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# Display industry outlook for 2011: Speculative thinking about the future of LCDs and OLEDs

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# Agenda

- Our 2004 predictions: How did we do?
- The rules on the display industry in 2011
- Our 2011 views on the future of the industry

## In 2004 we had 10 key points:

(see [www.hendyconsulting.com/downloads/industry\\_outlook.pdf](http://www.hendyconsulting.com/downloads/industry_outlook.pdf))

1. Investments in Gen 6/7 fabs would lead to oversupply
2. Consumer retail channel mark-ups would inhibit demand elasticity on panel pricing
3. Gen 7 fabs might not improve historical outcomes from a financial perspective
4. Display players would become materials traders, primarily
5. The industry might see the following developments:
  - A. Forward integration
  - B. Rearward integration
  - C. New equipment approaches
  - D. M&A and consortia behaviour
  - E. New business models, including semi-finished products
6. We mapped possible survivors and their industry structure

## Our scorecard: we underestimated how fast retail prices would fall and how quickly supply chains would adapt but our strategic value insights were on target

- Investments in Gen 6/7 fabs would lead to oversupply
- Consumer retail channel mark-ups would inhibit demand elasticity on panel pricing

Prices fell faster and chain lengths shortened to clear the new capacity. Cycles continued and economics declined

- Gen 7 fabs might not improve historical outcomes from a financial perspective

Gen 7 fabs delivered better outcomes as long as they made much larger TV panels

- Display players would become materials traders

That's what happened

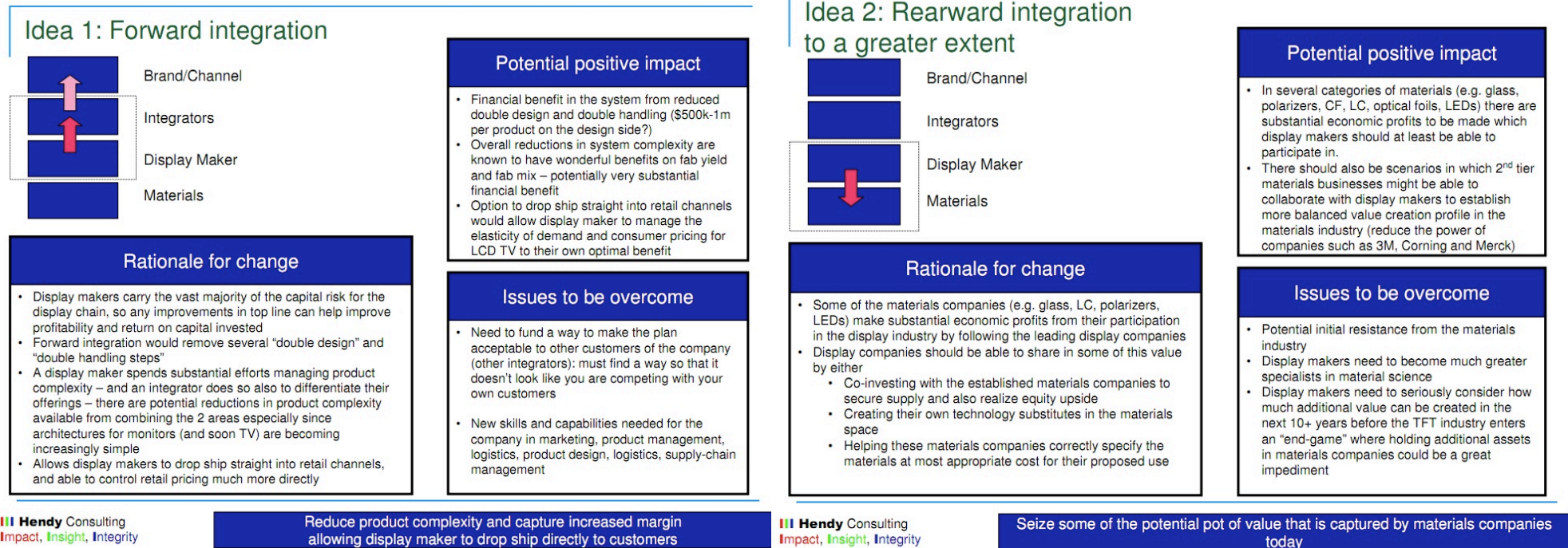
- The industry might see the following developments

- Forward integration and LCM JV became key strategies
- Rearward integration increased
- Some players made end products
- Some used project funding
- New equipment concepts were offered but LCD makers avoided risk

