

Key Thoughtz:

- AMLCD fab investments are more fungible today than in the past.
- Undifferentiated assets create price pressure in multiple market segments.
- Producer prices decline faster than their cash costs do.
- Scale benefits decrease over time but aid companies with affiliated brands.

AMLCD Producer Trends

From Big Glass to Small Panels

Commencement of TFT fabrication on tenth-generation glass substrates will be one of the more impressive achievements by LCD producers this year. I recall having doubts ten years ago that glass larger than sixth-generation substrates would find use in many fabs. Boy was I wrong. My cost model was OK, sixth-generation substrates remain near the point of diminishing returns based on cash cost of sales. The assumption that cost was a key factor in panel makers' decisions was not OK. Producers committed themselves to building fabs that support panels of 50 diagonal inches or more. That was not irrational: out-of-home advertising and messaging systems that include such large panels provide growth opportunities in markets where consumer demand has weakened in recent quarters. Given such applications and the retail shelf space freed by reduced Plasma TV offerings, one would think that the average size of AMLCD panels would be increasing rapidly. The numbers indicate the opposite.

DisplaySearch data shows that the average glass substrate size has increased faster than the average panel size has in recent years. There are four reasons for this.

- New techniques for cutting glass and relieving stress have increased yields for center panels with four cut corners.
- Panel makers have rebalanced cell assembly lines or outsourced panel cutting.

- Designers and manufacturing engineers have solved other problems once considered intractable.
- Producers value flexibility, the ability to make serve a variety of market segments with a single fab. That remains a given but it is an unexamined assumption.

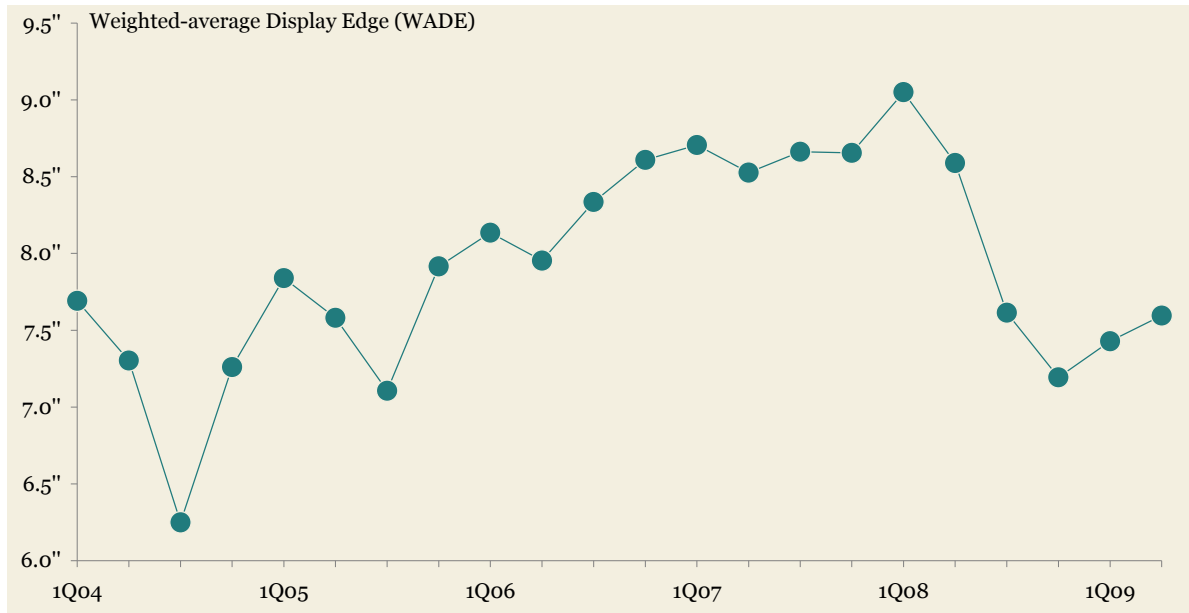
As a result, the AMLCD industry average number of panels per substrate increased from 13 in 2002 to 36 in 2008. At first, the increase came from converting second or third generation plants from PC display fabrication to mobile phone display production. Lessons learned from that transition allowed producers to imagine making many TV panels from much larger substrates. Development of one-drop filling systems as alternatives to traditional liquid-crystal injection processes was a key step towards realization of that vision. The traditional injection process time increased non-linearly with panel size. One-drop fill process time was less variable (but still varies with the cell perimeter). Injection under pressure caused cells to swell, which added to distorting stresses during cutting. One-drop fill provided means for reducing stress. Until such processes were perfected, making more than six or eight panels on a substrate led to low yields. Strong effort by panel designers and process engineers led to an average 23 panels per substrate in 2004 and to 32 in 2006. The average decreased slightly in 2007 as producers introduced larger HDTV panels but weaker demand in rich nations during 2008 caused the average to rise again as consumers sought bargains. Strong appetites for smart phones worldwide added to the number of smaller panels demanded.

