특 집

Forecasting the Future of the Desktop Monitor Market

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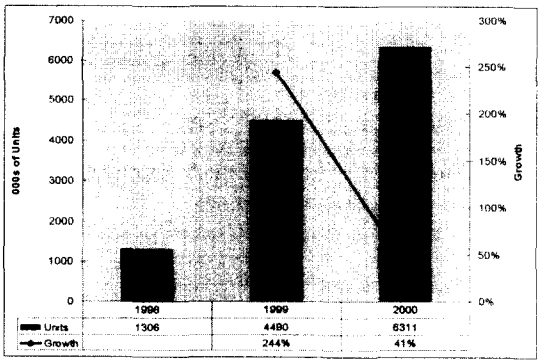
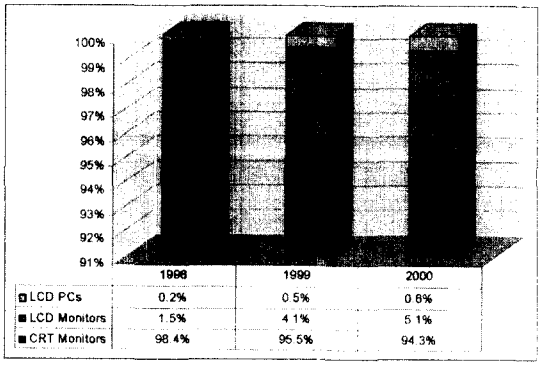
Abstract

The LCD monitor market enjoyed rapid growth in 1999 but only experienced modest growth in 2000. It is now poised for rapid growth from 2001 to 2005 as prices and costs decline. Price reductions will enable LCD monitors to move beyond limited vertical markets and extend into the broader consumer markets. This article will examine the future outlook for LCD monitors and provide a growth forecast.

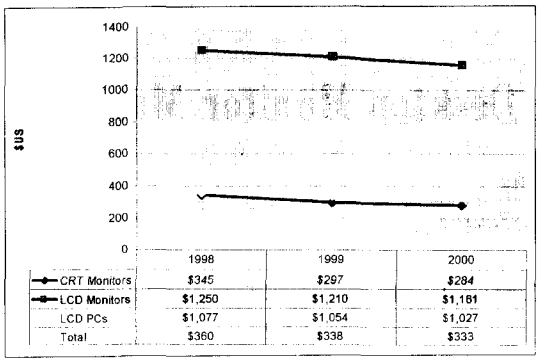
LCD monitor shipments rose 41% in 2000 to over 6 million units as shown in 〈Figure 1〉, accounting for just a 5.1% share of the worldwide desktop monitor market as shown in 〈Figure 2〉. LCD monitor shipments were plagued by rising LCD prices. The average LCD monitor ASP fell 4.1% in 2000 to $1161 as shown in 〈Figure 3〉, while the average CRT monitor actually fell faster at 4.5% to $284. Thus, the price difference between LCD and CRT monitors actually widened in 2000. This is harmful to the LCD monitor market as past data shows that it is an extremely price sensitive market. As indicated in 〈Figure 4〉, sequential price reductions have tended to result in significant shipment growth. Growth has occurred despite the minimal price reductions due to strong need from space sensitive applications, wider availability, improvements in display quality, availability of dual interfaces, increased functionality from integration of additional features, new applications, cost of ownership benefits, positive reference



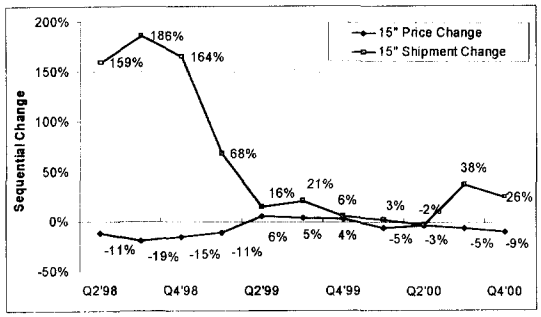
〈**Figure 1**〉 1998-2000 LCD Monitor Unit Shipments