- We mapped possible survivors and their industry

We were not far off given the time scale

# The comments on forward and rearward integration were important then and remain important now:

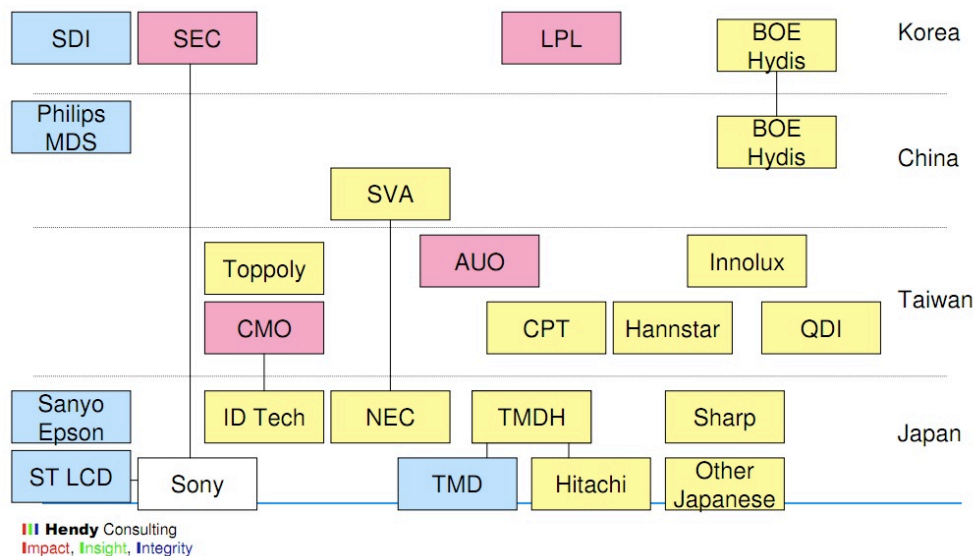


- The basic business strategy of the Foxconn/CMI group and of the recent high number of (LCM) module JVs for LCD TV are testimony to the strategy of forward integration
- In general the Taiwanese and SEC have grasped the concept of rearward integration best, although LGD has made some use of group companies
- SEC's 50% ownership of SCP is important

# In particular we made predictions on the future players in the industry according to trends we saw at the time:

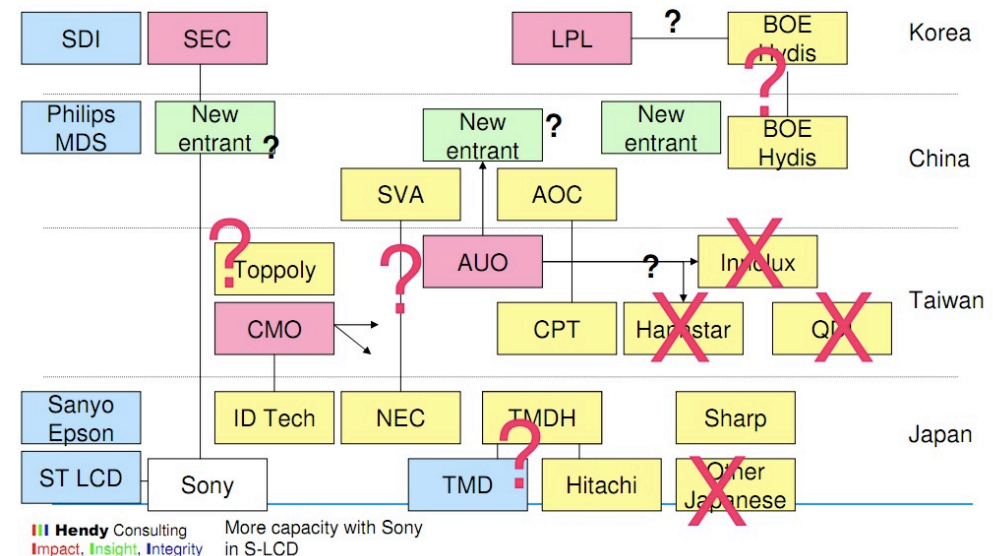
## 2004 players

Industry outlook (Today's leaders)



## 2004 prediction of future

Industry outlook: ..and if industry over supply continues, we will begin to see exits...



- The notion that Taiwan would seek further consolidation and that CPT and Hannstar would be marginal businesses was spot on. New Chinese entrants in combination with the majors: that is playing out now
- The notion that CMO, AUO, LPL (LGD), SEC and SDI (now SMD) and Sharp would remain important was also clear
- PVI acquired Hydis (while we imagined it might be acquired by a Korean major)
- This picture over-emphasises the role of Sanyo, STLCD and ID Tech. Philips MDS merged with Toppoly, CMO and Innolux to make the industry number three. SDI split out its display business to merge with smaller SEC fabs as SMD.

## Implication of our look back:

- We called the view on Gen 6/7 too early, but it was clear that fabs did meet diminishing returns to larger and larger glass. Experience shows Gen 8 is the practical economic limit with Gen 10 not proven successful.
- The LCD TV substitution curve was the major driver, and we called it correctly that when this growth was exhausted that the industry would mature
- Years before the trends emerged, we called it correctly that value chain plays, both forward and rearward integration would be important, including module JVs with customers and equity participations in materials groups
- Consolidation has occurred but not with the exact players that we might have foreseen
  - Current outcome has reinforced the value that technology can bring to smaller players living on the edge financially: Hitachi and TMD have survived thus far, though Hitachi is in rumoured in play
  - PVI has pulled up its position through the long term bet on E-readers. We didn't even have PVI on our market map in 2004. We always believed that e-readers would only mature with the availability of eBooks, which Amazon made happen
- We correctly called the direction of economics. Players seized some rearward value, but have not worked hard enough to change the game. We would like to have seen more soda-lime glass experiments and more functional integration to create high end propositions
- We over-estimated the level of innovation that equipment players would deliver. Is there an opportunity now for equipment players to show the display industry a new path?

