LCD Demand, Panels, Substrates All Move From Large to Larger

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LCDs are literally everywhere today, from the mobile phones consumers carry in their pockets and the computer screens they stare at all day to the video walls they pass in shopping malls and the TV screens they watch in their spare time. The use of LCDs in these kinds of products also means that LCDs today come in virtually every size possible. The large screens attract some of the strongest attention today, because of the interest surrounding digital broadcasts and high-definition TV.

Since 1990 when the first large (10–inch and larger) thin-film transistor (TFT) LCD panels began serving as displays in notebook computers, the uses for TFT LCDs have expanded to LCD monitors, flat-panel TVs, and many other industrial, commercial and medical uses. Huge capacity gains in TFT LCD production have been the main drivers expanding LCD uses, as has the technological evolution of TFT LCD panels. Panel and component manufacturers and others in the TFT LCD supply chain participate deeply in this evolution.

These product trends are more than a simple matter of deciding which panels are more efficient in which fab, or deciding to adopt newly developed materials. They are the result of a complex combination of company strategies, fab generation strategies, customer bases, research and development (R&D) capabilities, and cost considerations.

Believing that the industry needs a reference report on this evolution, DisplaySearch in January released "The Quarterly Large-Area TFT LCD Product Plan Report." There will be quarterly updates to this document, which analyzes the product and technology roadmaps of TFT LCD manufacturers.

Panel vendors choose display sizes and screen formats to meet strategic goals.

LCD Development Outlook

In general, TFT LCD manufacturers have the power to pursue any development avenues they want to provide the market with whatever products they choose to offer. Panel manufacturers have been successful in stimulating demand for enlarged screens. For example, displays in notebook computers averaged about 12.1 inches between 1996 and 1998, but the average expanded to 14.1 inches in 2000 and to 15.0 inches in 2002. Starting in 2004, the average grew again to 15.4 inches, because TFT LCD fabs were shifting from so-called third-generation (Gen3, about 550 × 670mm) substrates to Gen4 or Gen4.5 (about 730 × 920mm), which is optimum for supplying 15.4-inch panels.

At the same time, the sizes of the mainstream LCD monitors grew from 15 inches to 17 inches.

Each vendor attempts to offer a variety of panel sizes in the premium ranges.

Vendors find that wide screens serve as value-added models.

		X = XGA (4:3)						W = Wide (15:9, 16:9, 16:10)								
Generation	Motherglass (in mm)	X10	X12	X13	X14	X15	X16	W11	W12	W13	W14	W15	W17	W19	W20	Fab
G3	550 × 650	6	6	4	4	4	2	8	6	4	4	3	2	2	2	Sharp, BOE-Hydis, Samsung, HannStar
	550 × 660	9	6	4	4	4	2	8	6	4	4	3	2	2	2	NEC
	550 × 670	9	6	4	4	4	2	8	6	4	4	3	2	2	2	Sanyo Epson, TMDisplay, Chunghwa Picture Tubes
G3.25, G3.5	590 × 670	9	6	6	4	4	2	8	6	6	4	3	2	2	2	LG.Philips LCD
	600 × 720	9	6	6	6	4	4	8	8	6	6	4	3	2	2	Samsung, AUO
	610 × 720	9	6	6	6	4	4	8	8	6	6	6	3	2	2	AUO
	620 × 720	9	6	6	6	4	4	8	8	6	6	6	3	2	2	BOE-Hydis
	620 × 750	9	6	6	6	4	4	10	8	8	6	6	3	2	2	Chi Mei, Quanta, Toppoly, Sharp
G4	650 × 830	10	9	6	6	6	4	12	8	8	8	6	4	2	3	Hitachi
	680 × 880	16	9	9	6	6	4	12	12	8	8	6	4	4	3	Sharp, LG.Philips LCD, AUO, Chunghwa Picture Tubes, Chi Mei, Sanyo Epson
G4.5	730 × 920	16	9	9	9	6	6	12	12	9	8	8	6	4	3	Samsung, Hitachi, LG.Philips LCD, Chunghwa Picture Tubes
G5	1000 × 1200	28	20	16	15	12	9	24	24	20	15	12	12	8	8	LG.Philips LCD
	1100 × 1250	30	24	20	16	15	12	28	24	24	18	15	12	8	8	Samsung, AUO
	1100 × 1300	35	25	20	16	16	15	32	24	24	20	15	12	12	8	AUO, Chi Mei, SVA-NEC, BOE-Hydis, Quanta, Samsung
	1200 × 1300	35	30	24	20	16	15	32	28	24	20	15	15	12	8	HannStar
G5.5	1300 × 1500	45	35	30	25	20	20	40	40	28	28	20	18	12	12	Chi Mei
G6	1500 × 1800	60	45	40	36	30	28					32	24	20	18	Sharp
	1500 × 1850	66	49	42	36	30	28					32	24	20	18	LG.Philips LCD, AUO, Quanta, Chunghwa Picture Tubes

Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 1: Economic strategies cutting notebook computer panels from substrates

They soon will grow again to 19 inches, because of the efficiency of Gen5 (about 1,000 × 1,250mm) fabs.

In LCD TVs, 32-inch panels became the mainstream LCD TV screens, and captured more than 30 percent of the market in the second half of 2005. Shipments of 40–inch and 42-inch panels are likely to climb past 4 million units in 2006. Meanwhile, the industry is witnessing continuing competition among manufacturers operating Gen6 and Gen7 fabs.

