

LCD manufacturing

DTI: Lessons from a Successful Joint Venture

Many believed it couldn't be done, but hard work and a bold approach have made the IBM-Toshiba joint LCD venture a remarkable success.

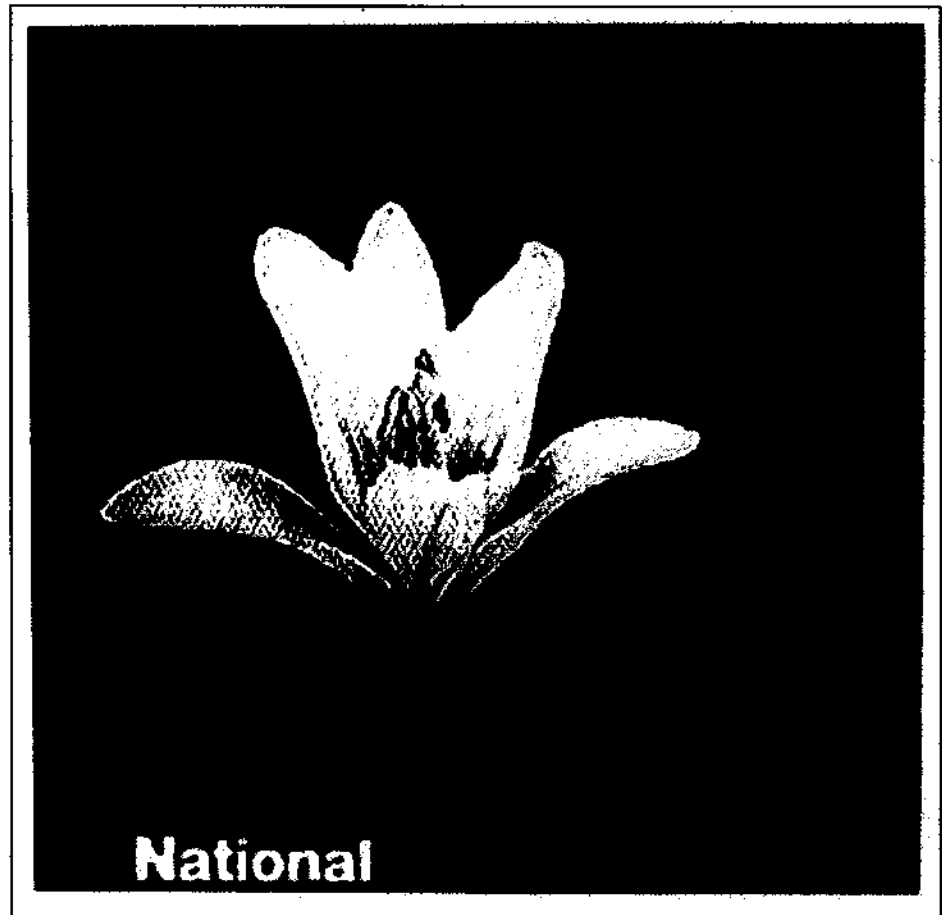
by Jim McGroddy

A LITTLE OVER 10 YEARS AGO, on the strength of its extensive display R&D experience, executives at IBM foresaw the likely importance to the computer industry of large high-quality active-matrix liquid-crystal displays (AMLCDs). The company's desire to get into the AMLCD business was tempered by, among other things, its lack of high-volume LCD-manufacturing experience.

Executives at Toshiba had a similar vision. Toshiba was successfully mass-producing small LCDs, but the company's ambitions were tempered by its lack of large-screen experience. On the basis of their common goal and complementary strengths, the research units of the companies started doing joint R&D in 1986.

In 1989, IBM and Toshiba created Display Technology, Inc. (DTI), and began construction of a plant in Himeji, Japan. Three years later, DTI was the world's second-largest producer of AMLCDs. In 1996, DTI produced over 2 million panels.

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National

Fig. 1: DTI was founded with the belief that AMLCD technology would start with relatively small displays, such as this one for a c. 1986 3-in. TFT-LCD TV set, and "trickle up" to bigger and more expensive displays. [Photo from S. Tanaka et al., National Technical Report 33/1, 64-75 (1987)]

DTI's success is based, in part, on a disciplined view of what the enterprise should do. As a business strategy, the company's functions are strictly limited to late-stage display-process development and the design and manufacture of the active-matrix display cells themselves. DTI does not produce the finished display unit, and so, for example, it does not attach drivers or add backlights.

Good Fences Make Good Neighbors

A line from a poem by Robert Frost says, "Good fences make good neighbors." IBM's and Toshiba's effective relationship is based in part on the fact that the terms of that relationship are very clearly defined. Production output is divided equally between IBM and Toshiba. Both companies separately sell DTI-made displays into OEM markets, as well as using the displays in their own products. From IBM's perspective, selling to OEMs keeps the company in touch with market needs, as well as balancing demand/supply. The two companies cooperate fully in doing the research and development to support the joint venture, IBM in Yorktown Heights, New York, and in Japan, and Toshiba in Japan.

