

Preface

This special issue of the *IBM Journal of Research and Development* marks the advent of an important new core technology for IBM. More than seven years ago we began to focus on the technologies required for compact, lightweight, portable personal computers and terminals. While the path to meeting requirements in major areas such as processor and memory technology and storage was reasonably clear, the goal of providing a display with function equivalent to that available on the desktop was more of a challenge. At that time, high-information-content flat-panel displays were almost exclusively plasma displays, easily identified by their monochrome, orange-on-black appearance. IBM was then the world's largest manufacturer of such displays. Unfortunately, the plasma technology did not fit the scenario for portables which could replace desktops.

The desktop display world was already starting to move to color, so it was apparent that providing equivalent function meant providing full color. In other words, a successful flat-panel technology would have to offer a display image equivalent to that of a color cathode ray tube (CRT). In addition, there would be a premium for light weight and low-power operation. Plasma displays did not fit the bill.

When all of the candidate flat-panel technologies were reviewed, only the emerging technology of active-matrix liquid crystal displays, in which each picture element was controlled by a thin-film transistor, appeared to meet the strategic requirements. Thin-film-transistor/liquid crystal (TFT/LC) displays, which had been conceived in the late 1960s, had by the 1980s reached the market only in small screens for pocket television sets. Since the technology employs what is in effect a large integrated circuit of thin-film devices, it was easy to project the possibility of large screens useful for portable computers.

Having reached that conclusion, IBM Research initiated a project at the Eastview laboratory of the Thomas J. Watson Research Center aimed at developing the technology and extending its capability to high information content and large screens, based upon the use of amorphous silicon for the thin-film transistors. No sooner had we started, however, than we began to realize that others were reaching the same conclusion, and we were in a technological race.

At this point we decided to find a partner in order to accelerate the development. In 1986, working with the Asia Pacific technical organization, we entered into a joint research and development agreement with the Toshiba

Corporation, with the goal of demonstrating the feasibility of extending the technology to large sizes, for example 14-inch-diagonal screens. At this time the IBM Japan Yamato Laboratory became involved. This joint development was extraordinarily successful, producing within a two-year period 14-inch prototypes with 720×550 16-color picture elements, requiring more than one and a half million transistors. Credit for this success is due to the IBM teams in Yamato and Eastview, and to the Toshiba team with whom they worked closely.

Having demonstrated feasibility, we were still faced with another formidable hurdle, the need to move very rapidly to the manufacturing of these displays in large volumes. Once again, partnership offered an attractive balance of risk and benefit, so in 1989 IBM Japan joined with Toshiba to create Display Technologies, Inc. (DTI), a jointly owned subsidiary corporation located in Himeji, Japan, which is now manufacturing TFT/LC displays for use by both parent companies. Since DTI is chartered only as a manufacturing company, the two parent companies continue to work jointly to carry out the necessary research and development.

The course of this technology in IBM is perhaps a good example of the changes taking place in the way in which we do research and development. The rapid transition from research to parallel research and development, and the acceleration afforded by partnership, are increasingly becoming essential elements to maintaining leadership in fast-moving competitive technologies. That the effort is truly international is also significant.

This program has successfully overcome the potential obstacles of language differences, cultural differences, and a 7000-mile geographical separation, to a degree that is surprising even to the participants.

The following pages present a sampling of IBM contributions to this exciting new technology, from both the Thomas J. Watson Research Center and the Yamato Laboratory. These papers convey a clear sense of the excitement, the challenges, and the opportunities of TFT/LC technology.

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