Panel Power

Although the supply and demand cycle exerts a heavy influence on their financial performance, panel manufacturers possess enormous power to change the industry landscape. Their power flows from cost and performance. TFT LCD panels account for more than 70 percent of the materials costs in LCD monitor systems, 25 percent in notebook computer systems, and more than 70 percent in LCD TV systems. There is proof that decreasing panel prices effectively drive the growth of a market for a given use.

Meanwhile, even though the embedded display electronics in these systems affect the front-of-screen performance, panel quality provides the ultimate key to picture quality. Widening notebook computer displays, and the improvements that panel vendors have introduced in the color saturation and brightness of LCD TVs are driving end users' acceptance of new products.

Nevertheless, there are limits to the power that panel manufacturers can wield. They face a number of constraints in developing panel products.

Out of One, Many

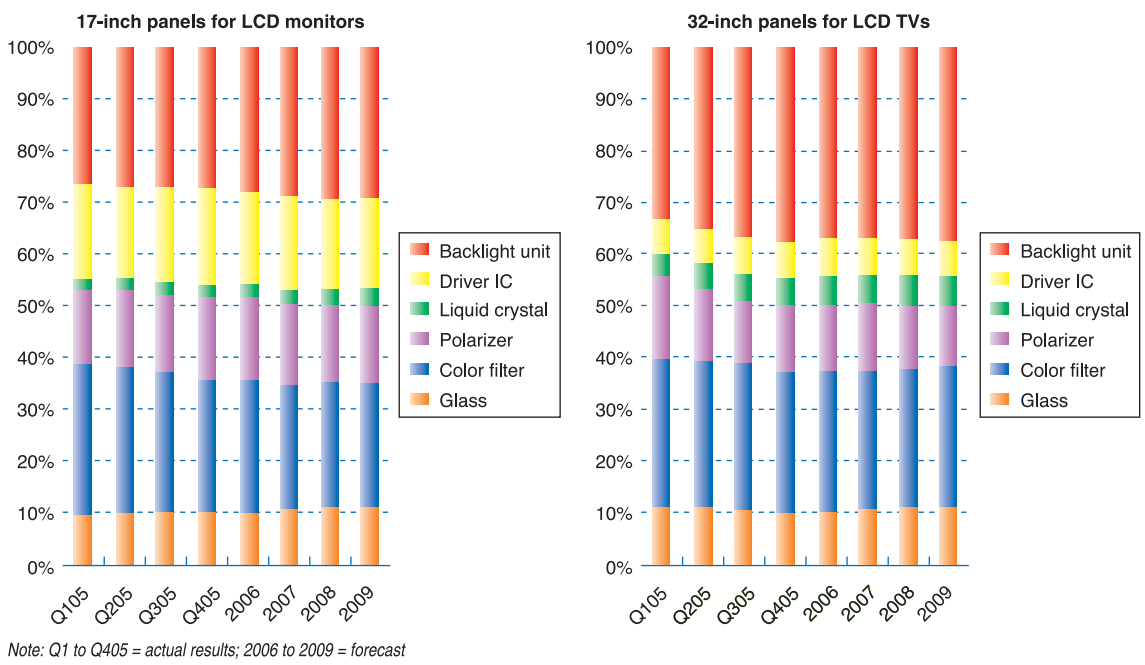
A common misperception about the LCD industry is that panel builders strategically adopt the most efficient approach to cutting panels, by determining the maximum number of panels they can extract from a single substrate, using their existing generations of glass substrates. In truth, each company decides the product sizes before it even builds the fab. First the product development people and the marketing respondents at TFT LCD companies gauge the market forecasts and identify the next target sizes for their products. Then the process engineers and fab builders choose the optimum generation, after considering the investment risk and the equipment capabilities. Yes, an efficient cut is essential, but it is not the only consideration.

Furthermore, panel suppliers themselves define many of the panel sizes that become market standards. The 15.4-inch screen now common in notebook computers provides an example. When working with 730 × 920mm substrates, which originally was for making 17.0-inch LCD monitors, panel manufacturers determined they could use these substrates to produce wide-screen panels for notebook computers. In 2002, the companies making panels for notebook computers found that panels with wide aspect ratios generally enable more efficient cuts from the substrate than standard-ratio panels. They also discovered that end users were willing to pay a premium for these screen sizes. As a result, manufacturers generated huge capacities, then started to encourage adoption of panels with wide aspect ratios.

For each generation of substrate, certain cuts offer the best efficiency (Fig. 1). Each TFT LCD supplier focuses on a particular set of products, and therefore chooses certain generations of substrates in line with those target products. In 2006, DisplaySearch forecasts that displays with wide aspect ratios will account for more than 60 percent of the global demand for displays in notebook computers.