The Himeji plant, in western Japan near Kobe, was originally built with a Phase-1 production line; a Phase-2 line was added subsequently. A Phase-3 line and a color-filter manufacturing facility were later added at a converted IBM semiconductor plant in Yasu.

Trickling Up

Ten years ago, the common view was that most high-technology products start off in high-end applications and trickle down to less demanding ones, with prices decreasing and production volumes increasing as time goes on. At IBM 10 years ago, we believed that thin-film-transistor LCDs (TFT-LCDs) would be a "trickle-up" technology, with initial products being relatively small and inexpensive, such as pocket television sets (Fig. 1), and later ones being larger and more expensive as manufacturing expertise and substrate size increased.

That led us to Toshiba, with its small-display manufacturing expertise. Other aspects of a joint venture that were attractive to IBM at the time were an interest in seeing up close how a successful Japanese company introduced technology and a desire to take advantage of Japan's cost of capital, which was very low at the time.

These were IBM's initial motivations for wanting to do business with Toshiba, but joint ventures were not part of IBM's culture at the time. There were many skeptics, both internal and external.

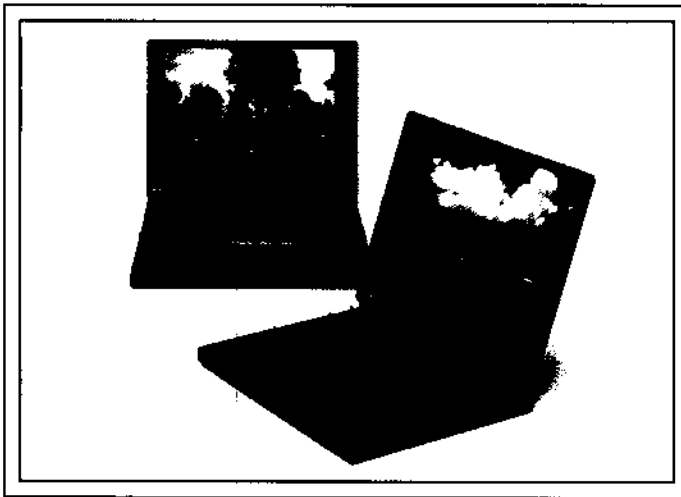
Early Success, but Not Effortless

Despite the skepticism and the cultural leap, the joint venture with Toshiba was successful from the beginning. Early prototype units made on a cobbled-together pilot line at

Toshiba's Shinsugita plant worked right off the bat. Then, a more refined pilot line at an IBM facility produced excellent large prototypes. It wasn't just that the prototype manufacturing processes were successful - more importantly, the interpersonal relationships worked very well at every level.

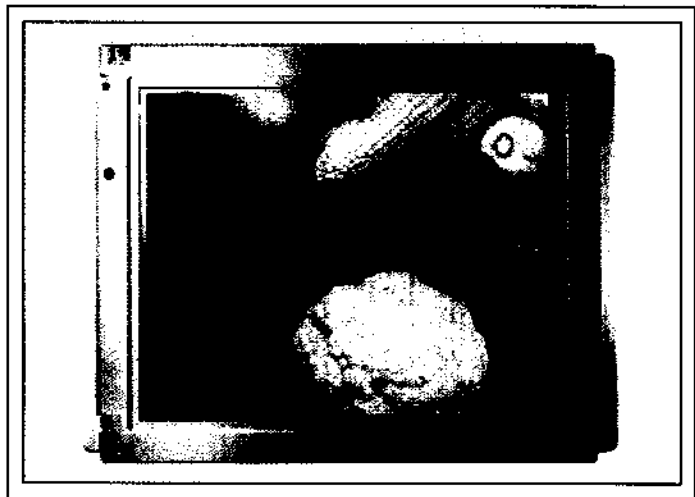
An essential element of DTI's success was that both Toshiba and IBM had an absolutely common goal: the manufacture of large high-quality AMLCDs. Commonality of goals is, in my experience, essential to the success of a joint enterprise. Many joint enterprises have been founded on the seemingly logical foundation of the partners having complementary goals - for example, one partner doing the software and the other doing the hardware, with the assumption that both will win. Such arrangements, however, often fail because the world evolves in a way that favors one partner while putting the other under tremendous pressure. The partners in DTI had a common goal, and they did the work that was needed to make their relationship work.

With technical feasibility demonstrated on the pilot line, the partners reached the point of building a \$400 million plant. The low cost of capital in Japan at the time was an important motivation at this point, since it dramatically reduced the up-front investments required of the partners.



