Climate Change and Flooding on Planet Display

Source: Jantoo cartoons

January 2014

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Hendy Consulting: Service offerings to the display industry

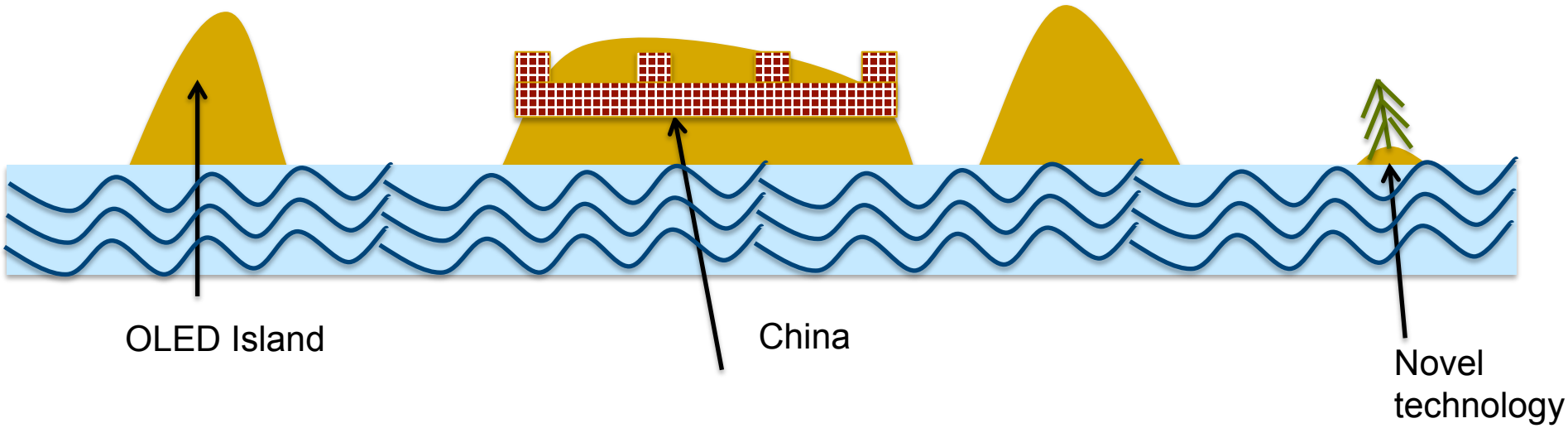
Growth strategy	Performance improvement	Equipment and Capex	Sourcing strategy (Purchasing)
• Market entry strategy • Business unit strategy • Growth strategies for new technologies	• Product portfolio management • Pricing strategy • Cost reduction	• LCD/OLED factory capex decisions • Strategies for equipment makers	• Sourcing strategies, especially LCD and medical detectors • Make/buy decisions

Technology strategy and technology assessment	Partnering and alliances	Professional advisory and business planning	Strategies for materials providers
• Market and commercial strategies for new technology businesses • Market tracking services for corporates monitoring technology	• M&A candidates and assessments • Alliance formation support • Post merger integration planning	• Specialist insights for bankers, equity investors and other consultancies • Reviews of business plans and models (Strategic audits)	• Strategy support for materials providers in the FPD, SSL, and PV markets • IP and pricing plans

Agenda

- Impact of climate change on planet display
- What does this mean for the future?

Water is rising on planet display: Threatening display islands



- Pricing falling faster than cash costs (Pricing has declined at 16%, cash cost at 14% per year)
- “Novel technology Island” almost submerged
- OLED Island still viable but only supports 2 major villages
- China building walls as fast as possible. China capacity closing on that of Taiwan in 2016-2017
- Drowning display players: All of them bailing water out as fast as possible
- Prognosis is for rising waters unless behaviours change

Source: Analysis of public results of LGD all numbers based on Won from Q1 2002 to Q3 2013

Water is seeping in from every side
Display players are drowning

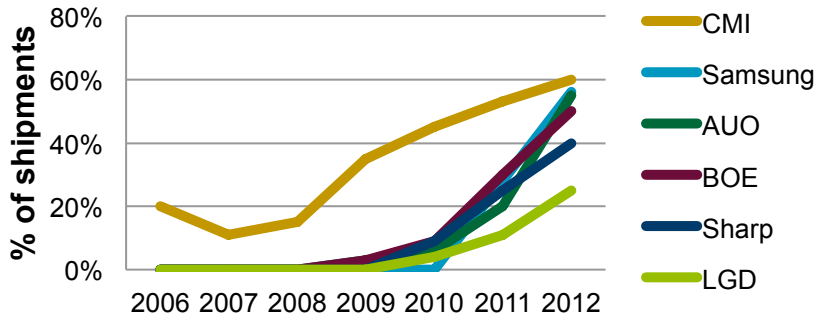
Shortening value chains	Mobility trend destroys computing markets	Large substrates seek small panels	4K volume pressures destroy value
• Open cell models (especially to China) limit ASPs and value add potential for major display companies forcing them into utilization maximization to spread depreciation load • In cell touch seems to be relegated to long run projects for specific high end devices	• Mobility trend impacts notebook market which otherwise was reasonably profitable • Monitor market also undermined • TV market has always been relatively unprofitable so make smartphone market sole remaining profit centre • Within mobility markets white box strategies driving down price in the low end segment	• Conversion of Gen 6 and even Gen 8 fabs to small fabs threatens one of the remaining strongholds of some current value • Conversion of even a small amount of such capacity will swamp small panel markets (Gen 8 is in excess of 500 up)	• Everyone rushing to the high ground of 4K • UHD in China is under immense price pressures as display players try to hit penetration rates of up to 29% of TV shipments • UHD pricing in China at 50% of levels in USA. Notion of “pseudo UHD”