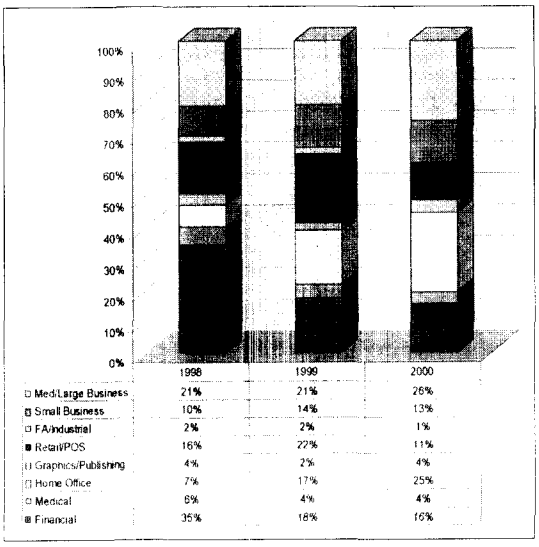
〈**Figure 2**〉 1998-2000 Desktop Monitor Shipments By Type(% Basis)



〈**Figure 3**〉 1998-2000 Desktop Monitor ASPs By Type



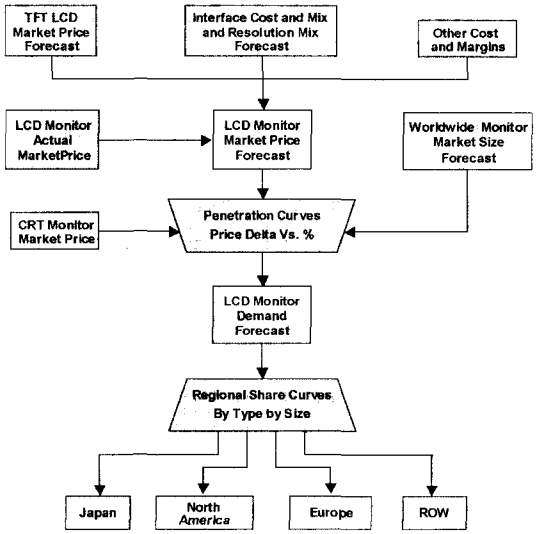
〈**Figure 4**〉 15″ LCD Monitor Shipment Vs Pricing Changes



〈**Figure 5**〉 1998-2000 LCD Monitor Shipments By Application

examples and the status or cache that comes with using new technology. However, the LCD monitor market has been relegated to vertical markets to date. As shown in 〈Figure 5〉, the home office or consumer market reached a high of 25% in 2000 with the financial, medical and retail/POS markets accounting for 31%. The corporate market currently accounts for the highest share at 26%.

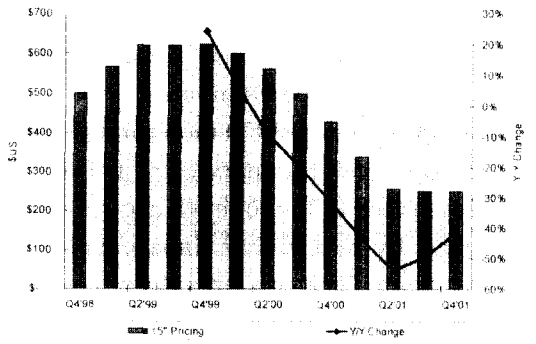
In order for LCD monitor manufacturers to reach the consumer market, prices will have to fall significantly. As shown in 〈Figure 6〉, DisplaySearch calculates its LCD monitor shipment forecast based on price/penetration curves comparing similar-sized LCD and CRT monitor prices. Future LCD monitor prices are determined by determining the LCD panel price, the interface electronics price and costs for overhead, assembly and distributor margins. Our price/penetration curves are fine-tuned every quarter as we gather



〈**Figure 6**〉 LCD Monitor Market Calculation Flow Chart

shipment and pricing information on a quarterly basis. Rather than price ratios, the price-penetration curves are based on the absolute price difference between LCD and CRT monitors.