Market Pressure Squeezes Panels

Recent numbers create a picture different than the one people may expect to see after reading about big fab investments. A more accurate picture comes from disclosures by AU Optronics. That leading producer in Taiwan has not invested as much in next-gen fabs as Samsung Electronics or Sharp have since 2007 but it remains competitive in all

AMLCD market segments. Dividing its reported display area shipments by its reported display shipments generates the following chart. The weighted-average display edge (WADE) is an alternative to diagonal size that remains independent of aspect ratio. It is simply the square root of the average display area. If we translate that into HDTV diagonals, we see the average size of AU Optronics panels increasing from 11.8" in Q1'04 to 13.8" in Q1'08. Since then, the average 16:9 diagonal fell to 11.0" in Q4'08 but rebounded to 11.6" in Q2'09.

FIGURE 1 WEIGHTED-AVERAGE DISPLAY EDGE FOR AU OPTRONICS (INCHES PER SIDE)



Source: AU Optronics disclosures, 2004–2009

Conditions for other panel producers may be similar, despite investments in larger plants. Rapid expansion of consumer markets in China or India is unlikely to mean rapid expansion of demand for 52" HDTV panels. Indeed, consumers in Europe and the USA are seeking bargains in smaller LCD TV sets and behaving more like consumers in emerging markets than they have in the past. The good news is that producers have become adept at cutting 35 or more TV panels from a large substrate. Their new fabs can support such demand.

The bad news is that premium prices for larger panels were part of the rationale for investing in larger substrate fabs. Larger

substrates cost more per square inch than smaller ones do. Glass suppliers face greater yield risk and they must invest in new foundries, so costs go up. Overhead efficiencies (e.g. more output per engineer) offset some of this cost increase but the overall effect may be neutral. Without premium prices for lots of 52" or larger panels, new fabs may have little positive effect on producer profits.

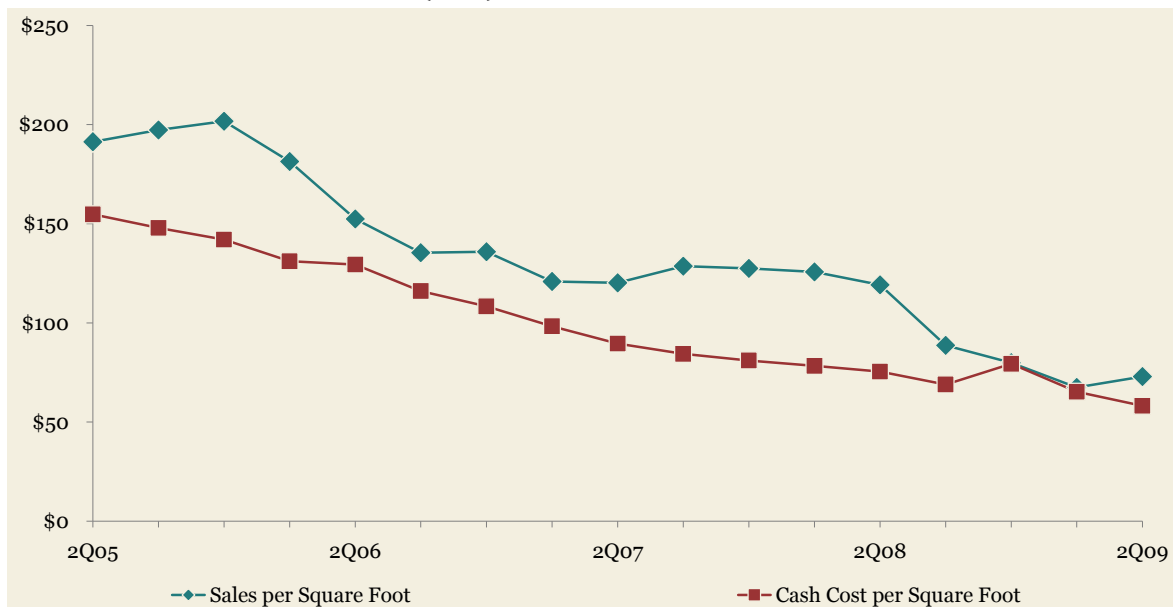
The combined numbers for AU Optronics and LG Display illustrate such effects in Figure 2 on page 2. If we add their reported area sold, we obtain the following chart. (Their results

are added to offset the differences in their reporting currencies relative to the dollar and to represent the total industry better.) The diamonds plot sales per square foot and the squares plot cash cost (ignoring depreciation charges). Their combined sales per square foot have fallen 22% a year since 2005 but their cash cost has fallen slower at 21% a year. At those rates, producers are heading towards a zero margin condition despite increases in scale. Indeed, zero cash margin was reached in Q4'08 and in Q1'09. Fortunately, cash margins improved in Q2'09 but investing more seems to deliver less.

