Prior to the twentieth century, science and engineering were carried out mostly by university professors and amateur scientists working mostly alone with only their own funds or perhaps a rich patron's munificent interest. This changed completely in the new century, first by the establishment of a number of industrial and governmental research laboratories, and then by governmental science and engineering funding agencies following World War II. I review the founding of these laboratories and their central importance to twentieth century optics.

A very important optical industry has a history that almost exactly spans the first century of the existence of The Optical Society: film-based photography. Todd Gustavson recounts the history of photography, concentrating particularly on the first 40 years of the twentieth century. A lot of optical instrumentation is fairly specialized in its application, with but a few thousand to a few tens of thousands of units sold. With the introduction of George Eastman's Brownie camera in 1900, optics became "mass market" with sales of hundreds of thousands to millions. The economics of optics was completely changed, and with that technology changed equally rapidly.

A second mass-market development in optics was the production of affordable eyeglasses. Bausch and Lomb sold 20 million in 1903, and American Optical was not far behind. This supported rapid progress in vision research, which Patricia Daukantas reviews. From the founding of OSA to today this has remained a central concern of the Society and its members. As the average human lifespan increased due to improvements in sanitation, nutrition, and medical science, age-related vision problems became more important, and this field of optics responded with rapid developments.

The development of color photography and color printing as mass industries required standardization of color measurements and the development of a better understanding of color vision. Roy Berns recounts these developments with particular emphasis on the role of OSA and its committees.

This series of essays takes us up to the beginning of World War II, after which the climate for research and development in optics changed dramatically into something approximating its current form.