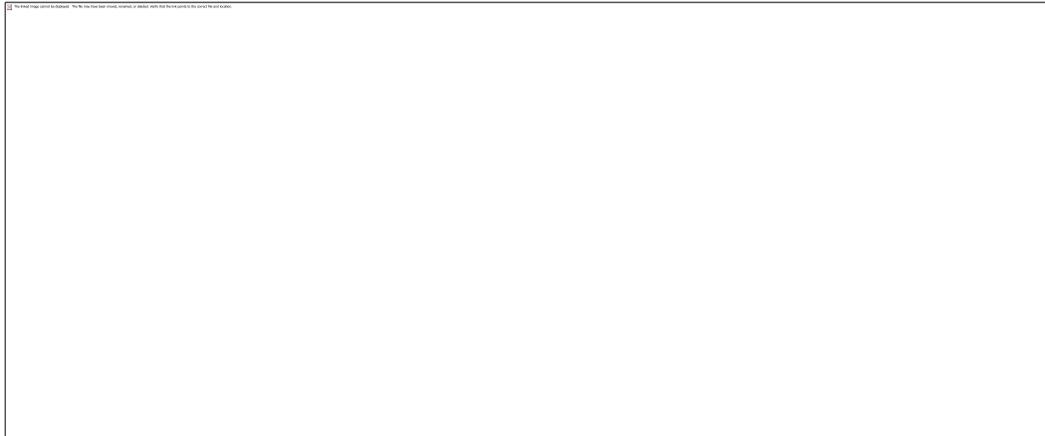

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[JTEC](#) Panel on

DISPLAY TECHNOLOGIES IN JAPAN

[Lawrence E. Tannas, Jr.](#), Co-chair

[William E. Glenn](#), Co-chair

[Thomas Credelle](#)

[J. William Doane](#)

[Arthur H. Firester](#)

[Malcolm Thompson](#)

June 1992

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EXECUTIVE SUMMARY

BACKGROUND

The Japanese have recognized that as we enter the "information age," both the computer industry and the television industry will need new display technology. The introduction of the laptop computer has created a need for a thin panel display with good readability and low power

consumption. Television is entering a new era of high definition television (HDTV) or Hi-Vision, which the Japanese expect to be the first revolution in television since the introduction of color. The display is the major cost in HDTV sets, which require very large screens for the improved resolution to be appreciated. The new generation of computer workstations requires the same high-resolution performance as HDTV. Some Japanese companies are in both the television and computer businesses. They view the consumer television business as the high-volume market that will drive the cost of displays down, providing the critical display component for the new generation of computers that will make them competitive in the computer market.

The Japanese have recognized that new display technologies are critical to making their electronic products highly competitive in the world market. The cathode-ray tube (CRT) is rapidly losing market share to the solid-state flat-panel display (FPD). The Japanese estimate that by the year 2000, the sales volume of CRTs and liquid-crystal FPDs will be shared 50/50. The passive matrix liquid crystal display (LCD), the electroluminescent display panel, the plasma panel, and now the active matrix LCD are being introduced for computer and television displays.

During the 1980s, the Japanese electronics industry achieved worldwide preeminence in FPDs and, in particular, LCDs. This preeminence is due to their technical achievements and broad industry base in research, development, and manufacturing. This has been achieved almost completely within Japan, where there is industrial participation, government guidance, a larger domestic market end use, and a complete infrastructure.

The FPDs have made feasible new end-use products that have stimulated the entire electronics industry in Japan. Flat-panel displays have not been developed to replace CRTs but to expand electronic display applications where the weight, power, and volume of CRTs inhibit their use. Currently FPDs still cannot compete with CRTs in price and performance.

SUMMARY OF REPORT

The purpose of this study is to characterize the research, development, and manufacturing status of the Japanese FPD industry today, to predict how this industry will evolve during the 1990s, and to report the findings to the U.S. scientific and engineering communities. The JTEC committee, consisting of a group of six JTEC panelists (technical experts in display technology) and five observers, derived its information principally from its field visits to 33 sites in Japan in October 1991. To determine the depth of the FPD industry and the emphasis in LCDs, the committee visited industrial laboratories, supporting infrastructure, manufacturing facilities, and the Japan Electronics Show. To confirm its conclusions, the committee interviewed key technical leaders in government, industry, and universities and reviewed the literature.

The emphasis in the industry and in our study is on LCD panels. Approximately 90% of the LCD panels currently produced are passive matrix panels, which are used primarily for computer displays where high resolution, fast response time, grey scale, and high contrast are not essential. The performance of passive matrix displays has improved recently with the introduction of supertwisted nematic (STN) materials. However, active matrix LCDs (AMLCDs) provide much improved resolution, response time, grey scale, and contrast. While AMLCDs comprise only

about 10% of current production, that percentage is growing rapidly. AMLCDs not only give improved performance for computer displays but, with the exception of cost and size, also meet almost all of the requirements for television displays, as long as the viewer is not too far off axis.

Future display needs will probably be met with a combination of types. For small displays--from 14- to 16- inch diagonals and eventually up to 20 inches--it is expected that LCD panels will dominate for the foreseeable future. At present this market is primarily passive matrix LCDs, but the higher performance AMLCD panel is rapidly expanding its share of the market. It is expected that the CRT will still dominate the market for sizes from 20 to 30 inches. For displays larger than this (as in HDTV displays), light-valve projectors using AMLCD panels are thought to be the near-term solution. In the longer term, NHK and several others expect plasma panels to be used for the long-sought-after "hang-on-the-wall" display panel. Although the scope of the GTC consortium has been reduced, its supporters still think that, in the long term, the AMLCD will be the "hang-on- the-wall" display.