Contributing Issues

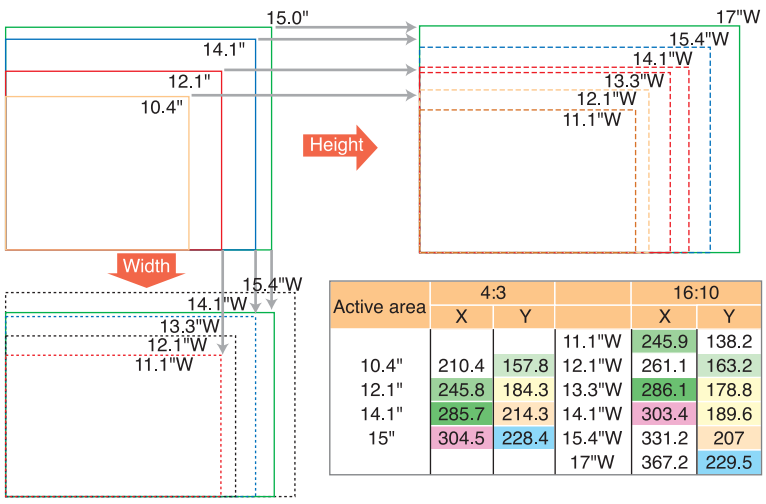
Other themes that also help determine a company's choice of panel size and target products include processes, components and standards.



Note: Q1 to Q405 = actual results; 2006 to 2009 = forecast

Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 2: Cost structures for the main components in 17-inch and 32-inch panels



Active area	4:3			16:10	
	X	Y		X	Y
			11.1"W	245.9	138.2
10.4"	210.4	157.8	12.1"W	261.1	163.2
12.1"	245.8	184.3	13.3"W	286.1	178.8
14.1"	285.7	214.3	14.1"W	303.4	189.6
15"	304.5	228.4	15.4"W	331.2	207
			17"W	367.2	229.5

Notes: Height similarities between panels with 16:10 and 4:3 aspect ratios
- *12"W ≈ 10.4"*
- *13.3"W and 14"W ≈ 12.1"*
- *15.4"W ≈ 14.1"*
- *17"W ≈ 15"*

Width similarities between panels with 16:10 and 4:3 aspect ratios
- *11.1"W ≈ 12"*
- *13.3"W ≈ 14.1"*
- *14.1"W (15:9 or 16:10) ≈ 15"*

Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 3: Comparison of standard and wide-screen aspect ratios in notebook computers

Process engineering includes the capabilities of the equipment, the shop flow for the process, and the liquid crystal injection. For example, the process known as One-Drop Fill or ODF began as a way to shorten the time it took for liquid crystal injection. Ultimately, it also enabled the production of 32-inch and larger panels.

Several key components are critical in deciding whether to develop a product. Driver ICs affect resolution. The trend for multiple-channel driver ICs helps developers cultivate increasingly high resolution levels at increasingly low cost. New color filter technology helps to improve the color saturation. With the introduction of light-emitting diodes (LEDs) as backlights, displays have achieved large color gamuts while retaining thin, lightweight designs.

Many of the latest development in compensation and retardation film technologies contribute to wider viewing angles than ever before. Brightness-enhancement films (BEFs) live up to their name by ensuring excellent display brightness. An alternative to BEFs is the diffuser plate, which raises the display brightness while keeping costs down.

Standards address a whole range of issues important to display developers. The Standard Panel Working Group (SPWG), which formed in 1999, and the Panel Standardization Working Group (PSWG) are working to establish standards for monitor-use LCD panels. The development of standards like DisplayPort, Digital Video Interface (DVI), and High Definition Multimedia Interface (HDMI) all aim at improving the signal transmission between TFT LCD panels and other devices.

Standards for mechanical outlines, screw sizes, the length of power cables, and the kinds of connectors help panel manufacturers control their component inventories. At the same time, they reduce the barriers set manufacturers face when trying to switch from one vendor to another. This increases the volatility of the industry's supply-and-demand cycle.

Environmental issues have attracted their own set of standards. Panel manufacturers are paying attention to the European Union's recently announced Restriction on Hazardous Substances (RoHS), which will go into effect in July of 2006. They are working to cut the amounts of lead and mercury that they use in their panels. Most panel manufacturers are starting to add Green Panels or Green Products to their roadmaps and catalogs.

Cost Considerations

One of the most critical issues for panel developers is the choice between cost and performance in components. As long as the substrate expands, depreciation costs will decrease as a share of total costs, but the ratio of the component costs will increase. Panels for notebook computers, LCD monitors and LCD TVs all have different cost structures. This is apparent from a look at the cost structures for the materials in 17-inch LCD monitor panels and in 32-inch LCD TV panels (Fig. 2). The backlight becomes the challenge when panel manufacturers need to drive panel costs down, because this item forms almost 40 percent of the total bill of materials (BOM).

Trends in Notebook Panels

Most TFT LCD manufacturers make 12.x to 14.x products in fabs that are smaller than or equal to the fourth-generation fabs. Fabs for 730 × 920mm motherglass make 15-inch and 15.4-inch wide-screen panels. To meet surging demand, many panel manufacturers, including AU Optronics Corp., Samsung Electronics Co., Ltd., LG.Philips LCD Co., Ltd. and Quanta Display Inc., recently have begun shifting their panel production activities for notebook computers to fifth-generation fabs.