Sources: DisplaySearch, Bloomberg, Hendy Consulting

Water is seeping from every side:

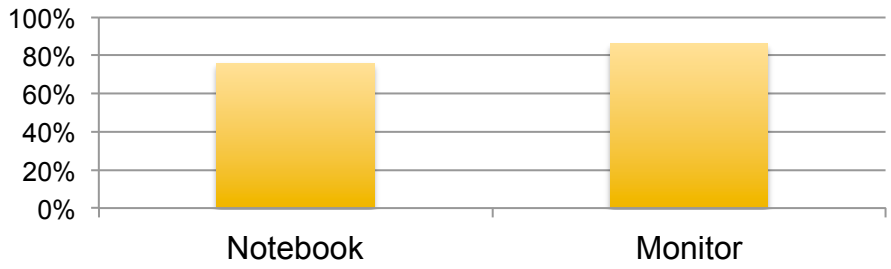
Shortening value chains

LCD TV Open cell business shipments



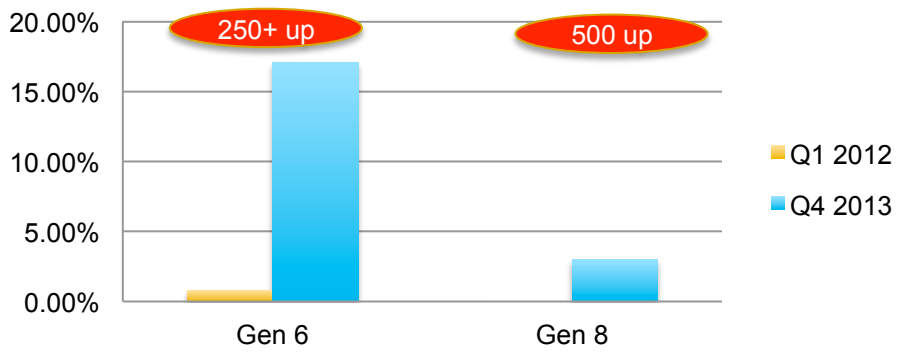
Mobility trend destroys computing markets

2014 volumes as portion % of peak



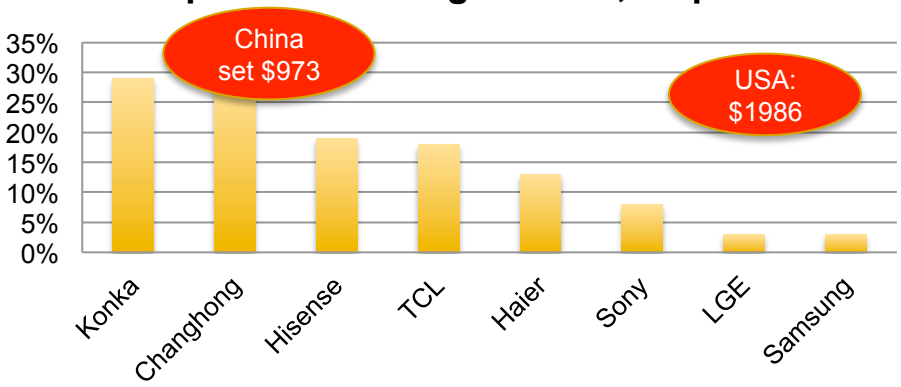
Large substrates seek small panels

Allocations of glass to small medium



UHD volume pressures destroy value

UHD penetration targets 2014, shipments



Sources: DisplaySearch, Bloomberg, Hendy Consulting
Large substrates discusses 5.7 inch phablet
UHD pricing is estimated 2014 set pricing per DisplaySearch

The display industry suggests several buckets, but all are futile:

"Technology and capacity"

- Proponents claim IGZO and LTPS create value
- LTPS peaked at 7.8% of industry capacity in 2003
- IGZO slower due to new physics problems
- Technology does not deliver additional value over the medium term. It is arbitraged away

Premium markets and customers

- Not many customers like Apple
- A large display company cannot have all of its business as premium business
- Arbitrage of areas of profit opportunity means that few profitable segments stay that way for more than 18 months