Readers who find this surprising might think about the effect of new panel products. For example, there has been a lot of excitement

about netbooks and other low-cost mobile displays. Notebook designers deserve congratulations for creating new value propositions for consumers, but what have they done for panel producers? A growing market for mini-notebooks decreases the average size of notebook panels. The cost of electronics and backlights rise as a portion of production cost. In addition, smaller pixels drive post-fabrication costs upwards. More panels-per-substrate has a less positive effect on operating performance over time.

FIGURE 2 SALES AND CASH COST PER SQUARE FOOT FOR AU OPTRONICS PLUS LG DISPLAY (USD)



Source: AU Optronics and LG Display disclosures, 2005–2009

More panels per substrate have another effect on the industry that may come as a surprise to some. If fab generations were differentiated by the market segments they served, a capacity increase in one substrate size might have little effect on panel supply or price in markets served by other generations. In that happy case, a 50% increase in eighth-generation capacity would not decrease the price of monitor panels. The sad case is that it does because producers have learned how to make many monitor panels on a eighth-generation substrate. Thus, while there is little capacity growth in older fabs, the markets they serve are served by newer plants as well. There is no where to hide. Niche market opportunities are few and really small.

That’s why we saw such rapid price declines for digital picture frames. The niche couldn’t hold all the capacity that producers had to allocate for it. Expect to see more pile-in behavior as panel producers add undifferentiated capacity.

Strategic Implications

Generating enough cash flow from operations to cover the cost of new fabrication plants becomes more difficult as cash margins narrow. Producers with less pricing power or less capacity (scale) than the leaders have

may become unable to afford new plants without taking on large amounts of debt. Loans are hard to find today (outside China) and expensive. It therefore comes as no surprise that producers arrange project funding with brands. The recent alliance between Sharp and Sony is a good example. Sharp sought scale but its brand demand was less than a large, next-gen fab could supply. Sony sought secure supply of panels for its global brand. By spinning the new fab out as a subsidiary, Sharp allowed Sony to fund part of the project without taking a stake in all of Sharp. Together, these brands can share the benefit of scale the tenth-generation plant may provide. There have been similar deals made between semiconductor companies recently. These make sense given the amount of investment and risk involved.

Leading brands such as Panasonic, Samsung and Sony have integrated rearward through investment in panel producing assets already. Panasonic acquired assets from Hitachi and IPS Alpha Technology. Samsung was integrated vertically but it took control of some Samsung SDI assets recently. Sony formed industrial joint ventures with Samsung and Sharp. In addition, LG Electronics has increased influence and reliance on LG Display as Philips Electronics restructures its TV business. Other brands without significant AMLCD capacity have moderated their aspirations, also. These include Mitsubishi and Toshiba. Meanwhile, new brands are emerging such as Videocon in India or Vizio in the USA that are more adept at leveraging merchant producer capacities. Such asset-light strategies work well until the brand outgrows the supply of merchant panels, which depends on the surplus remaining after merchants serve leading brands. Over the long term, then, it seems likely that leading regional or global brands will need some supply agreement or capacity-sharing arrangement with leading panel producers.

If so, what better place to situate such ventures than China? That nation wants high-tech employment and infrastructure and it is eager to stimulate such development. There are several provincial networks for panel production and TV assembly, already. The time seems right for the panel industry's center of gravity to shift from Korea/Taiwan to China. The two leading producers in Korea resemble Intel already: they retain key fabs in their native country while running back-end assembly in other countries. Taiwanese companies still face legal barriers to exporting assets or expertise but these may lessen as Taiwan strengthens its relationship with the mainland. After all, Chinese business culture is more oriented towards economic growth than towards economic value added. What better place for a low-margin, high-volume business?

In summary, the numbers often show a different picture than the ones we imagine while reading press releases. Despite exciting announcements of newer, larger substrates, panel producers have used these to make

more panels for mainstream markets. Cash costs have not fallen as fast as commodity prices have, so profit margins have decreased. This condition might change when employment in Europe and the USA recovers and consumers start spending again. No one knows for certain when that will occur, but it may be several quarters from now. In the meantime, producers will be fighting for every penny of margin as more eighth and tenth generation capacity comes on line.

—by David Barnes for BizWitz LLC, a consultancy specializing in electronic display and imaging business decisions throughout the supply chain from raw materials through retail, worldwide

