Job Prospects in Flat Panel Display

The world market for flat panel displays–primarily active-matrix screens made for laptop computers–was more than $4 billion in sales in 1994 and could exceed $20 billion in the year 2000.

Liquid crystal FPDs, especially active-matrix LCDs, represent classic examples of technologies invented in the U.S. but commercialized in Japan, where Seiko and Sharp developed the technologies with watches and pocket calculators in mind. About 90% of the total U.S. market and very close to 100% of the U.S. market for active-matrix screens is supplied by Japanese firms.

With a steady stream of new applications–from monitors on athletic equipment to cellular phones and pagers–the market is projected to grow, whether or not high-definition television takes off in the next few years. Much of the U.S. R&D work in flat panels will be rather uninspiring–trying to find ways to manufacture panels just a little more economically than Japanese competitors. But there are U.S. firms committed to developing innovative technologies where physicists may find happiness. It appears there will be abundant job opportunities. You may have to choose, however, between exciting high risks or routine stable work.

Flat panel initiative

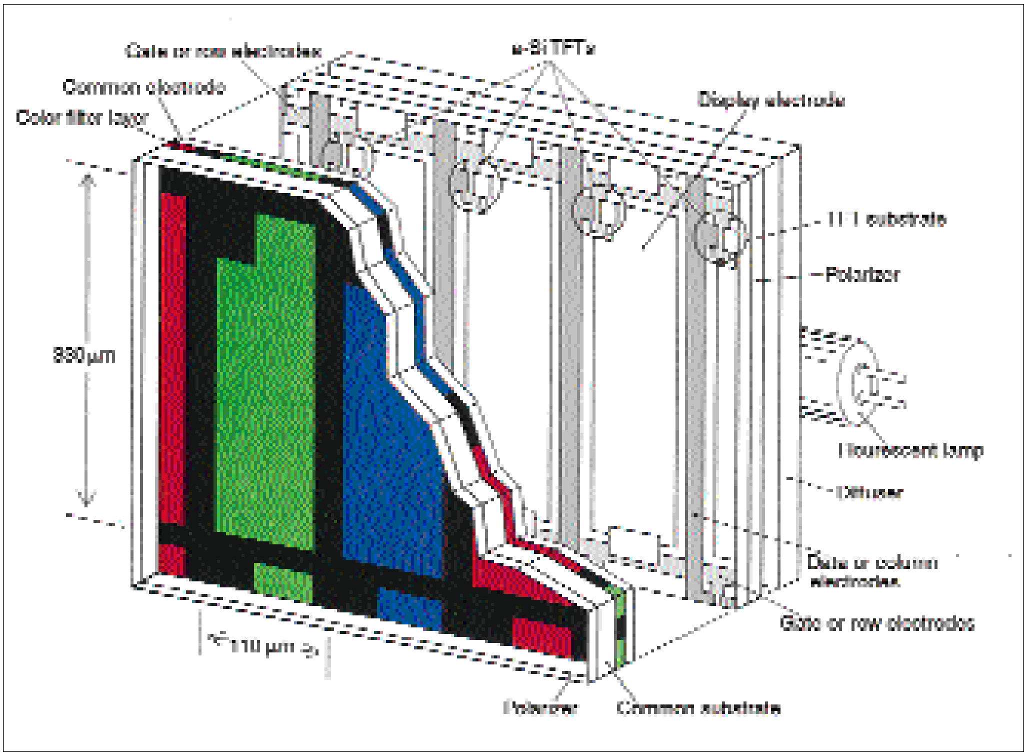
Since 1989, according to a recent Department of Defense report, the Advanced Research Projects Agency (ARPA) has invested about $300 million in advanced display R&D. The ARPA effort, probably the most prominent item in the Clinton Administration's competitiveness program, has to a great extent been inspired by the success of Sematech, Inc., the chip-manufacturing consortium sponsored in part by ARPA.

Last year the Administration launched a flat panel initiative to invest $600 million in FPD manufacturing capacity between now and 1998. About $580 million is to come from the Pentagon, between $10 and $20 million from the Department of Energy and perhaps a few million from the Commerce Department. The Clinton initiative roughly doubled the rate of government investment in flat panel research, but it remains unclear how much of it will survive efforts by the Republican-controlled Congress to curtail spending and discourage an active government role in the private sector.

Display Consortium

The projects that ARPA has supported to date include a new $100-million production line for active-matrix displays, to be built by Optical Imaging Systems, Inc. in Troy, Michigan, the only U.S. company currently making and selling AM-LCDs.

The most ambitious of ARPA-supported efforts, however, is the U.S. Display Consortium, which is sponsoring several projects: Xerox Corporation is working mainly on arrays of thin-film transistors on substrates, Standish Industries, Inc. in Lake Mills, Wisconsin (currently the largest LCD manufacturer in the U.S.) is doing research on cell assembly and liquid crystal processing, and AT&T is exploring back-end packaging and module assembly.