OLED

- OLED is smaller than some predicted and certainly not the "Replacement for LCD"
- OLED is now predicted at < 10% of TFT capacity for TV
- OLED will have to forward price heavily to gain volume. Samsung looking at no further price drops till 2017

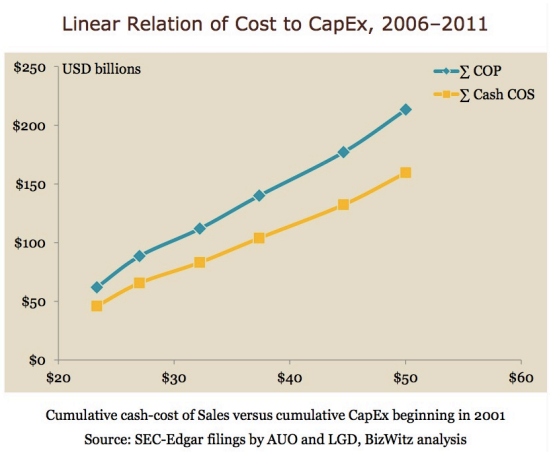
Flexibles & Wearables

- iWatch is 200m (2018) pieces say some
- Flexible shipments of 300k in 2013
- Not clear more profitable
- Too small right now to make a difference to $20bn corporations

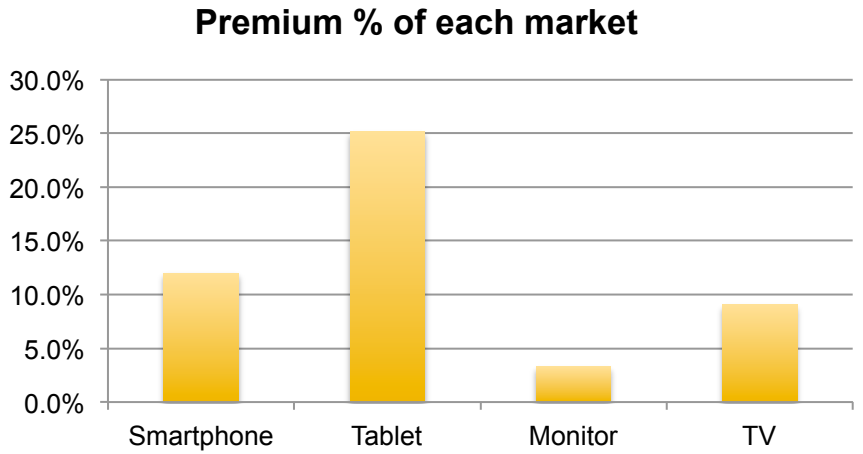
Sources: DisplaySearch, Hendy Consulting analysis

The display industry suggests several buckets, but all are futile:

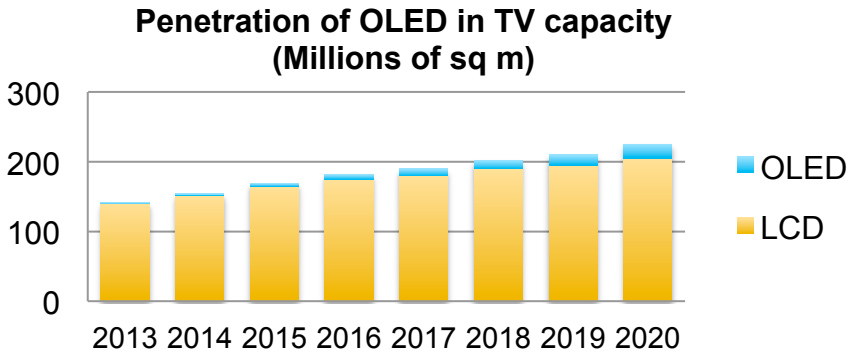
Technology and capacity do not drive value



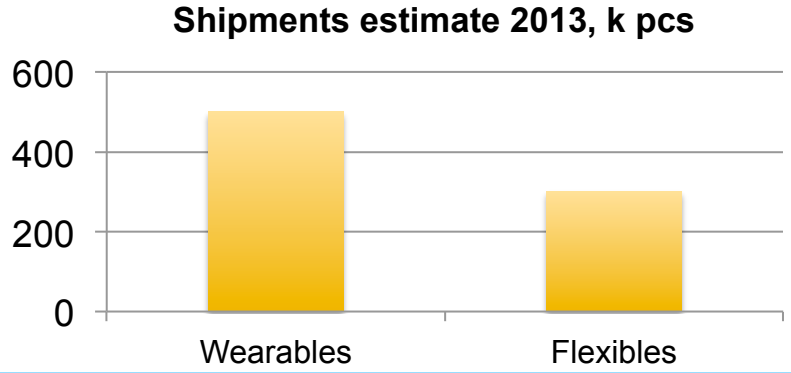
Premium markets



OLED (< 10% of TV)