Fortunately for LCD monitor manufacturers, LCD and interface electronics prices are decreasing. LCD prices are falling for LCD monitors due to excessive investments in capacity in 1999 and 2000. Equipment spending rose over 100% in both 1999 and 2000 resulting in capacity rising 147% from 1999 to 2001 to 7 million square meters. Demand has not kept up with the surge in supply. The over-supply is resulting in sharp price reductions. As shown in 〈Figure 7〉, prices for 15″ LCDs will fall to $258 in Q2'01, down 54% Y/Y. The decline has been particularly share in Q1'01 with average prices falling $29 in January, $28 in February and $53 in March. Prices are expected to rise slightly in 2002 due to a significant decline in 2001 capital spending due to reduced profitability and increased demand resulting from the reduced LCD monitor prices. However, investment is expected to rebound in 2002 putting further downward pressure on LCD prices.



〈**Figure 7**〉 Q4'98-Q4'01 15" LCD Pricing and Y/Y Changes

〈**Table 1**〉 Interface Electronics Descriptions

Front End Components	Image Processing	Other
• ADC, PLL, pre-amp and/or DVI receiver • Video • VGA and/or DVI connector • Glue logic	• Scaler • Frame buffer • MCU with RAM/ROM • OSD • Gamma control, zoom/shrink • Color control, PIP • Flash ROM, DDC/EDID E PROM • Reset IC, crystal, other glue logic	• PCB • Power • Other glue • Control board to panel board cable & connector

In addition to falling LCD prices, we expect to see interface electronics prices fall as well. Interface electronics can be segmented into three categories-front end components, image processing and other-as shown in 〈Table 1〉 and described below.

We believe there are four implementations of LCD monitor interface electronics, which will be described below :

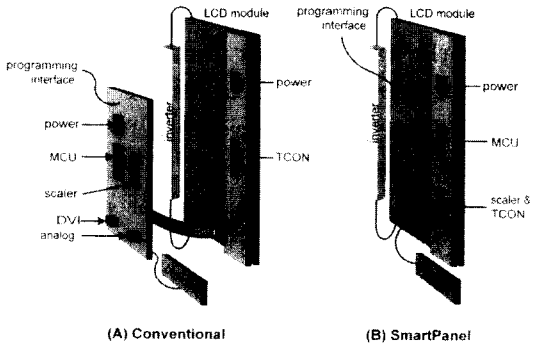
- Discrete
- Integrated
- SmartPanels Phase 1
- SmartPanels Phase 2

The discrete approach features no integration of the front end components and image processing ICs. This is the most expensive approach as it is burdened by the highest part count, largest PCB and additional glue logic. A discrete dual solution could feature a separate DVI receiver, ADC, PLL, scaler and microprocessor all of which have already been integrated by multiple product offerings from Genesis

Microchip and Sage. One advantage of this approach, however, is the ability to use best of breed components in all areas such as the top-of-the-line ADCs and top-of-the-line scaler ICs. It also allows for increased flexibility as interface ICs and image processing ICs can be mixed and matched depending on the configuration. However, due to the increased costs, which can be significant vs. alternative approaches, the industry is moving away from discrete approaches.

The integrated approach was originally developed by Paradise Electronics, which was later acquired by Genesis. Paradise was the first company to integrate the ADC and the scaler. Silicon Image was the first company to integrate a DVI receiver with a scaler and Arithmos, later acquired by ST Micro, was the first company to developed an integrated dual solution with a TMDS receiver, ADC and scaler all in one IC. Benefits of the integrated approach include reduced silicon costs, a smaller PCB and reduced glue logic costs. The cost reduction from moving to the integrated approach ranges from $6-$16 depending on the resolution. As a result of the significant cost reduction benefits, this approach is gaining popularity. Concerns with this approach include the level of quality of all of the components. For example, an external PLL may be required if the internal PLL does not meet requirements. A controller supplier may be at risk in the integrated approach if it does not establish best of breed capability in all areas.