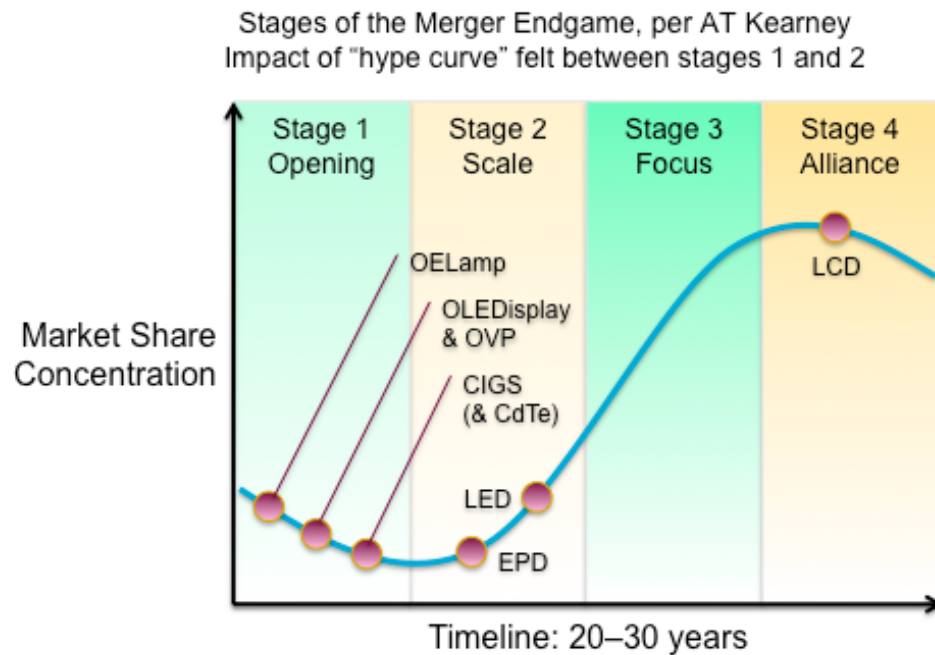
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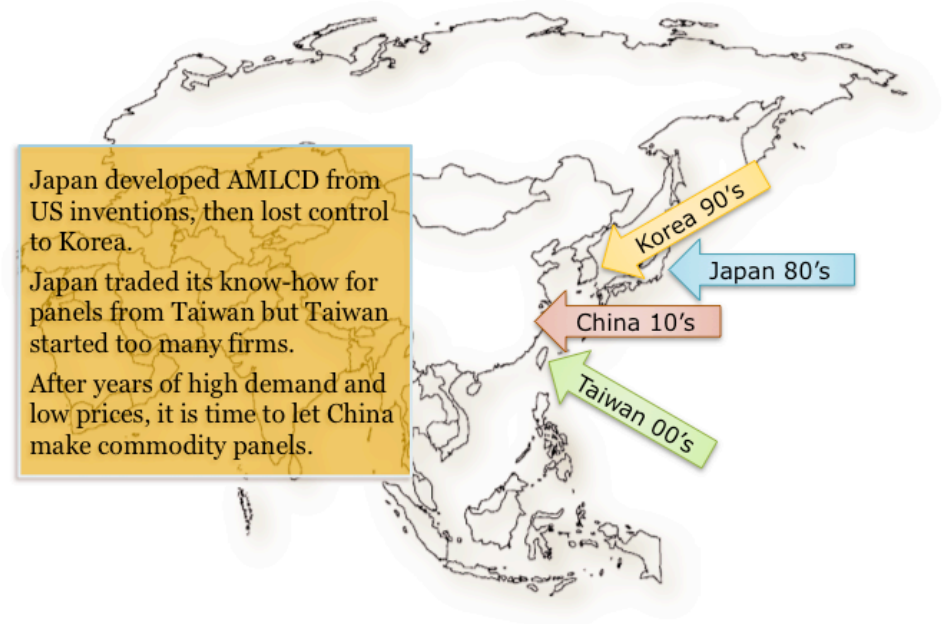


The display industry today: Mature and at the top of the LCD TV first-cycle replacement curve.

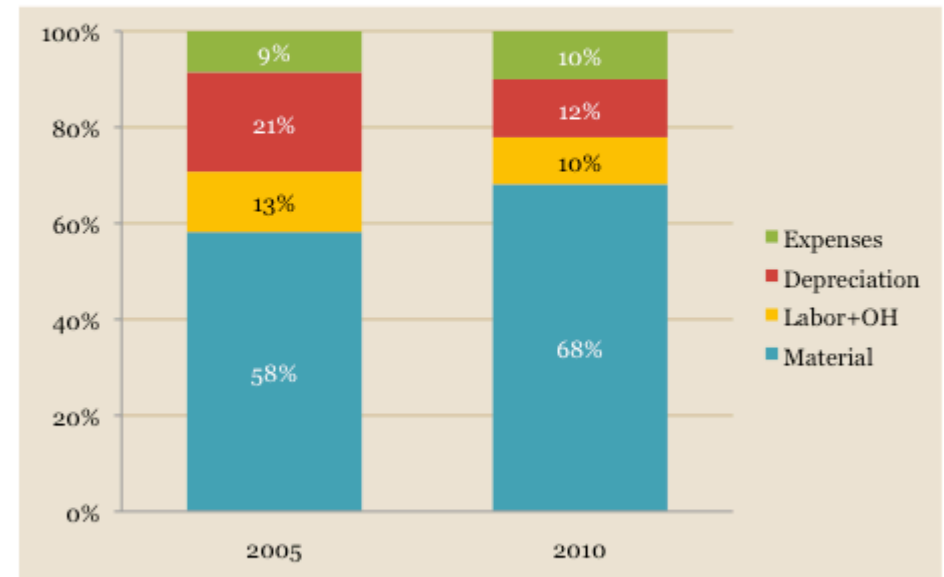
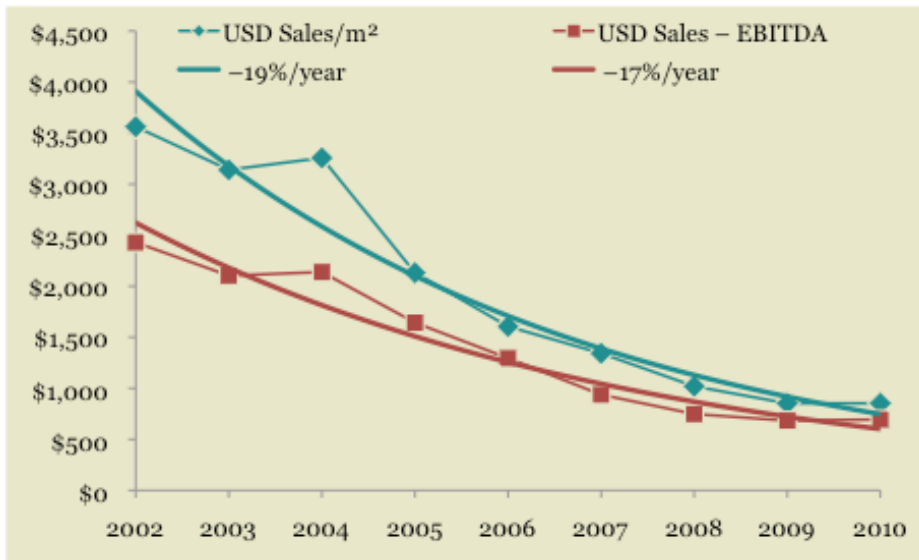
Legacy transfer 3<sup>rd</sup> round occurring with Chinese investments