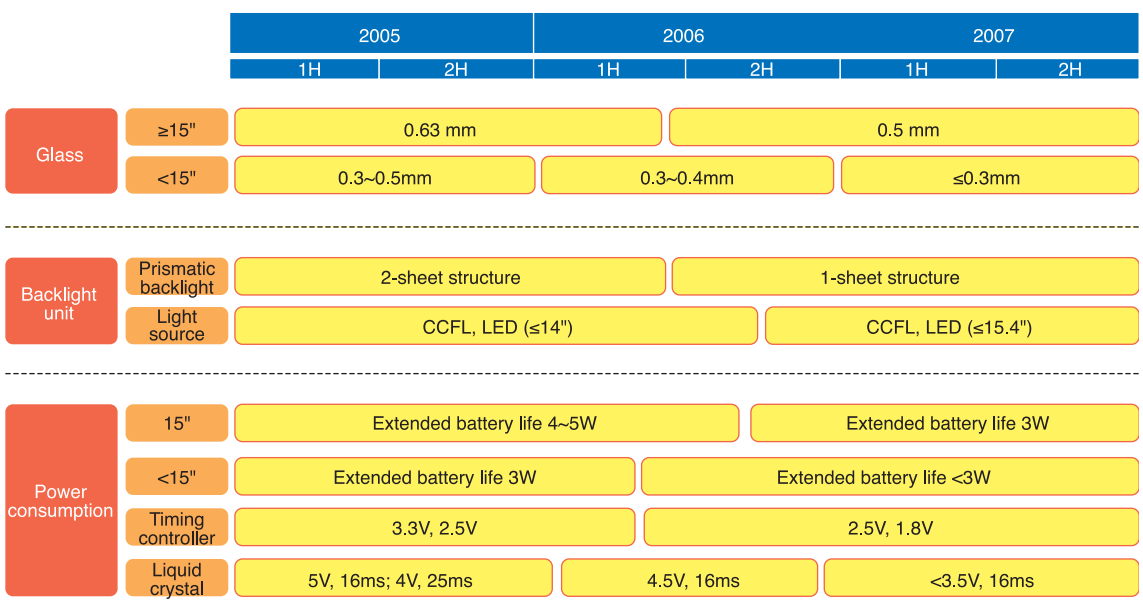
Initially, there was some resistance to the idea of using wide-screen formats in notebook computers. Some argued that wide screens were suitable only for consumer products, where they would enhance the experience of viewing multimedia content. However, broad acceptance of laptop displays with wide aspect ratios has nullified that argument. Notebook computers using wide-screen formats accounted for just 1 percent of the market for notebook displays in the fourth quarter of 2002. The share grew to 12.8 percent in the fourth quarter of 2003, 28.4 percent in the fourth quarter of 2004, and was approaching 40 percent by the fourth quarter of 2005. DisplaySearch predicts that this ratio will climb past 60 percent by the end of 2006.

For end users, the transition from conventional to wide-screen aspect ratios is just a matter of horizontal extension because the heights of the wide-screen and standard-width panels look very similar (Fig. 3). This helps erase barriers to wide-screen acceptance, because consumers tend to focus on the extra width instead of considering whether the wide-screen format provides a larger overall panel than the standard aspect ratio.

Altering Preferences

Even so, vendors encourage end users to choose something larger than their previous panels when they shift from conventional screens to models that sport wide aspect ratios. Once end users become accustomed to the wide-screen formats, they find it difficult to return to conventional aspect ratios, because the wide-screen models, especially the WXGA (1,280 × 800 dots), provide a better visual experience than the XGA models (1,024 × 768 dots).

Among the wide-screen panels, the 13.3-inch models get the most attention. These panels are similar in height to 12-inch displays with stan-



Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 4: Panel development trends for notebook computers

	Fab	Gen4, Gen4.5		Gen5				Gen5.5	Gen6		Gen7	Gen7.5
		LG.Philips LCD AU Optronics Chi Mei Sharp	Samsung Chunghwa Sharp	LG.Philips LCD	Samsung LG.Philips LCD AU Optronics	Samsung AU Optronics Chi Mei Quanta Innolux BOE Optoelectronics SVA-NEC	HannStar	Chi Mei	Sharp	LG.Philips LCD AU Optronics Chunghwa Quanta	Samsung	AU Optronics Chi Mei LG.Philips LCD
Aspect	Size	680 × 880	730 × 920	1000 × 1200	1100 × 1250	1100 × 1300	1200 × 1300	1300 × 1500	1500 × 1800	1500 × 1850	1870 × 2200	1950 × 2250
5:4	17"	4	6	9	12	12	12	6	25	24 (93%)	36	36
	19"	4	4	9	9 (80%)	9 (78%)	12 (94%)	12	16	16 (71%)	28 (85%)	30 (90%)
15:9	19.0"W	4	4	8	8	12	12	15	20	12	35	35
	20.0"W	3	4	3	8	8	8	12	20	20	32	32
	21.0"W	2	3	8	8	8	8	12	12	12	20	28
16:9	19.0"W	3	4	8	10	10	10	15	24	24	35	36
	20.0"W	3	3	8	8	8	8	12	15	15	32	32
	21.0"W	3	3	8	8	8	8	12	12	12	24	32
16:10	19.0"W	4	4	8	8	12	12	15	20	20	32	35
	20.0"W	3	4	8	8	8	8	12	20	18	28	30
	21.0"W	2	3	8	8	8	8	12	18	18	28	28
	22.0"W	2	3	6	8 (92%)	8 (90%)	8	12	15	15	21	24
	23"W	2	2	6	6	6	6	8	12	12	20	20
	24"W	2	2	4	6	6	6	8	12	12	20 (94%)	20 (89%)

Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 5: Cut patterns and fab generations for wide-format monitors

dard aspect ratios, and similar in width to 14-inch screens with conventional aspect ratios. Notebook computers from Sony Corp., Apple Computer, Inc., ASUSTek Computer Inc., BenQ Corp. and Lenovo Group Limited are adopting 13.0-inch or 13.3-inch wide-format panels from Quanta, Samsung, LG.Philips LCD, AU Optronics, and Chi Mei Optoelectronics Corp.