SmartPanels take the integrated approach one step further. While the integrated approach reduces the part count and significantly shrinks the controller board, SmartPanels add all electronics to the panel column or row boards eliminating the monitor controller board completely as shown in <Figure 8>. Other benefits of the SmartPanel approach include:



<Figure 8> Conventional vs. SmartPanel Side View Schematics

- Eliminating the power circuitry as the controller circuitry can utilize the existing power source on the column board.
- Integrating the panel's timing controller (TCON);
- Eliminating one instance of testing the panel. Typically, the panel is tested after all the panel electronics are added and then again after all of the monitor electronics are added. By adding the monitor electronics in the LCD module process, the additional test and inspection step can be eliminated.
- Simplifying the LCD monitor assembly process and eliminating the OEM. Today, most LCD monitors are manufactured by an OEM in Japan, Korea or Taiwan which procures the panel from the panel supplier, adds the LCD monitor electronics and the inverter, manufactures or procures the plastic

housing, provides the power brick and cables, tests and assembles the monitor, and inventories and ships the final product to the brands regional warehouses. With SmartPanels, both the LCD monitor electronics and inverter will be integrated into the LCD monitor module. Thus, the LCD monitor OEM must only manufacture the plastic LCD monitor housing, insert the finished module into the plastic LCD monitor housing, provide the power brick and PC to monitor cable, and inventory and ship the product. However, because of the simplicity of assembling SmartPanels, brands will likely bypass the LCD monitor OEM and use regional assemblers, which can perform all the tasks of the LCD, monitor OEM. The elimination of the monitor OEM results in a reduction in logistics costs as the monitor module is now shipped one less time.

- Dramatically reducing labor associated with the interface electronics. In SmartPanels, labor will be performed in the TFT LCD module process.
- Reducing the thickness and weight of LCD monitors. By eliminating the monitor controller board, cable and connector, the LCD monitor can be manufactured thinner and lighter.
- For LCD monitor controller suppliers, it increases the value added.

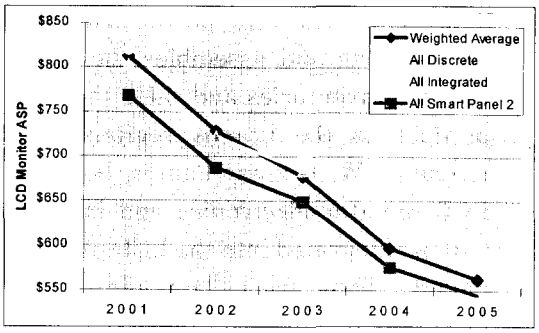
Concerns with this approach include :

- Yield loss associated with integrating the TCON ;
- Need to redesign the panel controller board to accommodate the LCD monitor electronics ;
- Lack of working relationships between controller IC suppliers and panel suppliers ;
- Reduced flexibility due to the custom nature of the TCON. TCONs are typically specific to a type of driver ICs on the panel. Thus, a different integrated controller will be needed if the driver ICs are changed unless the integrated controller is programmable. It is likely the industry will quickly move to programmable integrated controllers. Otherwise, panel suppliers will have to carry multiple integrated controllers.
- Need to carry both SmartPanel and non-SmartPanel products increasing part numbers and complexity.
- Panel suppliers lack of software knowledge regarding the OSD/programmable interface. Panel suppliers would benefit from cooperation with existing monitor OEMs in this area.
- Panel suppliers potential reluctance to take ownership for the inverter.
- Concerns with robustness of the connector being on the panel rather than on a separate PCB.
- Monitor OEMs exerting strong influence over panel suppliers. Because there will be a transition period before SmartPanels dominate the market, LCD monitor OEMs will see their current panel suppliers as competitors and panel suppliers will view their current LCD monitor OEMs as potential competitors. This could result in monitor OEMs providing incentives to panel suppliers to delay their entry into

the production of SmartPanels as long as possible. For example, significant business could be promised to panel suppliers who delay their entry into SmartPanel manufacturing.