Wearables and flexibles



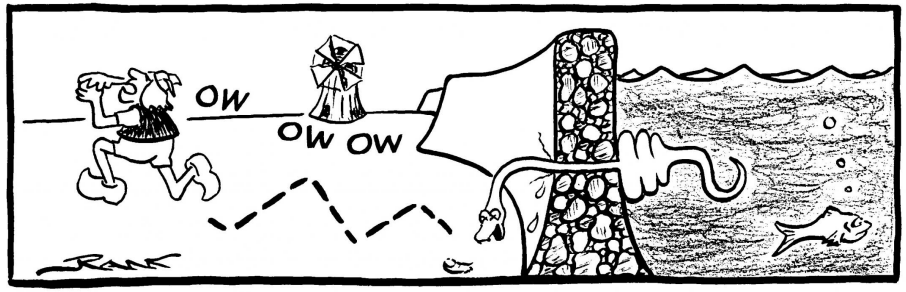
Sources: DisplaySearch, Hendy Consulting analysis

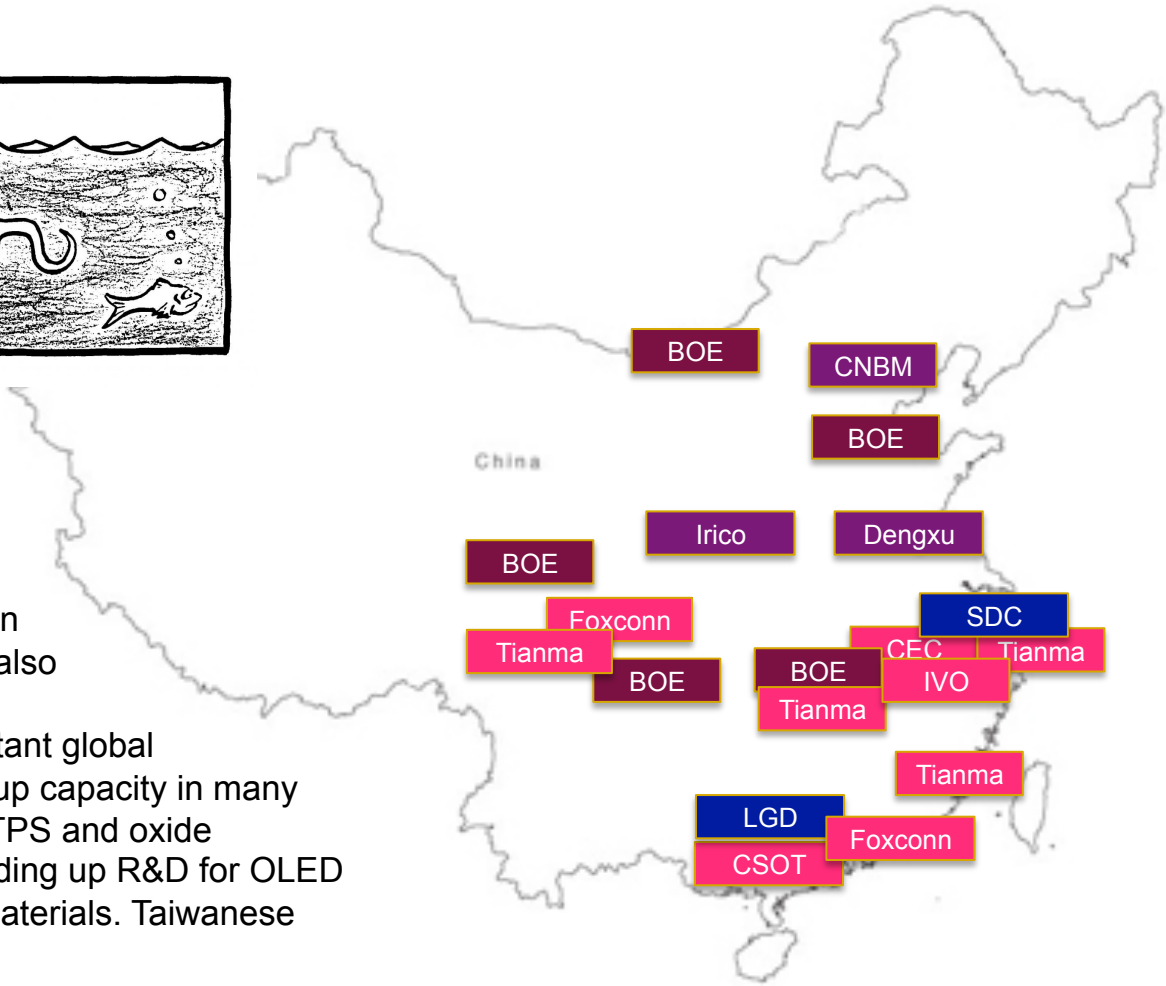
Some islands are almost completely under water already: Novel technology