More Than Formats

Other changes also redefine the landscape for notebook computers. All items relevant to electronic displays, from glass thickness and backlighting to power consumption and weight are undergoing dramatic changes (Fig. 4). To answer the needs for mobility, designers are focusing on the three principal considerations of weight, thinness, and power consumption.

For instance, the etching processes and the use of thinner glass than before help lower the panel weight. DisplaySearch believes that for notebook computer-use panels smaller than 15 inches, glass 0.5mm or thinner will be the main trend from the second half of 2006.

Prismatic backlights, which adopt a prismatic structure on the light-guide plate, improve the brightness and decrease the panel weight and thickness. However, prismatic backlights must overcome several obstacles including low yields and light leakage.

As an alternative, vendors in 2005 released commercial versions of light-emitting diode (LED) backlights for 11-inch and 12-inch panels in notebook computers. DisplaySearch expects panels larger than this to adopt LEDs as the light source during the second half of 2006.

Issues that relate to power consumption include a standard for extended battery life, timing controller technologies, and the liquid crystal itself. Specifically, to accommodate the requirements for extended battery life at 3W, engineers are cultivating low-power timing controllers, innovative driver ICs and advances in liquid crystal. The results of their efforts already have begun to make an appearance in some of the latest displays for notebook computers.

Moves in Monitor Trends

With shipments of 107 million units in 2005, LCD monitors account for 69 percent of the overall market for desktop monitors. DisplaySearch predicts that market permeation of LCD monitors will escalate to 80 percent in 2006, with shipments rising to more than 130 million units.

Monitors have evolved from large to larger, and this pattern continues. The ramp-up from fourth-generation to fifth-generation facilities enables 17-inch panels to replace 15-inch displays. In the third quarter of 2005, 15-inch XGA monitors accounted for just 15.3 percent of the global market for LCD monitors, while 17-inch SXGA models represented 58.2 percent and 19-inch panels accounted for 22.7 percent. DisplaySearch forecasts that by the third quarter of 2007, 17-inch SXGA monitors will slide to 37.9 percent while 19-inch monitors will take first place with 46.5 percent of the market. Monitors 20 inches and larger will account for 9.5 percent by that time.

Sizing Up the Strategies

There are two reasons that large panels continue to replace their smaller predecessors. Panel manufacturers are able to make increasingly efficient cuts from the motherglass, even without moving to the next generation. For instance, efficient cut patterns for fifth-generation motherglass, which measures 1,100 × 1,300mm, include 16-up for 15-inch panels, 12-up for 17-inch panels, and nine-up for 19-inch panels.

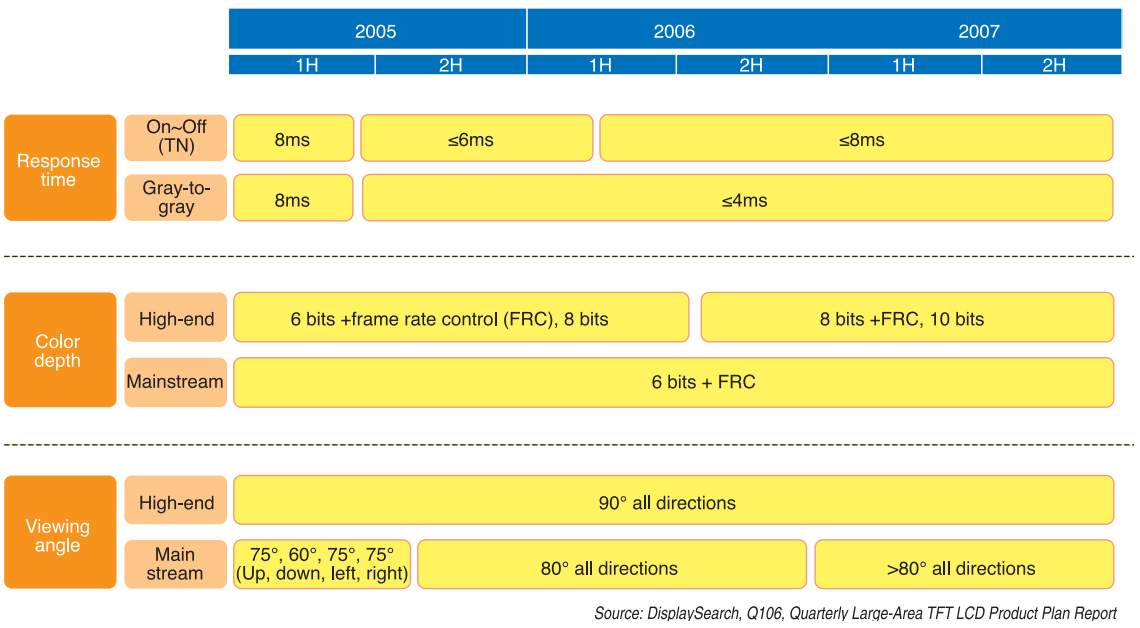
At the same time, many suppliers are using larger glass substrates than in the past to produce panels for LCD monitors. HannStar Display Corp. adopted 1,200 × 1,300mm as the motherglass dimensions at its fifth-generation fab. This move gave the company a decisive market lead by allowing it to cut three additional 19-inch panels from the substrate, while lowering the depreciation costs. Similarly, Chi Mei offers 19-inch wide-screen panels, which are compatible with a 12-up cut pattern from fifth-generation substrates. To end users, 19-inch wide-screen displays look much larger than 17-inch panels. In reality, the 19-inch wide-format screens only offer 14 percent more area than the 17-inch displays. Additionally, a 19-inch wide-screen display with a resolution showing 1,440 × 900 dots provides a better visual experience than a 17-inch screen with a 1,280 × 1,024-dot resolution. The depreciation costs are similar for 17-inch panels and for 19-inch wide-screen displays using the same cut patterns, but the materials cost for the 19-inch wide-screen model is only slightly higher than for the 17-inch display.