Source: A.T. Kearney, 2002 and HCL analysis



## Margins are down and display players have become materials traders

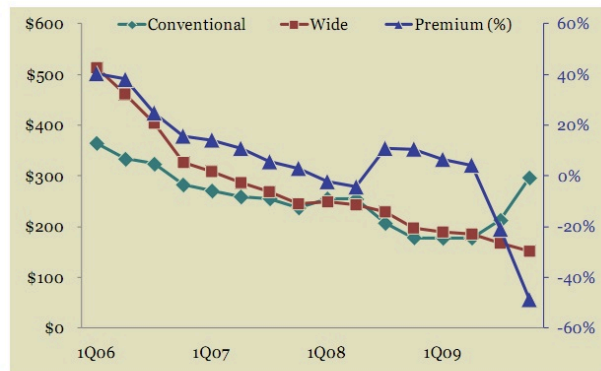


- Financial disclosures from LGD in 2005 and 2010
- Expenses here include: SG&A and R&D
- OH here is manufacturing overhead

- More than 2 decades of > 20% per year price declines
- Cost structure becomes more and more variable and shows less and less impact of technology in the financials

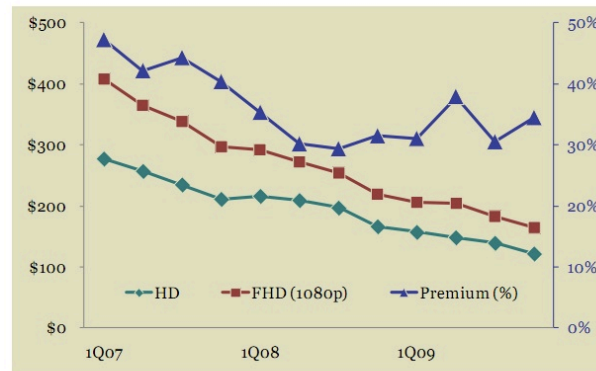
Display players are desperate for “premium product” but the value from most features is arbitrated away. Resolution seems to be ongoing and there may be some small value for higher frame rates

ASP/ft<sup>2</sup> Premium for Wide-format LCD TV Sets



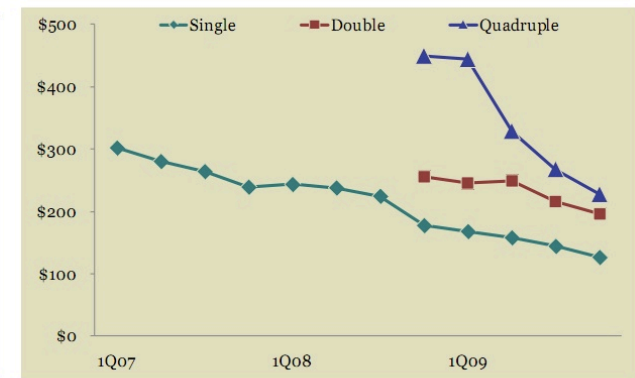
The feature premium declines until it becomes commoditized

ASP/ft<sup>2</sup> Premium for Full-HD (1080p) Sets



The feature premium remains viable if it can remain distinguished

ASP/ft<sup>2</sup> Premium for Faster Frame Rates



The feature premium declines until it becomes commoditized

- The industry has been on the hunt for the “elusive premium” for the last 2 decades
- Most feature benefits (see the example of wide format displays) see the value proposition competed away within 2-3 years
- Resolution however, sells sometimes. Full HD LCD TV selling at a 30% premium to 768 line sets
- Initial premia for frame rate but the premium here likely to close

## Each of the majors is seeking a different leadership position

### SEC

- The outright leader of the display industry and one of the more aggressive in terms of IP or tech acquisitions recently
- A large panel only player after the split and restructuring with SMD
- S-LCD JV with Sony