- Mirasol is now lost in action. Polymervision bankrupt. Liquavista still working on commercialisation and now owned by Amazon
- EPD: 2011 was the peak of the EPD business and is now in decline
- New liquid crystal modes are largely missing in action (other than broad licensing of IPS/FFS)
  - Blue phase: Samsung display demos but no production yet
  - Flexoelectric and others seem to be going the way of OCB
- 3D not a strong value proposition
- With current pressure on display company financial results then unlikely that we will see other fundamentally new technology until next decade

Sources: Hendy Consulting
www.cartoonstock.com

China building dikes to keep out the water, and the International players:





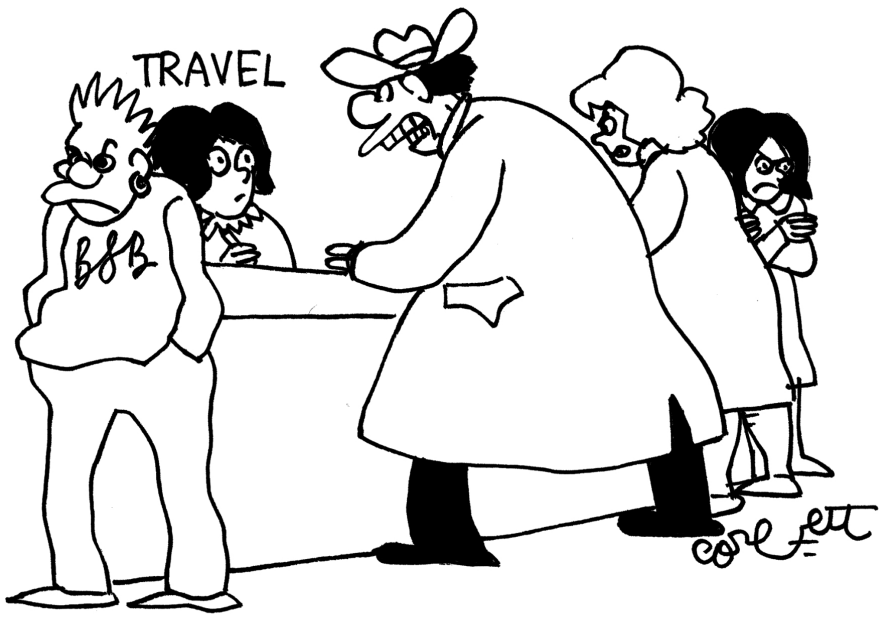
- Chinese FPD industry expanding rapidly and aiming for self sufficiency in what is the world's largest market
- Government increasing local tariffs on open cells and finished modules
- Government recently calling for tarriffs on substrate glass to support local players also
  - Irico, Dongxun, CNBM
- BOE and CSOT shaping up to be important global players, especially BOE that is building up capacity in many different provinces an placing bets on LTPS and oxide
- Foxconn putting down capacity and building up R&D for OLED
- Companies buying talent in electronic materials. Taiwanese majors trying to get inside China
- Losers are Innolux and AUO
- Koreans have single fabs inside China as they try to optimise based on changing tariff structures

Sources: Hendy Consulting, DisplaySearch.
Jantoo cartoons

Civil wars in Korea fighting portfolio fights: “Business with brothers, worse than others”

LG Group

- LGD dealing with portfolio choices
  - OLED line up of 55” through 77” OLED
  - UHD LCD (49, 55, 65, 84 inch) but expected only 3% of the target unit
  - Broad range of lower priced FHD LCDs also
- Ahead on factory commitment in M2 fab based on oxide than Samsung
- The key question for the LG Group would be the implications on the LG Chemical polarizer business if LGD were to push OLED hard



"SEPARATE VACATIONS- FOUR OF 'EM!"

Samsung

- Samsung also dealing with portfolio choices
  - OLED vs
  - UHD (40, 48, 55, 65, 85, 98)
  - Again only low expectation for UHD sales
- Recent internal reorganisation has eliminated OLED division
  - Even more likely now for challenging portfolio planning decisions
- Samsung’s love of LTPS leads it to scalability challenges for OLED and a slower path. Corporately though a much stronger starting point based on mobile, and soon tablets

Sources: Hendy Consulting
www.cartoonstock.com

OLED Island for TV may only support 2 major tribes for now:

- OLED Island looks like it can only support 2 for now:
  - LGD and Samsung. Sony and Panasonic abandoned OLED JV plans. Not clear what AUO and Innolux will do
- Many Chinese firms claim to be interested but not clear how many can manage the double challenge of OLED deposition and oxide/LTPS. Challengers include: Everdisplay, Visionox, Foxconn, AIV and IMEC
- Water coming in from multiple sides: LCD is closing gaps and in cases exceeding the performance of OLED
  - Waves of technology improvement in pixel design (RGBW), QD, Sharp's Revolution technology, curved & thin
  - Only energy performance might be better
- OLED another plasma?