DisplaySearch figures that within a quarter after the release of the 19-inch wide-format monitors, monthly shipments reached more than 300,000 panels. Thus it seems that Chi Mei's product innovation was a success.

Wide Competition

In the "Monthly LCD Monitor Pricing, Pricing Specification and Design Win Database," DisplaySearch notes that in December 2005, Acer, Inc. aggressively marketed a 19-inch wide-format LCD monitor with a street price of US$279. This was US$8 less than Acer's own 17-inch SXGA LCD monitor, which was selling for $287. The Acer 19-inch wide-screen monitors certainly flew off the shelves, initiating a war of LCD monitors with wide aspect ratios.

In response, LG.Philips LCD, Chunghwa Picture Tubes, AU Optronics, and Quanta developed 20-inch wide-screen models. These companies all have sixth-generation fabs, which can



Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 6: Development trends for LCD monitor panels

accommodate 18-up and even 20-up cut patterns for the 20-inch wide-format panels.

With these moves, the TFT LCD manufacturers have split into two camps. In one camp, Chi Mei, Samsung, HannStar, Innolux Corp. and BOE-Hydis Technology Co., Ltd. offer 19-inch wide-format panels. In the other, Chunghwa, Quanta, LG.Philips LCD, and AU Optronics supply 20-inch wide-screen panels. Targeting the market for wide-screen displays larger than 20 inches, some companies are starting to develop 21-inch, 22-inch, 23-inch, 24-inch, 27-inch and even 30-inch wide-format panels.

Arguably, LCD monitors of these sizes would be too big for most desktops, either at home or in business offices. Therefore, the market for wide-screen LCD monitors might be too small to cover the development costs, especially if several panel manufacturers are targeting the same size or sizes. What is clear, though, is that panel manufacturers must adopt strategies that will make optimum use of their fabs, and that will give them full product lines to attract OEM customers and own-brand manufacturers. Clues to each manufacturer's strategy are detectable in comparisons of the cut patterns for different sizes of wide-format monitors (Fig. 5).

Analysis of these plans indicates that manufacturers consider Gen5 and Gen5.5 fabs as optimum for producing 19-, 22- and 24-inch versions of wide-format monitors. They find Gen6 fabs economical for manufacturing 20–, 22- and 24-inch wide-screen monitors. Gen7 fabs are optimum facilities for the production of 24-inch wide-screen panels.

Therefore, if efficiency is the primary consideration for panel manufacturers, it seems likely that within the wide-format category, 24-inch panels will replace 23-inch models; 19-inch and 20–inch models will compete directly with each other. Meanwhile, 22-inch and 24-inch monitors will dominate the sector for wide-screen models larger than 20 inches.

More Changes Ahead

Response, color and viewing angle also remain important considerations for those who buy display panels. Engineers have been just as busy on these fronts as they have been with the cut patterns, because these are key points for those developing monitor panels.

In particular, response time always takes the specifications spotlight. Some of the latest developments that address response times include the use of new liquid crystal materials, improvements in the driving method or the design, and changes in the sequence of the timing controller. With these advances, response times faster than 6ms now are possible for monitors.

With new dithering methods and fast frame rate control, monitors now can work with 16.7 million color, even if the video signal transmission works at only 6 bits. From the second half of this year, panels using 8 bits and frame rate control will achieve color depths similar to those of monitors that work at 10 bits. These 8-bit panels therefore will be able to compete in the market for high-end monitors.

Some of the latest polarizers control the angle of the liquid crystal on a discotic layer, thereby enabling viewing angles of 80° in all directions. Recent developments in viewing-angle films help manufacturers of TFT LCDs to expand the viewing angles of their products without changing the liquid crystal structure or the structure of the TFT LCD. Thus, these films offer a significant improvement in performance for only a moderate increase in cost.

The market for LCD monitors is large, with annual shipments of more than 130 million units. In the fourth quarter of 2005, LCD monitors with wide aspect ratios accounted for just 3 percent of the total market. In its "Quarterly Desktop Monitor shipment and Forecast," DisplaySearch predicts that the percent of wide-format models will grow to 5.3 percent by the third quarter of 2006, and to 8 percent by the fourth quarter of 2007, as panel manufacturers aggressively expand the market volumes.

A Look at TV Panels

Flat-panel TVs form a most promising use for TFT LCDs. Shipments of TFT LCDs to the TV market surged to 25 million units in 2005. DisplaySearch predicts that TV-use LCD shipments will surpass 42 million units in 2006.