### LGD

- Korea's number 2
- Solid technology and customer execution
- Likely to follow a similar strategic path to SEC, but it has a smaller small-medium LCD business
- Tends to watch what SEC is doing

### AUO

- Taiwan number 2
- Focused on being the "green player"
- Interest in PV
- Acquisition of SiPix
- Recent acquisition of AFD in Singapore to form basis for LTPS AMOLED backplanes

### CMI

- Taiwan number 1 formed of a merger of CMO, Innolux and TPO (Toppoly and Philips)
- Becoming more aggressive on technology and IP
- Small-medium business is one of their stronger stories
- A "relationship" player focusing on customer intimacy

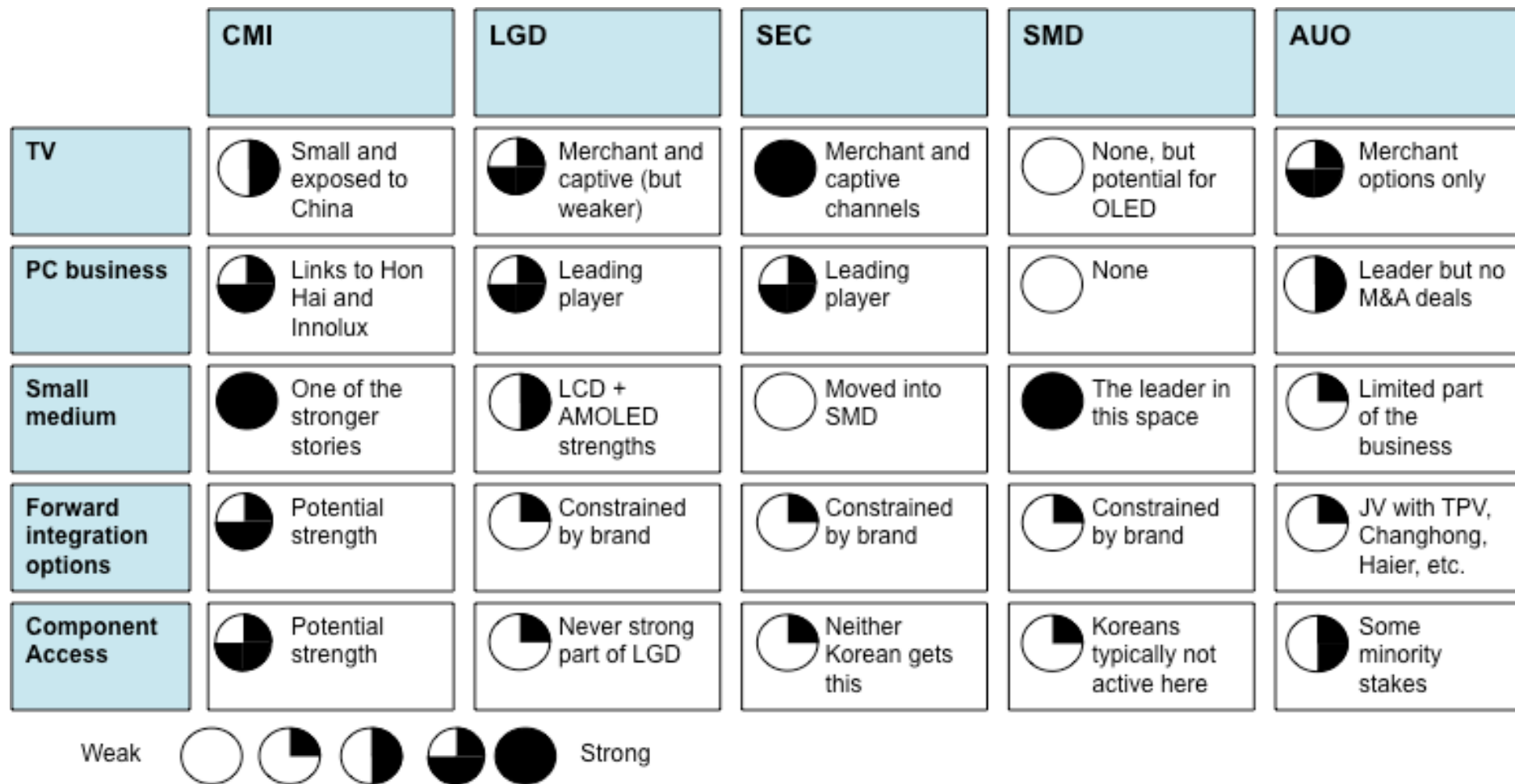
### SMD

- SEC's little scrappy brother
- Leading the way on AMOLED: the dominant market share player
- Focus is small medium displays
- Taking huge technology bets and trying to change the game in AMOLED
- JV of SEC and SDI

### Sharp

- Sole remaining Japanese player on the leadership board
- Sees the world very differently and has more investment in Solar
- Japan market focus of late. Gen 10 fab has incomplete Sony investment
- Reputedly in talks with China on transfer of Gen 10 technology

...and at a detailed level, the leaders are actually quite different in their business portfolios is not their financial returns:



Metal oxide and AMOLED, signage, LCD TV replacement rates and whether display players can capture more value through architecture are the key shocks. Apple is becoming more important as a shaping hand:

	Description of shock or uncertainty	How this changes the future
<b>Metal oxide processes</b>	Role of IGZO process as higher mobility option for higher frame rate or higher resolution	Question of whether this will be a relatively simple retrofit to current facilities or whether this will require a bubble of new capital spending in the medium term. Changes role of sputter vs PECVD in equipment value
<b>AMOLED</b>	Degree to which AMOLED is important in TV and the demand elasticity here of AMOLED vs LCD TV	Our general view is that most consumers will not pay the premium that will be needed for AMOLED to be a
<b>LCD TV + Signage</b>	Replacement cycle for LCD TV becomes key metric in determining future LCD TV growth. Signage may be an adder but immature now	Substitution of CRT TV is basically done in many markets and will be complete in others within 3 years. A move to a 6-year refresh (which Corning believes in) will deliver some forward growth. Can the industry create enough "Wow" to deliver this
<b>Role of architecture to add value to display players</b>	LCD players may try to find new ways to seize back value. We believe that new fabs and functional architectures are key	Functional architectures and new fab designs that are not "fungible" are key to market areas that are more easily defensible against high levels of competition. Unique technology (electrowetting, E-Ink and Sipix) all play within this category
<b>Ongoing role of Apple and Samsung</b>	The Apple vs Samsung battle is defining the display landscape: for mobile devices now and for a growing domain later	If Apple and Samsung continue to shape the display industry then we will see display players more and more being commodity players taking risk for no return and relying on hand-outs to fund fabs. More consolidation and less self-determination

If we had to give scores on strategic execution then SEC would win for now but CMI is getting more aggressive:

Imperative	Samsung group	LGD	AUO	Sharp	CMI	Summary
1: M&A for novel display						Clear Leader
2: Fast mover AMOLED						Absolute Leader
3: Consider new fabs						Sharp leads LCD. Samsung for OLED
4: New pricing, consolidation						CMI leads consolidation
5: Drive standards						Samsung-Android collaboration?
6: Partner with suppliers	Not clear differentiation visible yet in end product					
7: New architectures						Samsung, Sharp lead
8: Integrated touch						One of the leaders

Weak Strong

- We defined 8 strategies as being important for display players in the end-game for LCD to change the amount of economic value captured
- For now the Samsung group as a whole seems to understand the major strategic imperatives based on their recent moves

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# The reason the display industry does not make money is that large “Fungible Fabs” destroy value in all markets

Leaders learned how to make smallish panels on large glass

Their capacity is fungible: it can serve most large panel markets

Maker	Fab	Small Size	Small Panels	Large Size*
LGD	P5	9.7”	35	27.0”
Samsung	L6	9.7”	36	27.0”
LGD	P6	9.7”	56	30.0”
Samsung	L7-2	17.0”	36	46.0”
LGD	P7	19.0”	35	47.0”
LGD	P8e	20.0”	40	55.0”
Samsung	L8-2	18.5”	50	55.0”

\*6 panels per substrate is the typical target for new fab investments because larger panels command a price premium... making smaller panels makes new fabs undifferentiated...

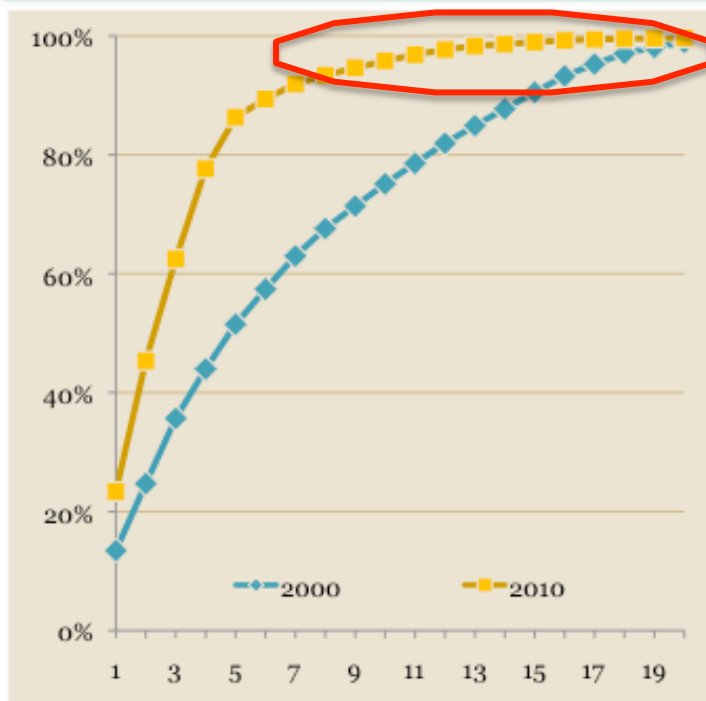
Source: DisplaySearch US FPD 2011

- Piling more capacity into commodity markets leads to hyper-competition.
- We believe this causes calendar-cyclic behavior in terms of price rivalry. Tit-for-tat reactions drive prices down, even for the leaders.
- Similar behavior occurs among retailers who face e-tail competitors.
- As a result, consumers see better prices but the supply chain sees worse profits.
- Differentiation is one way out of this commodity trap