Cartoon from Jantoo cartoons

Summary: Climate change likely to continue

- Temperatures and waters will rise: LCD maker profits will continue to be under pressure. Few positive drivers for improved performance. UHD TV and smartphone are areas of buzz. Much of what makes the display companies unprofitable is learned behaviours (Pricing behaviours). Makes the challenge of changing direction hard. Continued massive build up in China keeps the pressure on
- OLED vs LCD is different to LCD vs CRT: “Civil war”. The OLED companies are the leading LCD companies. This will make the dynamics very different to when LCD replaced CRT
- Many of the novel technologies that we have seen in the last few years are fading to the background. Remainder of the decade will see LCD the dominant display solution
- Continued trend of mass white-box commoditisation: will put pressure on the Dells and HPs of this world and support brand development of the Chinese players
  - At the same time growth in high end of many markets too from smartphones to tablets
  - “Hi-Low” bifurcation of the markets
- In-cell touch limited to key strategic projects
- We predicted the 4K pile in back in 2010 at SID: Pixels have always sold well and been used by the display industry. 8K is next

Source: Hendy Consulting

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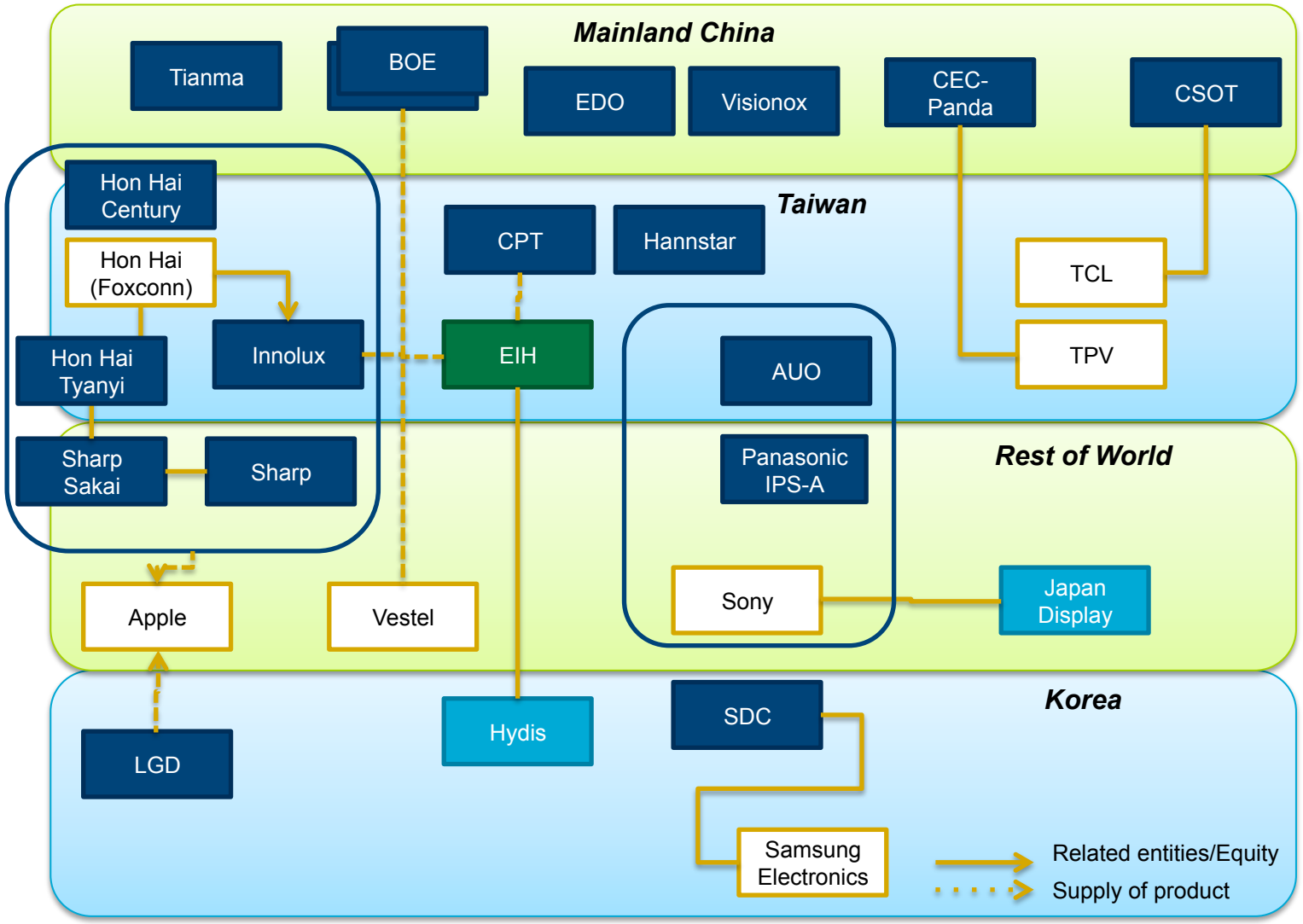
The changing shape of the chess board:



- Sony and Panasonic have stopped work on their joint venture for OLED. Panasonic on the path to exit of display business (PDP gone and closing factories)
- BOE much more important than they were 2 years ago
- Sharp waning but clinging on in there
- Foxconn looking at putting their own additional fab in Tyanyi in collaboration with Sharp
- CEC-Panda now moving ahead with Gen 8
- SDC has had internal shake up to eliminate OLED division
- Many new players in China threatening OLED capacity: EDO, Visionox and others
- Negotiation between Terry Guo and Sharp seems somewhat stalled for now
- Japan Display trying to put down a subsidiary in Taiwan
- Complete management change at EIH

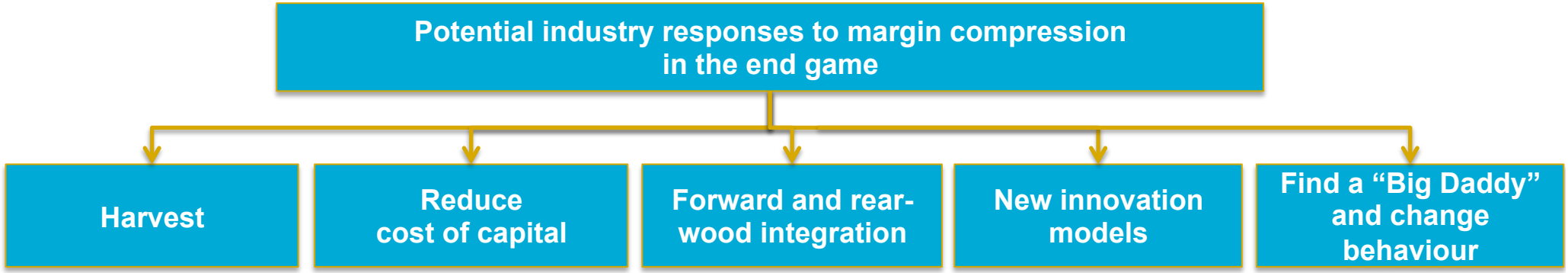
Source: Hendy Consulting

So in our scenarios: A-Si wins or Race to the bottom results

	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

Source: Hendy Consulting

So what should the industry do:



- Simply stop building and manage for cash
- Nearly 70% of all the TFT capacity that the industry is ever likely to need by 2020. Increasingly difficult to change industry fundamentals if you are more than half done with the total build out of the industry (Actually 80% if we look at fabs in place for 2016)

- This option has already been seen with the industry effectively moving to a lower cost of capital market, China
- Taiwan is already beginning to face issues in raising finance. More and more complex financial products to help raise money

- Materials companies create decent value but even if these are affiliates of the display firms, usually not owned by the shareholders of the display companies (Transfer of value)
- Forward integration might eke out additional value but brings display firms often in conflict with their parent corporation objectives or customers

- New collaborative models with customers and separately perhaps with the materials industry to allow display companies a seat at the table in defining the new "next big thing" as opposed to just being fast followers

- This option is very clearly on the mind of all display companies as they try to cosy up to the very few Big Daddy's in town: Apple, Samsung
- Margins may be slightly better on such captured business
- Behavioural change in pricing and utilisation decisions

Source: Hendy Consulting

Winners and losers:

	Race to the bottom	a-Si wins since "Good enough"
Metal oxide	Metal oxide destroys LTPS value proposition but gains no premium over a-Si	Metal oxide fails to be important in comparison to a-Si
AMOLED	AMOLED survives in mobile apps as MO TFT becomes cost competitive with a-Si	AMOLED flounders and remains a niche technology
Market development	Markets grow but at low price points. Prices fall at 20%+	Markets grow but prices continue down
Impact on players	Faster exits from the industry. Customers gain more power in funding future fabs	Niche technologies fail. Legacy transfer continues faster and more new players
Impact on profits	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