Xerox's Palo Alto Research Center, the leader of the group, has been developing ultra-high resolution technology employing thin-film transistors to make imagers for use both as displays and scanners. While Xerox has done a lot of work over the years with amorphous silicon (the material most widely used for TFT displays), its flat panel effort concentrates increasingly on polysilicon. It argues that polysilicon will allow full integration onto the substrate of row-and-column drivers (the circuitry that activates each pixel).

Two and a half years ago, using amorphous silicon, Xerox PARC unveiled prototype monochrome and color AM-LCD displays with 6.3 million pixels on each screen, providing resolution comparable to that from laser printers.

In recent months Malcolm Thompson, the British-trained physicist who leads FPD research at Xerox PARC, has hired about 50 new researchers. He has roughly doubled the size of his team, which is rapidly becoming a quasi-commercial unit within Xerox. About half of the team is working on development of a prototype active-matrix production line. The work is funded by a $100-million Display Consortium contract with ARPA.

Fully integrated displays

Although Xerox and AT&T agree that circuitry will increasingly be fully integrated with displays–"laptop computers will be just a piece of glass," as Thompson puts it–AT&T does not see eye-to-eye with Xerox on the virtues of polysilicon. According to Rick Gottscho, a leader of AT&T's flat panel effort, a-Si should be able to meet all of AT&T's needs for the foreseeable future. The production infrastructure for a-Si "is already in place and can be leveraged for low-cost production," says Gottscho.

AT&T is "not looking for a leap frog technology," says Webster Howard, a physicist who left IBM a couple of years ago to join AT&T's FPD effort. "What AT&T is looking for now is simpler and more robust production processes."

IBM, through a joint venture with Toshiba Corp. in Japan, produces flat panels called DTI for its ThinkPad laptops. When Howard was at IBM, he led a campaign to develop displays based on amorphous silicon after the first a-Si transistor was demonstrated at the University of Dundee in 1979. IBM continues to have about 40 to 50 researchers in the U.S. working on display technology, mainly in support of DTI but also on projection systems and on reflective transducers.

Steve Depp, a leader of the IBM group, tends to agree with AT&T that amorphous silicon will be quite adequate for the next couple of generations of displays. Depp likens polysilicon to gallium arsenide, which cynics have said is "the material of the future and always will be."

Advanced technologies

A number of companies are conducting research on an alternative new flat-screen technology called "field-emission" or "flat cathode-ray." FED technology generally involves cold emission of electrons from a matrix array of metal or semiconductor "microtips"–thousands of micron-sized cones at each pixel emitting electrons that cross a narrow vacuum gap and strike a phosphor-coated screen.

Both Raytheon Co. and Texas Instruments, Inc. have licensed a field-emission technology owned by Pixel International in Rousset, France, and are betting especially on military applications. Texas Instruments also has developed an electro-mechanical micromirror flat-panel technology, which has received a lot of publicity and some support from the Sarnoff Research Center in Princeton. It remains to be seen whether micromirrors will prove to be a viable technology for applications such as high-definition television.

InFocus Systems, Inc., a Wilsonville, Oregon company that mainly produces projection systems, has developed an alternative to standard AM-LCD displays called "active-addressed" passive displays. The technology involves reliance on more-complex row functions, rather than thin-film transistors. Motorola, Inc., anticipating applications in pagers and cellular phones, invested more than $20 million in a production line to make application-specific integrated circuits to do the row-algorithm processing.

Kopin Corp. in Taunton, Massachusetts, another company interested in projection systems, is trying to develop a different type of single-crystal display technology, which would enable it to borrow production techniques from complementary metal-oxide semiconductor manufacturing. With ARPA support it is doing TV-related joint development work with Philips Electronics North America Corporation. Kopin is interested in panels for use in virtual-reality goggles as well as for projection systems. This area, where very small and very big displays converge, is seen as one of the most promising commercially.

Gas plasma and EL

For standard applications in computers or television, active-matrix technology is thought to be approaching its maximum economic screen size of about a foot on the diagonal. Larger screens typically depend on gas-plasma or electroluminescent technologies. Until very recently these larger screens, used on trading floors or in certain medical and military applications, were always monochrome, often orange on black. But with the long-awaited discovery of adequate blue phosphors, major manufacturers of gas-plasma and EL displays are coming out this year with their first full-color panels.

Planar America, Inc., in Beaverton, Oregon, is the sole surviving U.S. manufacturer of EL displays and–together with Sharp, the world leader in active-matrix displays–supplies 100% of both the home and world markets.

About ten companies produce plasma displays in the U.S., and at least a couple of the more important ones–Photonics Systems, Inc., in Northwood, Ohio and Plasmaco, Inc. in Highland, New York–are keenly interested in HDTV. If high-definition or "digital" television really takes off toward the end of the century, the market for flat panels will grow far beyond all current projections. Even if HDTV falters, a wide variety of other applications will appear, guaranteeing a healthy market and strong industrial interest in any relevant research, whether it promises incremental improvement in existing production technology or the kind of breakthrough that could transform the field. ■