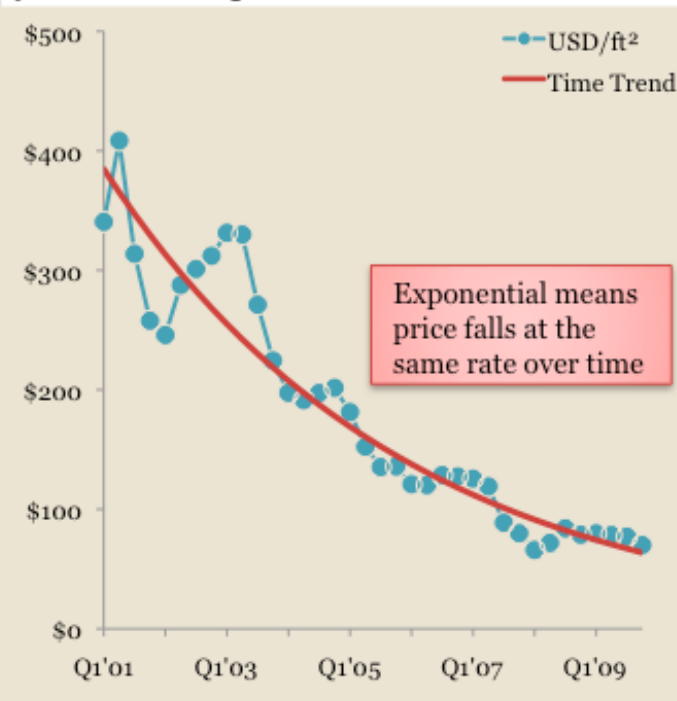
This coupled with always a tail of weaker players in the industry has led to aggressive price competition that has continued downwards at about 20% per m<sup>2</sup> for more than 2 decades

#### AMLCD Producers

##### Cumulative Share of top-20



Price falls about 5% a quarter or 19% a year on an exponential trend line



- While concentration has increased after several rounds of consolidation, there is a long tail of smaller companies whose incentives are too high to drop pricing to pick up orders
- Prices have continued falling about 20% per year

## Our view of the FPD industry future: Scenarios

	Base case	Tech race	Race to the bottom	a-Si wins since “Good enough”	Display industry saves itself
Metal oxide	Slow roll out for hi-def TV & mobile devices. Retrofit of a-Si	Metal oxide becomes important but coexists with architecture led LTPS	Metal oxide destroys LTPS value proposition but gains no premium over a-Si	Metal oxide fails to be important in comparison to a-Si	Metal oxide and a-Si coexist, with MO positioned above a-Si
AMOLED	2-3 players develop positions mostly in mobile devices	AMOLED flourishes and hits high-end price points in EU, Japan and US	AMOLED survives in mobile apps as MO TFT becomes cost competitive with a-Si	AMOLED flounders and remains a niche technology	AMOLED has a role for mobile devices and some TV and enables flexible
Market development	Mobile devices still more important. TV replacement faster, but not by much	Market is excited by new offerings. Some TV growth delivered in return	Markets grow but at low price points. Prices fall at 20%+	Markets grow but prices continue down	Price declines slow down as newer technology gains ground
Impact on players	Smaller players in Taiwan and Japan close or convert. New BRIC players	AMOLED or LTPS capable players break from the pack	Faster exits from the industry. Customers gain more power in funding future fabs	Niche technologies fail. Legacy transfer continues faster and more new players	Players begin to specialise in technologies or regional markets
Impact on profits	Profits stabilise but at lower levels. Participation in novel tech or materials key	Increasing profits for technology leaders and for AMOLED “all-in” players	Profits remain poor. Apple, Samsung and HP pay for the fabs they want	Profits remain poor, which leads to more vertical models. Merchants are poorer	Profit improves as display value offsets material cost

In the “**Base Case**” scenario: Samsung and SMD make forward strides and are reintegrated as one firm, investments are improved in China, one or two fabs appear in Brazil and India but profits remain disappointing.

	Base case
<b>Metal oxide</b>	Slow roll out for hi-def TV & mobile devices. Retrofit of a-Si
<b>AMOLED</b>	2-3 players develop positions mostly in mobile devices
<b>Market development</b>	Mobile devices still more important. TV replacement faster, but not by much
<b>Impact on players</b>	Smaller players in Taiwan and Japan close or convert. New BRIC players
<b>Impact on profits</b>	Profits stabilise but at lower levels. Participation in novel tech or materials key



- Market: Growth continues with small panel more important than large panel
- Investments: Go into LTPS for near term and then a bubble of metal oxide retrofits
- Players: Samsung (with SMD reintegrated) and CMI thrive, LGD and AUO fall back. Sharp limps along. CPT, Hannstar and others eventually exit or their assets are relocated
- Players eventually move to 1-2 technology standards for AMOLED
- 1-2 players in India and 1-2 in Brazil. Perhaps 1 in Russia
- Themes
  - Mobility remains an important IT theme, bandwidth increases
  - Signage emerges slowly
  - New operating systems do allow for some new product categories that we do not have today
- Prices: continue to decline at 20% per year
- Winners: Apple, Samsung, Corning, Google, HP and one or two of the Chinese or Taiwanese new brands
- Losers: Majority of display companies with the smaller players hits even harder

In the scenario 2 “**Tech race**”: AMOLED and MO see their day, and architectures allow the leading players to seize more value. Touch gets integrated and customers love all of the new innovations:

	<b>Tech race</b>
<b>Metal oxide</b>	Metal oxide becomes important but coexists with architecture led LTPS
<b>AMOLED</b>	AMOLED flourishes and hits high-end price points in EU, Japan and US
<b>Market development</b>	Market is excited by new offerings. Some TV growth delivered in return
<b>Impact on players</b>	AMOLED or LTPS capable players break from the pack
<b>Impact on profits</b>	Increasing profits for technology leaders and for AMOLED “all-in” players