Winners

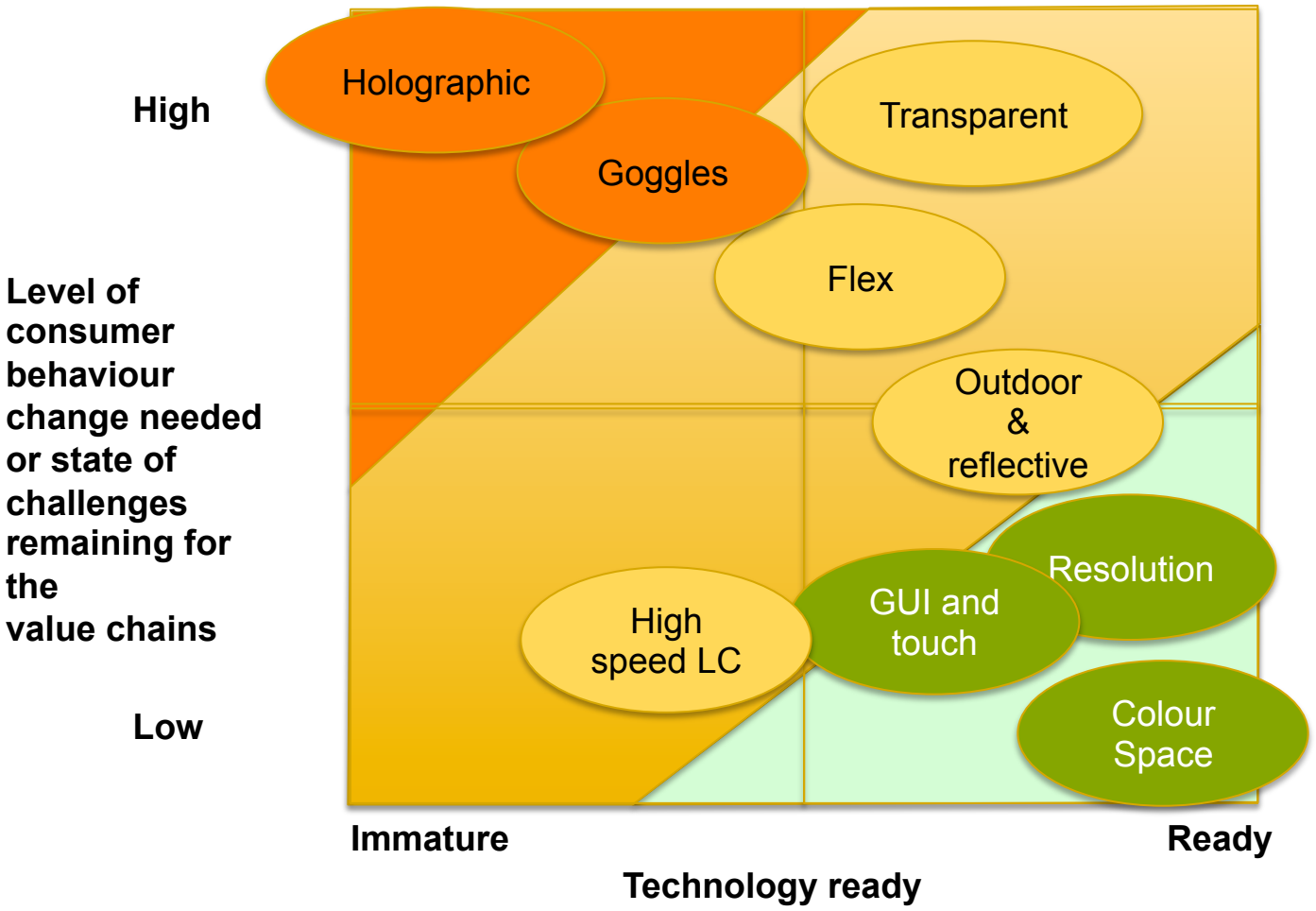
- Consumers
- Quantum dot players
- Driver IC players (4K) in mid term and related video
- Companies inside China
- Materials companies: Glass, optical films etc

Losers

- Display Companies and their shareholders
- OLED material companies (compared to their expectations)
- Niche technology players

Source: Hendy Consulting

Technology wise: Colour, resolution and GUI (touch) seem ripe areas for continued exploitation



Source: Hendy Consulting

And what predictions do we have for 2014:

- 2014 will be a better year than 2013 but with a seasonally weak first half
  - Utilisation rate probably cannot be maintained in H1
  - Capacity growth is slower this year than last. It is accelerations and decelerations in supply that trigger price changes
- May be the year that QD and 4K become more mainstream including novel pixel structures (such as Pentile), but otherwise much less technology substitution overall compared with other periods
- Proof year for IGZO: Does it break-through or not? If we don't see significant positive news from Korea and Sharp then this might be its LTPS moment. Profound implications on potential for OLED. OLED is more difficult without IGZO
- The decisions of the Taiwanese regarding competing in the Chinese market: Do the Taiwanese jump inside China or simply lose out?
- ITO replacements and moves to printable and embossable will continue: opens up pro cap at much larger sizes. Will people want touch panel monitors and touch notebooks after the non-event of Windows 8 touch notebooks? Or gestural/other solutions. Decouples the user interface from the display. In general in-cell reserved for long run strategic products
- Display industry importance is declining in nearly all markets except mobile. Race for lower price points in commodity white box markets

Source: Hendy Consulting

Hendy Consulting: Service offerings

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- Pricing still declining at 2% per year more than cash costs
- Continued value destruction from shortening value chains (open cell), reduction in computing markets, shifting capacity, UHD and the pressure from Chinese capacity
- Muted value creation levers have not shown financial gains display players promise
- Novel technology under real pressure as LCD innovations make it more competitive (QD, curved etc)
- 4K goes mainstream
- Ongoing movements in the chessboard: Honhai and BOE make their influence know. China makes an OLED push, but will they make it?
- OLED island may only support 2 tribes
- End-game market requires strategic transformation

Source: Hendy Consulting