However, in 2005, only the five leading suppliers, Samsung and LG.Philips LCD in Korea, Sharp in Japan, and AU Optronics and Chi Mei in Taiwan collectively shipped 90 percent of all TFT LCD panels for TV use. The technological barriers and the prolonged development periods necessary to qualify panel products mean that the LCD TV panel business concentrates in the hands of just a few suppliers.

Now, though, new panel suppliers are moving into the LCD TV segment. These contenders in-

Generation	Glass size (mm)	25"W	26"W	27"W	28"W	29"W	30"W	31"W	32"W	37"W	Fab
Gen4	650 × 830	2	2	2	2	1	1	1	1		Hitachi
	680 × 880	2	2	2	2	2	2	1	1	1	LG.Philips LCD, AU Optronics, Chunghwa, Chi Mei
Gen4.5	730 × 920	2	2	2	2	2	2	2	2	1	Samsung, Hitachi, LG.Philips LCD, Chunghwa
Gen5	1000 × 1200	4	4	3	3	3	3	2	2	2	LG.Philips LCD
	1100 × 1250	6	6	3	3	3	3	3	2	2	Samsung, AU Optronics
	1100 × 1300	6	6	6	4	3	3	3	3	2	AU Optronics, Chi Mei, SVA-NEC, BOE-Hydis, Quanta, Samsung
	1200 × 1300	6	6	6	6	3	3	3	3	2	HannStar
Gen5.5	1300 × 1500	8	8	8	6	6	6	6	6	3	Chi Mei
Gen6	1500 × 1800	12	12	10	8	8	8	8	8	6	Sharp
	1500 × 1850	12	12	10	10	8	8	8	8	6	LG.Philips LCD, AU Optronics, Quanta, Chunghwa
Gen7	1870 × 2200	18	18	15	15	12	12	12	12	8	Samsung, S-LCD
	1950 × 2250	18	18	18	15	15	15	12	12	8	LG.Philips LCD, AU Optronics, Chi Mei
	2000 × 2300	21	18	18	18	15	15	12	12	8	
Gen7.5 (G8)	2160 × 2460	24	24	21	18	18	18	15	15	10	Sharp, LG.Philips LCD
Gen8	2400 × 2800	32	28	24	24	24	24	18	18	15	

Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

Fig. 7: Economical cut patterns for 25- to 37-inch LCD TV panels

Table 1: 37- and 40-inch LCD panels and TVs, and their suppliers

	37-inch	40-inch
Panelization	6-up on Gen6 (1,500 × 1,850mm) 3-up on Gen5.5 (1,300 × 1,500mm)	8-up on Gen7 (1,870 × 2,200mm)
TFT LCD manufacturer	LG.Philips LCD, AU Optronics, Chunghwa, Chi Mei, Sharp, Quanta	Samsung, S-LCD
TV brands	Sharp, LG Electronics, Toshiba, Hitachi, JVC, Mitsubishi, BenQ, Encross, Daewoo, Kreisen, Philips, Polaroid, Syntax, ViewSonic, Westinghouse, Audiovox, Changhong, Haier, Hisense, Skyworth, TCL, Prima (Xoceco)	Samsung, Sony, JVC, Byd:sign, Encross, Mitsubishi, Skyworth, TCL, Prima (Xoceco), Amoi, Panda, Shinco, Hisense
TV brands with sets in both sizes	Samsung, JVC, ViewSonic, Encross, Mitsubishi, Skyworth, TCL, Prima (Xoceco), Hisense	

Source: DisplaySearch, Q106, Quarterly Large-Area TFT LCD Product Plan Report

clude Chunghwa Picture Tube, Quanta and BOE-Hydis. These moves promise to make LCD TV panels the most competitive segment in the TFT LCD arena during 2006. Although there will be strong competition on price and capacity, vendors also will play up product performance and specifications.

Now that Gen7 and Gen7.5 fabs are contributing to the overall production capacity for 40-inch and larger panels, 2006 will see severe competition between 37-inch and 40-inch LCD TVs, and between 42-inch LCD and PDP TVs.

The Cutting Edge

In the TV sector, as in the monitor sector, cut patterns are an essential aspect of each vendor's strategy (Fig. 7). Throughout 2005, the fastest-growing sizes for LCD TVs were the wide-format 26-, 27-, 32- and 37-inch models.

From now on, however, a war of costs and marketing will take place among the 32-inch wide panels from Gen5.5 fabs, from Gen6 fabs and from Gen7 fabs. Owners of Gen5.5 fabs claim their equipment investment costs are much lower than those for other fabs. Indeed, it is possible to argue that the total cost for 32-inch wide-format panels from Gen5.5 fabs is lower than the corresponding costs for 32-inch wide-screen panels from Gen6 fabs.

On the down side, however, Gen5.5 fabs can only use the three-up cut pattern to produce 37-inch wide-format panels. This does not provide sufficient volume to be competitive against the 37-inch wide-screen panels from Gen6 fabs. Therefore, Chi Mei, the only owner of a Gen5.5 fab, is developing methods to extract panels of multiple sizes from a single glass substrate. This will let the company make full use of its glass substrates.

Meanwhile, most TFT LCD suppliers continue to use their Gen5 facilities to produce 26- and 27-inch panels in standard and wide aspect ratios. At the Gen5 level, the two sizes and formats have similar costs.