The industry is likely to adopt SmartPanels in two phases. In Phase 1, the integrated controller IC will be moved to the panel controller board, but the TCON will remain a separate IC. Or, in what the industry is calling Smart Integration, a second PCB will be attached to the panel controller board. In the latter approach, the existing panel controller board does not need to be redesigned and there is no TCON integration. However, this approach will be burdened with a larger PCB and higher chip cost than in Phase 2 when the TCON is integrated. In Phase 2, all the circuitry is placed on the panel controller board and the TCON is integrated onto the panel. This approach will result in the lowest costs due to savings from TCON integration and a smaller PCB.

〈Table 2〉 reveals interface costs for a 15″ XGA resolution dual interface LCD monitor including the TCON. As indicated, the difference in controller IC silicon (interface+image processing) is relatively insignificant between all 4 implementations. On the other hand, the cost savings are significant in other components. By eliminating the monitor controller PCB, costs can be reduced by over $8 as the additional costs of the panel controller board are insignificant. In addition, bypassing the LCD monitor OEM and instead shipping direct to a regional assembler is expected to result in at least $5 in logistics costs reduction. In addition, other components such as power circuitry and glue logic are reduced resulting in nearly $22 in cost savings between the discrete and SmartPanel Phase 2 approaches. When margins and overhead are incorporated, the cost savings can reach over $50 as shown in 〈Figure 9〉. This results in additional shipments of nearly 10 million units in 2005 as shown in 〈Figure 10〉.

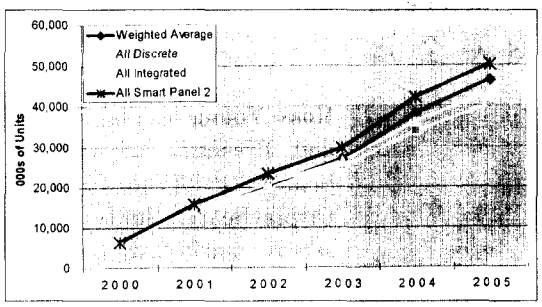


〈**Figure 9**〉 LCD Monitor ASPs By Interface Implementation

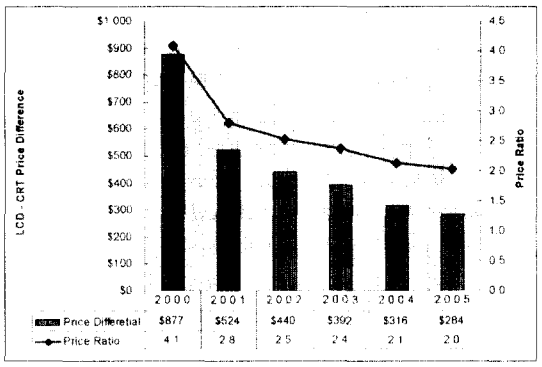
〈**Table 2**〉 Q2'01 15″ XGA Dual Interface Costs By Implementation Including TCON

	Controller IC Silicon	TCON	Total Controller Silicon	PCB	OEM Shipping/ Logistics	Total PCB/OEM Logistics	Other Costs*	Total
Discrete	18.38	3.90	22.28	8.91	5.00	13.90	17.18	53.37
Integrated	17.52	3.90	21.41	3.96	5.00	9.00	15.55	45.92
SP Phase 1	17.52	3.90	21.41	0.99	0.00	1.00	11.86	34.26
SP Phase 2	19.44	0.00	19.44	0.50	0.00	0.50	11.86	31.79

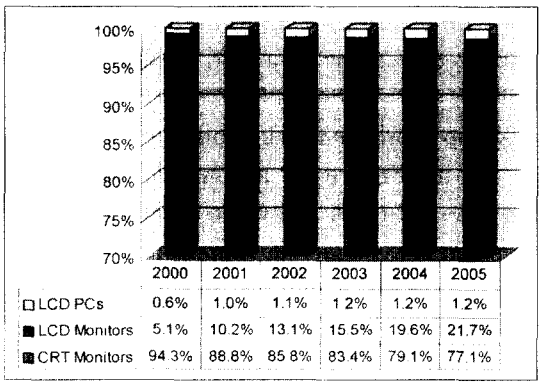
* Connectors, Cables, Other Chips, Labor



