Since the discovery of the liquid crystal phase in 1888, research in this intermediate state of matter and its fascinating optical phenomena has experienced several periods of intense interest. However, there was no large-scale application of liquid crystal technology until the 1970s, when the advent of microelectronic digital circuits during the 1960s created a need for low power, compact display devices for certain portable electronic products. Thus, the announcement in 1968 of the dynamic scattering liquid crystal display (LCD) triggered a great interest in the electronics industry and dramatically increased research activity on liquid crystal materials and their electro-optic effects. Within a few years these efforts led to the invention of the twisted nematic LCD and the discovery of several classes of stable liquid crystal compounds. These developments significantly improved the performance of the LCD such that by the mid 1970s the twisted nematic device became the dominant display used in electronic watches and calculators.

Driven by the increasingly demanding needs of the electronics industry, the twisted nematic LCD technology has made tremendous progress in the past 10 years. Device complexity has grown from simple 3½-digit watch displays to 16 line by 80 character displays for portable computers. The number of pixels in a single panel has increased from less than 25 to 160,000 in 25 line by 80 character displays to be introduced later this year. Multicolored LCDs have been demonstrated and produced. The desire to build pocket-size televisions has substantially expanded activity in the development of assisting arrays of thin film transistors, MOS transistors, and nonlinear resistors for LCD addressing. In the meantime, the search for new electro-optic effects and the refinement of display devices other than twisted nematic LCDs have continued. These efforts, in my opinion, will lead us in the next 10 years to flat panel LCDs that can match the performance and cost of cathode ray tubes.

This special issue of Optical Engineering on liquid crystal applications contains papers that describe some of these recent advancements in LCD technology. The opening paper, by Dewey, reviews the development of using a laser to write on a liquid crystal panel and project the image onto a large screen. The extremely high resolution demonstrated (8000×8000 pixels) challenges the best of any known electronic display technology. The recent development of small, flat panel LCDs with about 50,000 pixels makes it possible to build pocket-size television receivers. In the second paper Morozumi et al. describe various matrix addressing and assisting array technologies needed to fabricate these displays. From this modest start one can expect in the next few years to have larger size, high performance LCDs for flat panel televisions and portable personal computers. In the third paper Uchida presents several color generation schemes currently being developed for LCDs. Color LCDs will first appear in the pocket-size televisions and later expand into portable computers and large screen projection displays. A flat panel LCD with resolution comparable to that of a cathode ray tube can be built today by utilizing electro-optic effects that possess inherent memory. The fourth paper, by Hochbaum, describes a device that uses thermal switching of smectic A liquid crystal to obtain resolution and viewing quality superior to those available from twisted nematic devices. In the last paper, by Amaya et al., the dynamics of the switching in ferroelectric liquid crystal are analyzed numerically. This electro-optic effect, with its intrinsic memory and fast switching speed (measured in microseconds), may provide the possibility of building high performance LCDs without using assisting arrays.

It is my regret that some other applications and potential applications of liquid crystals, particularly outside the display field, are not represented in this special issue. These include, for example, optical switches for fiber communication, optical data processing with liquid crystal light valves, nonlinear effects in liquid crystals, and fast switching in nematic liquid crystals. Most of these fields are in the very early stages of development and provide a great deal of new territory to be explored.