Set for Battle

In observing channel sell-through activities in North America, DisplaySearch has noticed that in the fourth quarter of 2005, 40-inch LCD TVs began capturing market shares from 37-inch LCD TVs. This followed a spate of strong price and marketing promotions for several famous brands of TVs. For several weeks, sales of 40-inch LCD TVs surpassed those of 37-inch models. This competition became a hot topic for everyone in the TFT LCD industry. Some regarded the situation as a war between Gen6 and Gen7 facilities, because the 37-inch panels come from Gen6 fabs and are the result of six cuts, whereas the Gen7 fabs can cut eight 40-inch panels from 1,870 × 2,200mm substrates (Table 1).

Now that LG.Philips LCD has started to ramp up its 1,950 × 2,250mm fab, which is optimum for eight-up 42-inch LCD TV panels, it is likely that 40-inch LCD TVs will begin to feel some pressure from 42-inch models. DisplaySearch predicts that prices for 37- to 42-inch LCD TV panels will decline 3 to 5 percent each month starting from the second quarter and running through the end of 2006.

Enhanced Specifications

For LCD TV panels, as for monitor panels, development will target improvements in key specifications (Fig. 8). Response times will accelerate from 16ms to 4 or 6ms by the second half of 2006. Several panel manufacturers intend to release 32-inch panels that offer full high-definition capabilities (1,920 × 1,080 dots) by the end of 2006.

At the end of 2005, designers began using LEDs and flat fluorescent lamps (FFLs) in backlights, instead of the conventional cold-cathode fluorescent lamps (CCFLs). Most of the non-traditional backlight units are finding adoption in LCD TVs with screens of 32, 37 and 40 inches. In the near term, non-CCFL backlights are likely to become the mainstream for LCD TV panels measuring 50 inches and larger.

Other noteworthy technology developments address backlight issues as well. For instance, flashing backlights represent one of the most mature technologies for shortening the response time. Some manufacturers are apply U-shaped lamps in the backlight system, a move that decreases the CCFL count up to 50 percent, thereby lowering costs. Several manufacturers are adopting U-shaped lamps in 32-inch sets.

LG.Philips LCD was the first supplier of TFT LCDs to adopt external electron fluorescent lamps (EEFLs). With EEFLs, panel manufacturers can cut inverter costs and extend the service life. Companies that supply EEFLs are promoting their use for 37-inch backlight modules, and seem ready to overcome previous barriers to using EEFLs in extra-large displays.

Conclusion

Many market research activities focus on shipments and revenues only. Many financial analyses only discuss financial performance. DisplaySearch believes that the basic characteristics of the industry include the products that the panel suppliers are developing, as well as those that they ship daily. Through analysis of product plans, the strategies and strengths, weaknesses, opportunities and threats of each panel producer become apparent.

Every day, TFT LCD companies work on their product plans, product marketing, and product development programs. This includes process technology and components relevant to the process. These activities are not visible in the financial reports or in the shipment performance, but they have a deep influence on the competitiveness and potential of TFT LCD suppliers. DisplaySearch will continue its unique approach to market research by including a focus on TFT LCD product plans.

About This Article

The author, David Hsieh (david@displaysearch.com), is Vice President of the Greater China Market at DisplaySearch (www.displaysearch.com), now an NPD Group Company. This article is an abstract from the first issue of "The Quarterly Large-Area TFT LCD Product Plan Report," which DisplaySearch issued in January. A comprehensive report, it analyzes product and technology roadmaps, and discusses emerging trends including wide aspect ratios in LCD monitors, and the new environmental regulations in Europe. Previously David Hsieh worked in sales and marketing, production planning and production engineering at Taiwanese and Japanese LCD module manufacturing companies. His educational background includes a degree in industrial engineering.

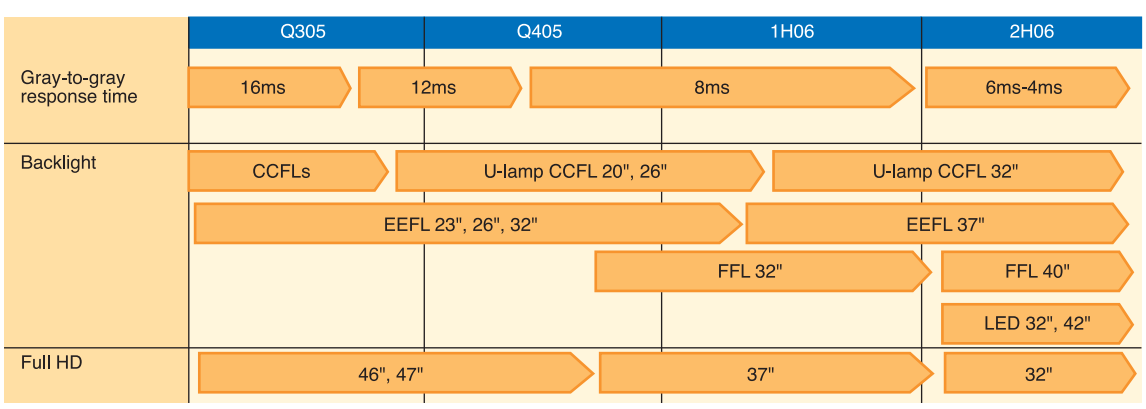


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Fig. 8: Development trends in TV-use LCD panels