IBM

Fig. 2: IBM's strategy is that its top-of-the-line Thinkpad™ laptop computer always have a better display than its competitors. The current Thinkpad 560 family has a 12.1-in. 800 × 600 (SVGA) display.



IBM

Fig. 3: IBM's 16.1-in. 1280 × 1024 (SXGA) display is now used in a variety of monitor applications. This TFT display is becoming important in non-mobile monitors.

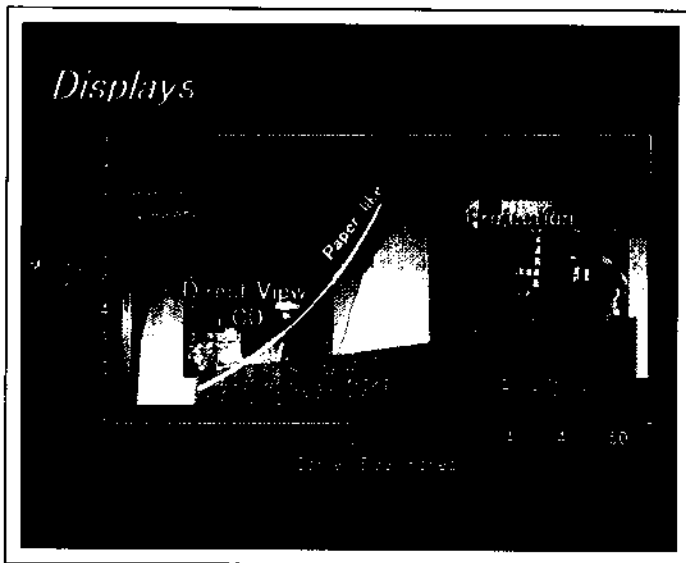


Fig. 4: AMLCDs will, over time, expand into a far greater portion of the display market.

The Payoff

In 1992, IBM introduced the Thinkpad™ notebook PC with a 10.4-in. DTI display instead of one of the 9.5-in. displays that were then common in competing PCs. Although the Thinkpad had other distinguishing characteristics, such as its innovative pointing stick, the large display made a critical contribution to the product's immediate success. Display availability for the Thinkpad was improved by what was effectively in-house production, and the display quality was excellent.

IBM's strategy was (and is) that the Thinkpad should always have the best available display, when compared to its competitors. The current Thinkpad 560 has a 12.1-in. 800 × 600 (SVGA) display (Fig. 2).

In addition to portables, these TFT displays are becoming important in non-mobile monitors. The current IBM 16.1-in. 1280 × 1024 (SXGA) monitor is another example of the fruits of this joint venture (Fig. 3).

The 10-Year Plan

In 1984, IBM's 10-year technology outlook predicted that AMLCDs would play a large role in our product line. The 1995 version of this technology outlook projects the introduction of paperlike displays based on AMLCD technology, as well as the use of AMLCDs as one of the technologies for large-scale projection displays.

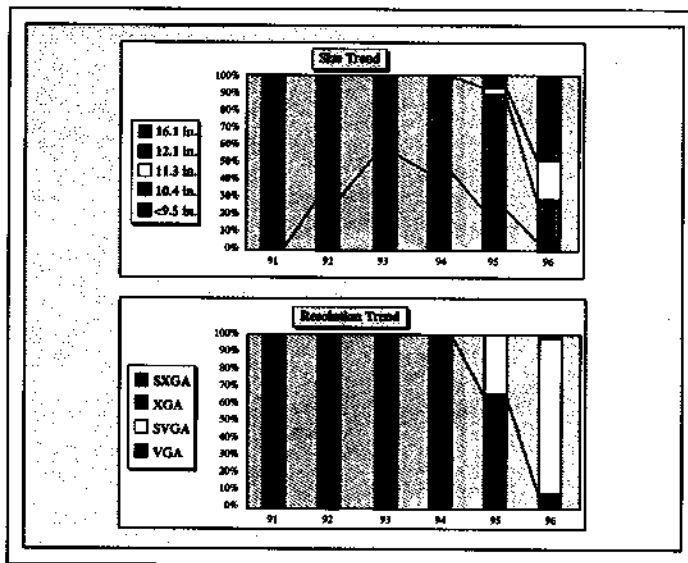


Fig. 5: The typical display produced by DTI for laptop use in 1996 was a 12.1-in. SVGA. The next wave is XGA, and then 16.1-in. SXGA.

It is one thing to project technological developments, quite another to act based on those projections. Although it is a great oversimplification, it is useful to think of two styles of corporate decision-making. The first is the "chess-playing style," which is well suited to periods in which technology and business practices are evolving predictably and continuously.