Our study covers the range from basic research in materials to automated manufacturing technology. The JTEC panel is divided in its opinion about the relative levels of effort and productive output in Japan and the United States in basic research on display technologies. It is apparent, however, that most of the past contributions to basic display technology have come from the United States and Europe. The group is unanimous in its opinion that the long-term investment in manufacturing technology and in manufacturing facilities in Japan is very impressive. In AMLCD manufacturing facilities alone, Japan's investment in the last few years exceeds two billion U.S. dollars.

In spite of the huge investment, there are still many manufacturing issues to be resolved. However, it is clear that for new matrix display technologies, Japan has the infrastructure to provide the long-term investment capital, manufacturing equipment, manufacturing technology, and all of the critical components to potentially dominate this market.

The panel feels that U.S. display technology is competitive in some areas and superior in others. However, without the long-term investment in manufacturing facilities and the resolve to lower manufacturing costs by addressing both the computer and the consumer markets, the United States will not be able to profit from its investment in display research. The relative status of the U.S. and Japanese display industries is shown in Tables [Exec.1](#) , [Exec.2](#) and Table [Exec.3](#) summarizes some conclusions. The body of this report describes in detail the technologies being developed in Japan for the manufacture of FPDs. [Chapter 1](#) gives an overview of the study results; [Chapter 2](#) describes the materials infrastructure; and [Chapter 3](#) describes the manufacturing infrastructure. [Chapter 4](#), [Chapter 5](#) and [Chapter 6](#) discuss progress in FPD devices with an emphasis on LCD technology, in which the most progress has been made over the last ten years, and in which the Japanese are significantly ahead of the rest of the world. [Appendix A](#) summarizes the panel members' professional experience while [Appendix B](#) contains trip reports describing each site visit. [Appendix C](#) is a glossary of some of the specialized terminology used in this report.

Table Exec.1
Japan Compared to U.S. in Flat Panel Displays

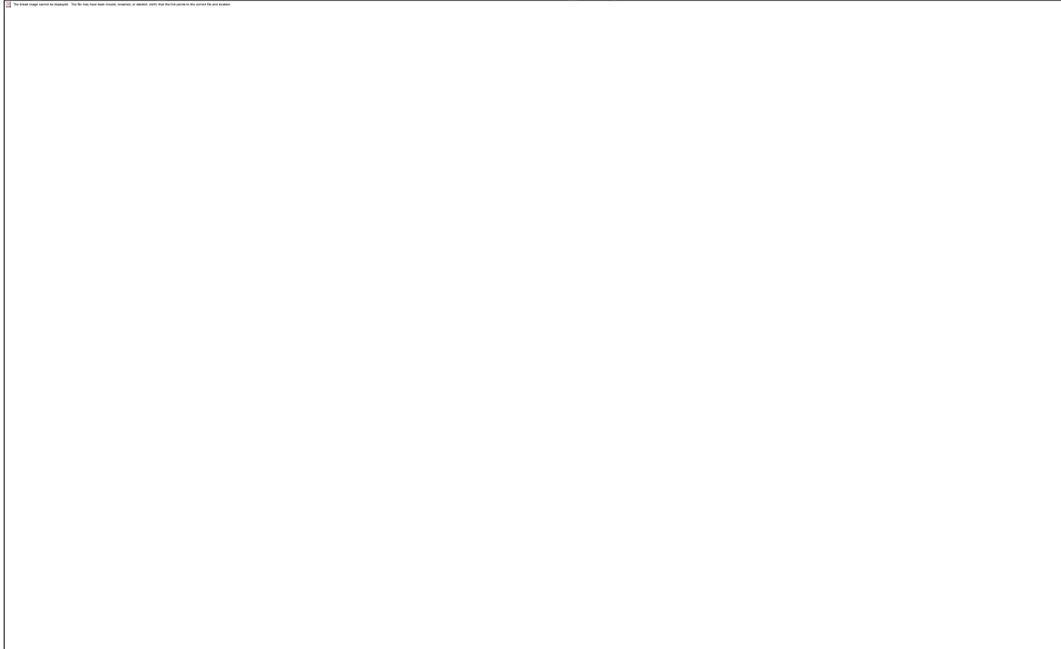


Table Exec.2
Comparison of Japanese and U.S.
Display Efforts

- Competitive in basic research and gaining
- Japan leading in product development and expanding
- Japan dominating in investment and implementation in manufacturing

Table Exec.3
Conclusions - Future Trends

- Japan has focussed primarily on direct-view LCD FPDs for the 1990s
 1. Amorphous-Si TFT LCD for 3" to 16" video performance in color
 2. Compensated STN LCD for 3" to 18" graphics performance
- FPD cannot compete in price with CRTs or high-end performance CRT
 1. The large, direct view, consumer TV or HDTV on-the-wall is not yet feasible before the year 2000
- LCD projectors are emerging to compete with CRT projectors
 1. Amorphous-Si TFTs and Poly-Si TFTs competing for market share
- EL and Plasma will be relegated to custom markets
 1. Color is needed to change trend



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