- Market: Both large panel and small panel markets see growth. More growth in mobile, but some meaningful growth in large panel at a revenue level
- Investments: Investments in new MO and AMOLED facilities
- Players: SEC/SMD, LGD, CMI, AUO and Sharp do well but companies like Hitachi and TMD gain value also. Samsung, CMI, LGD and Sharp break from the pack
- New players: If technology races ahead then we might expect slower legacy transfers since leading players will have their hands full managing their own factory and technology plans
- Themes:
  - Mobility important, but home digital media and internet TV (the role of fixed large displays) just as important
  - LTPS architectures allow functional integration allows displays to do more: integrated touch, sound, motion sensing or IR sensing, DRM protection and more
- Winners: SEC/SMD, CMI, TMD, Sharp, Corning, Merck, Sony, Hitachi
- Losers: Driver IC companies, ARM, TI, Lighting providers (LEDs and CCFL)

Scenario 3: “**Race to the bottom**” represents more and more commoditisation as leading OEMs seize the day and play off display players against each other. Scarily likely

	Race to the bottom
<b>Metal oxide</b>	Metal oxide destroys LTPS value proposition but gains no premium over a-Si
<b>AMOLED</b>	AMOLED survives in mobile apps as MO TFT becomes cost competitive with a-Si
<b>Market development</b>	Markets grow but at low price points. Prices fall at 20%+
<b>Impact on players</b>	Faster exits from the industry. Customers gain more power in funding future fabs
<b>Impact on profits</b>	Profits remain poor. Apple, Samsung and HP pay for the fabs they want



- Market: Market lower than other scenarios on a revenue level even though unit growth may well be solid in both small panel and large panel
- Investments: Investments in LTPS near-term and MO retrofits/ new capacity thereafter and long term outlook only dependent on how much capacity customers want to support in the industry
- Players: Ugly pricing outlook likely to lead to more exits, faster. LTPS facilities impaired
- New players: Not many unless they bring “dumb money” to the table
- Themes: More netbooks and other value destroying products and all products at new low price points
  - Low price mobility
  - Cheap TV: Bland vanilla boxes
- Pricing: Falls even faster
- Winners: Apple, Samsung and HP, Costco, Walmart, internet discounters, consumers in general (but techgeeks not happy)
- Losers: All major display companies

Scenario 4: “**a-Si wins since good**” enough leads to marginal positions for MO, LTPS and AMOLED. Players proliferate, but those that are successful serve vertical parent companies. Great times for material players to a-Si leaders

	a-Si wins since “good enough”
<b>Metal oxide</b>	Metal oxide fails to be important in comparison to a-Si
<b>AMOLED</b>	AMOLED flounders and remains a niche technology
<b>Market development</b>	Markets grow but prices continue down
<b>Impact on players</b>	Niche technologies fail. Legacy transfer continues faster and more new entrants
<b>Impact on profits</b>	Profits remain poor. Merchant models fail. Vertical models support parents



- Market: Market continues on current trends, large panel revenue falling, small panel has some growth
- Investments: There may not be many investment opportunities especially if LCD TV replacement cycles do not materially shorten
- Players: Potential continued proliferation of anyone who can buy equipment can play. Economic returns will not make this too attractive, but if you have captive demand you can serve and ways to make money on related business it might happen
- Themes:
  - LCD, LCD, LCD
  - Devices sell on other features than their displays
  - Resolution levels plateau and customers are happy with what they have already
- Pricing: Continues down at 20% per year
- Winners and losers similar to the last scenario (Race to the bottom) but perhaps in a less bleak sense. Vertically integrated models likely to triumph and merchant players under pressure



Scenario 5: “**Display industry saves itself**” is our dream, but not enough sign yet that this will happen. This requires discipline and a change of behaviour from the leaders

	Display industry saves itself
Metal oxide	Metal oxide and a-Si coexist, with MO positioned above a-Si
AMOLED	AMOLED has a role for mobile devices and some TV and enables flexible
Market development	Price declines slow down as newer technology gains ground
Impact on players	Players begin to specialise in technologies or regional markets
Impact on profits	Profit improves as display value offsets material cost



- Market: Both small and large panel might have some revenue growth in this scenario
- Investments: Would be a range of capacity investment options distributed across LTPS, MO and AMOLED
- Players: Would expect to see some new entrants but a tier of players from the leaders, the mid players and niche players
- Themes:
  - Smaller form factor, integrated functionality
  - Display centric future
  - Bright light and intelligent
  - New technology solutions reduce the power of today's economic winners Corning and Merck
- Pricing: Price declines slow down as some technology areas gain some premia
- Winners: Largest most capable technology players
- Losers: Apple, Corning, Merck, consumer price levels (but geeks will love it)



## Which is more likely? Our guess

	Base case	Tech race	Race to the bottom	a-Si wins since "Good enough"	Display industry saves itself
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	30%	10%	30%	25%	5%

## Summary and implications:

- While our 2004 strategic outlook underestimated how fast that channels would shorten and fabs would reach their economic diminishing returns to scale, it correctly called the role of value chain plays (forward and rearward integration) and rationales for consolidation
- For the industry today, margins have declined to low levels and display players have become materials traders, with only a little evidence for price premia based on technology
- The industry is now at a cusp with the twin game changers of metal oxide (MO) and LTPS. It is on the verge of the 3<sup>rd</sup> major round of legacy transfers and additional countries beyond China have shown interest in flat panel technologies
- We believe that scenario analysis for now is a powerful tool in thinking about the future
- It is decisions and investments made by the major display companies and other major corporates around the world that will influence which scenario results. We believe we can help developing these ideas