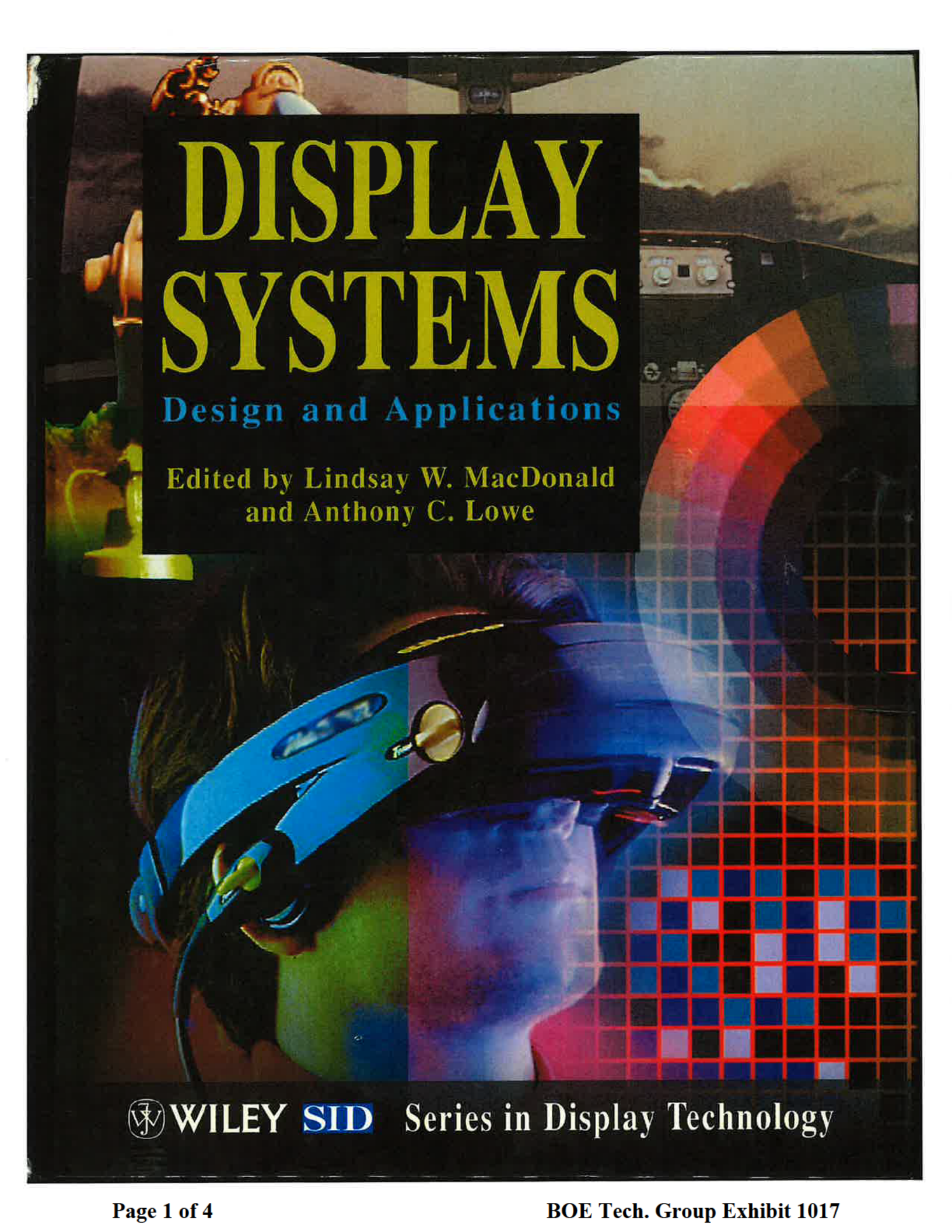




DISPLAY SYSTEMS

Design and Applications

Edited by Lindsay W. MacDonald
and Anthony C. Lowe



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Head-mounted displays for VR applications should not be considered as direct viewing devices, because optics of one design or another are necessary to enable infinity viewing. The highest levels of resolution are nevertheless demanded, as the display forms the entire field of visual information for the user. The closest market comparison to the VR display application is the growing projection display market sector (see Chapter 14). Here displays already in production are setting new standards of micro-miniaturisation. The small quartz substrate LCDs used for this market are approaching the complexity of the PAL HDTV specification (1920 colour pixels per line with 1125 lines, giving 2.16 million pixels). Sharp Corporation have demonstrated a prototype 1.31 million pixel LCD panel (Tannas, 1994).

Thus IVR displays are resolution intensive, and lens systems used with them are often of high magnifications in order to offer the wider Field of View (FOV). For example the Visette 2000 optics shown in Figures 4.13 and 4.14 were custom designed for the 1.3" diagonal LCD panel size and offer a FOV of 60° horizontal by 46.8° vertical with a magnification of almost 10.5. Now that LCDs can produce pixel densities approaching 1 million per square inch (Wei Wu, 1994), the associated pixellation problems are diminishing. Displays still face a formidable challenge in satisfying the human eye, which at its absolute peak performance can detect detail resolutions down to 10 seconds of arc. Human subjects can typically perceive a target as small as 1' 30" of arc for 50 percent of the viewing time (Rolfe & Staples, 1989).

4.5.3 Transmittance

Backlit LCDs have an energy, weight and cost penalty that designers currently have to accept. Optical transmission efficiencies of LCDs have in the past been very low, down to around 4 percent, although the latest generation are now closer to 6 percent. With two polarisers needed and the traditionally low aperture ratio of the light valve system, high levels of source luminance have therefore been required from backlight components, contributing to significant heat buildup in the HMD.

The efficiency of the backlight needs to be high, because the LCD system has two limiters on efficient light utilisation, namely transmittance and aperture ratio. Transmittance is defined as the percentage of light that is actually emitted from the viewing side of the display relative to the light incident on the back side of the display from the backlight system.

The aperture of the LCD is the actual area designed to allow light passage and therefore the effective image forming part of the display. The aperture ratio is the area of the aperture relative to the area of the complete light valve, including the opaque masks and tracks carrying control signals to the operating transistors. Micro-miniaturisation of tracks and transistor technology is allowing considerable improvements to be achieved in aperture ratios, with the latest products offering around 60 percent compared with 25–40 percent on previous generations (Wei Wu, 1994).

For cold cathode fluorescent backlights, the inverter is also prone to emit its own electromagnetic radiation and shielding is needed to maintain compliance with EMC regulations. The lifetime of the backlight, typically only 10 000 hours, often dictates the usable lifetime of the HMD system.

The HMD designer's goal for the future will be that, ideally, backlighting will be eliminated for FPDs, because low transmittances limit efficiency and complicate the design