In the other style, the "poker style," major bets must be placed before technical or business certainty has become established. The poker style is the key to winning in an era when new elements are rapidly transforming an industry and time is the most relevant variable. And poker - well-researched and well-analyzed poker, but poker nonetheless - is what we were playing when we founded DTI. The uncertainties were huge. Remember, even 2 years ago some reasonable people believed that FEDs might displace AMLCDs and be the ultimate winner in laptop-display technology.

At this point, it is pretty clear that LCDs are, and will remain, the mainstream portable flat-panel-display technology because of the huge base of manufacturing experience and consequent rapid cost reduction (Fig. 4). Screen diagonals and pixel counts continue to grow, as confirmed by DTI's production experience (Fig. 5). From 1991 to 1994, virtually all of our output was in 9- and 10-in.-class VGA displays. In 1995, we produced a

substantial percentage of SVGA product, some of it with 11.3- and 12.1-in. diagonals. In 1996, 90% of the output was in SVGA, and 70% was 11.3 in. or larger.

What We Learned

Speaking at Display Works 97 in San Jose in January, Hideki Wakabayashi, Senior Researcher for Nomura Research Institute, Tokyo, ranked DTI as the second-largest AMLCD supplier in terms of volume and the leading supplier in terms of technology. This success was hard won, and is based on a strategy of staying ahead of the competition. Implementing that strategy involved some things that were obvious, as well as some less obvious.

To further our commitment to clear and open communication between the partners, for instance, IBM hired a full-time Japanese teacher for its Yorktown Heights, New York, team.

IBM's motivation for participating in DTI has evolved with time and changing conditions. At first, we were moved by our "trickle-up" view of TFT technology and the desire to build on Toshiba's high-volume manufacturing experience, to learn the "Japanese Way," and to benefit from Japan's then low cost of capital. Later on, we were motivated by our own success, the rapid pace of progress, the effectiveness of the Toshiba-

IBM relationship, the commonality of our goals, and the still low cost of capital.

The risks and challenges have also evolved over time. Initially, we were concerned with technical uncertainty, cultural differences, and a large number of internal and external skeptics. It is a mark of the enterprise's success that later on the risks and challenges that most concerned us became those confronted in any business: schedules, costs, supply/demand issues, and business risk.

So what were the key lessons learned?

- Complementary partners and common goals are essential.
- Continuity is essential, as is commitment from the top. At DTI, and at both Toshiba and IBM, many of the key players have remained on the scene throughout the process.
- Teamwork at the working level is essential. Recruiting from both participating companies fosters the teamwork.
- Strong technical teams are key. In the case of DTI, both companies brought enormous technological strengths to the joint enterprise.
- Finally, it is necessary to apply highly focused management methodologies.

The lessons are clear, but that does not make them easy to implement. The implementation at DTI was highly successful, but it required a compelling view of the future, a commitment to making large investments and to bridging cultures - and a willingness to play high-stakes poker. ■

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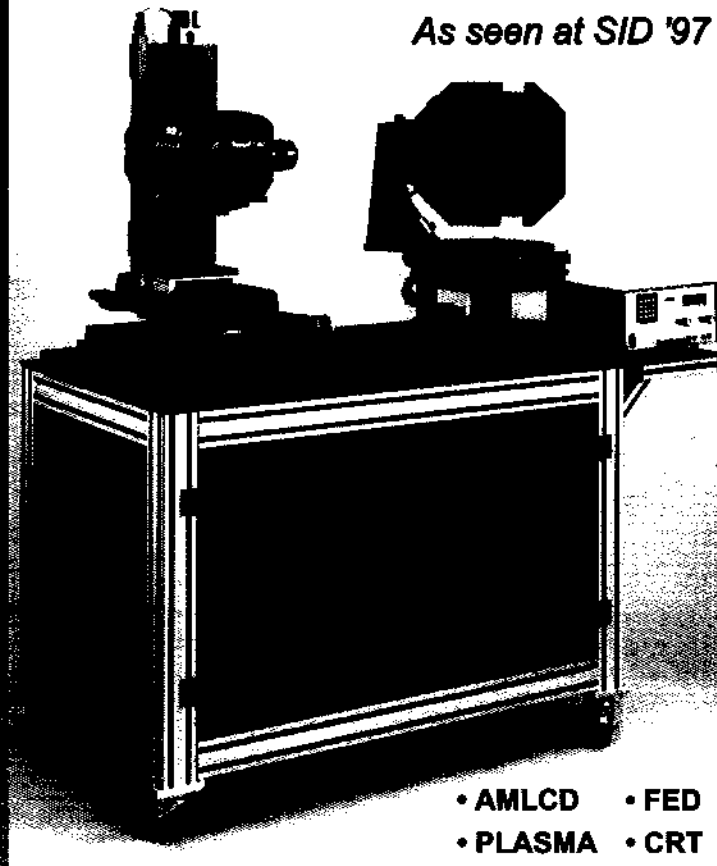
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