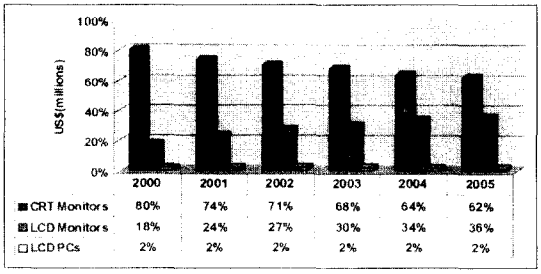
〈**Figure 10**〉 LCD Monitor Shipment Forecast By Interface Implementation



〈**Figure 11**〉 LCD-CRT Price Different and Price Ratios



〈**Figure 12**〉 2000-2005 Desktop Monitor Shipments By Type(% Basis)



〈**Figure 13**〉 2000-2005 Desktop Monitor Revenues By Type(% Basis)

Based on the cost reduction opportunities from falling LCD monitor prices and reduced interface electronics costs, the price differential between an average LCD monitor and average CRT monitor is expected to fall to $284 in 2005 with a price ratio of just 2.0 as shown in 〈Figure 11〉. Our average LCD monitor price forecast by size is shown in 〈Table 3〉. As a result of the narrowing price gap with

〈**Table 3**〉 LCD Monitor Price Forecast By Size

Size	2000	2001	2002	2003	2004	2005	CAGR
12.1 inch	$713	$490	$448	$428	$383	$361	-13%
13.3 inch	$728	$516	$478	$456	$413	$391	-12%
14.1 inch	$854	$638	$568	$541	$495	$472	-11%
15 inch	$1,009	$666	$584	$540	$487	$455	-15%
>15 inch	$1,448	$910	$769	$675	$581	$530	-18%
17 inch	$1,760	$1,136	$970	$877	$769	$713	-17%
18 inch	$2,850	$1,801	$1,476	$1,311	$1,129	$1,031	-18%
19 inch	$4,703	$2,218	$1,874	$1,669	$1,431	$1,303	-23%
20 inch	$4,451	$2,582	$2,210	$1,981	$1,710	$1,552	-19%
ASPs	$1,161	$813	$728	$678	$597	$562	-14%
Price Change	-4%	-30%	-10%	-7%	-12%	-6%	

CRT monitors, LCD monitor shipments are expected to grow at a 49% CAGR to 46.25 million units and reach a 22% of the global desktop monitor market on a unit basis as shown in 〈Figure 12〉 and a 36% share on a revenue basis as shown in 〈Figure 13〉. In summary, because of rapid falling prices, the LCD monitor market is poised for rapid growth.

저 자 소 개

Ross Young is the founder and President of DisplaySearch. Prior to founding DisplaySearch, he served in senior marketing positions at OWL Displays, Brooks Automation, Fusion Semiconductor and GCA in the driver IC, flat panel automation, etch and clean and lithography markets respectively. He also consulted to SEMATECH and numerous semiconductor and flat panel-related manufacturers prior to founding DisplaySearch. He authored a book on U.S.-Japan high tech competition entitled *Silicon Sumo : U.S.-Japan Competition and Industrial Policy in the Semiconductor Equipment Industry*, published by the University of Texas, which offered a unique perspective on U.S. -Japan competition. Ross has been an invited speaker at more than 13 conferences and has had articles published in more than 12 periodicals. Ross was also named to the VLSI Research Executive All-Star Team in 1994. He was educated at the University of California at San Diego (UCSD), Australia's University of New South Wales, UCSD's Graduate School of International Relations and Pacific Studies, and Japan's Tohoku University. Ross is proficient in Japanese, having received a Japanese Ministry of Education Fellowship from prestigious Tohoku University. Ross Young can be reached at ross@displaysearch.com