“Pivot” round the display spiral
Through the darkest times to new opportunities

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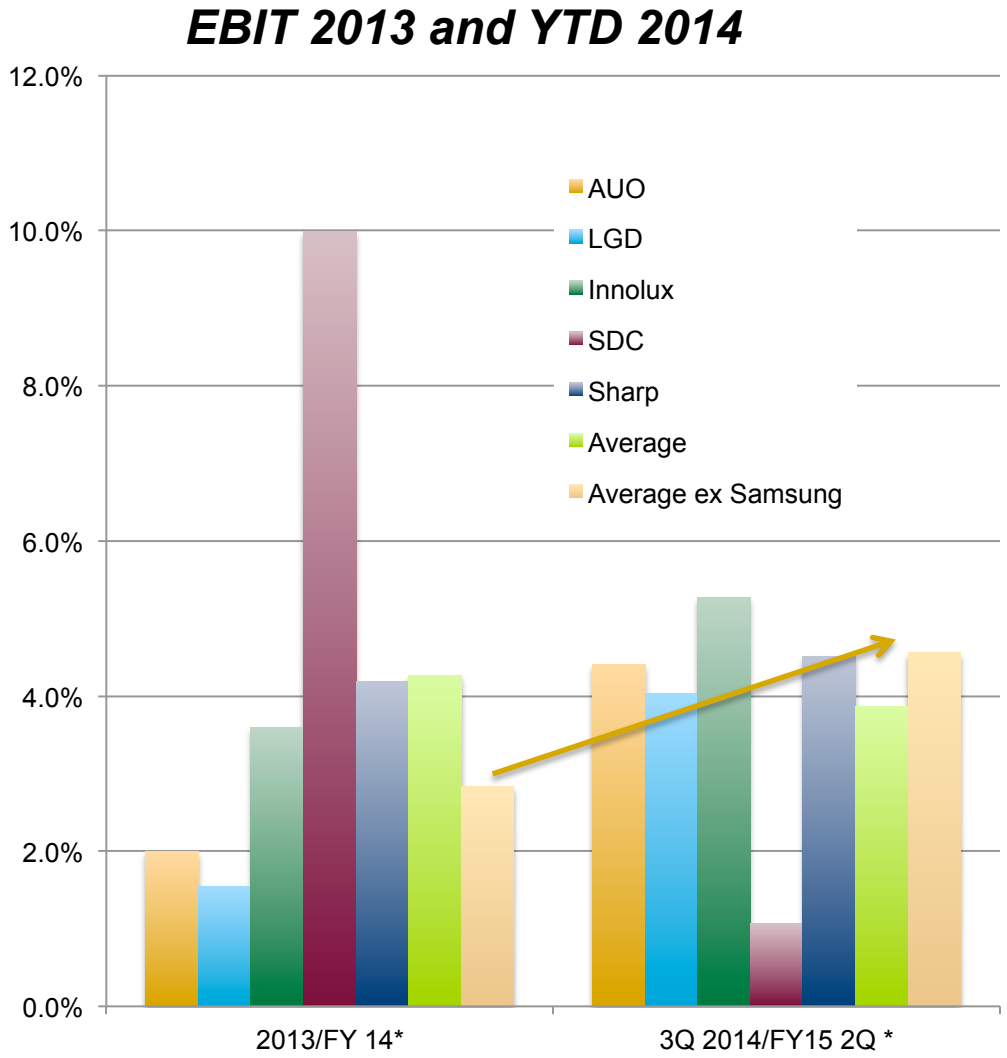
Ian.Hendy@hendyconsulting.com

Introduction to Hendy Consulting:

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

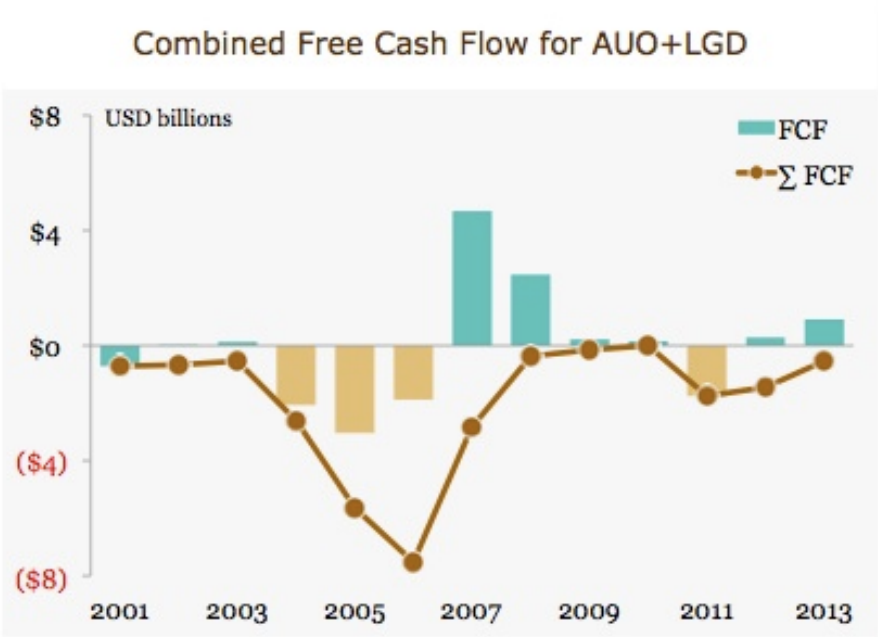
2014 was a reasonable year for the display industry:

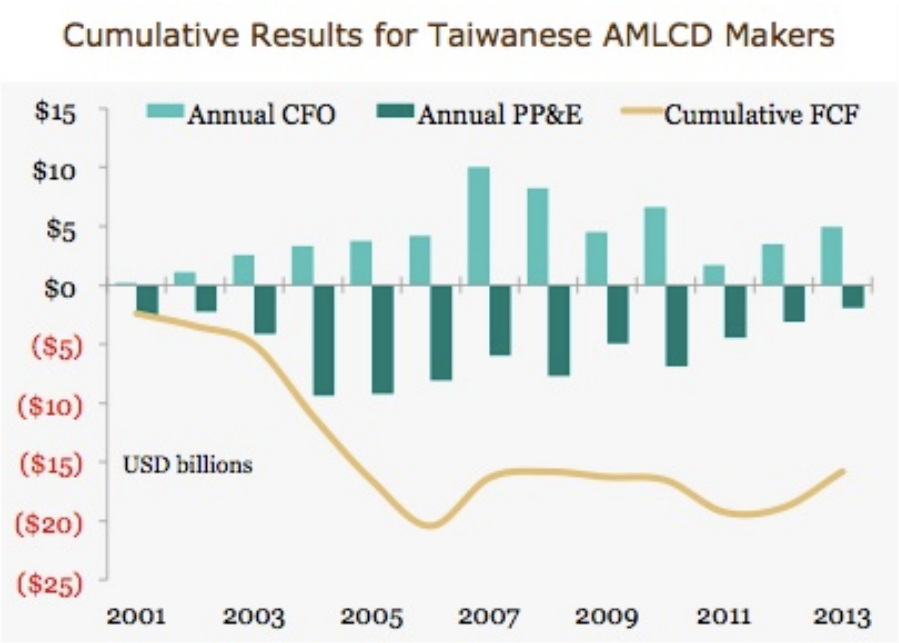


- 2014 on the whole generated better returns
  - EBIT of 4.5% and Q4 results not yet included for 2014. Q4 tends to be stronger
- In 2014, Samsung surprisingly was the weak performer with real problems with sell through of small panel OLED
- AUO, Innolux, LGD and Sharp did surprisingly well: Sharp pulled a major turnaround with improvements in mix, IGZO sell through. AUO has relatively low depreciation charge since has been reinvesting less
- Despite this the LCD industry still structurally destroying value

Source: HCL analysis based on financial results
* Sharp financial years run until March

….but in terms of cumulative history the display industry has still been a net value destroyer:



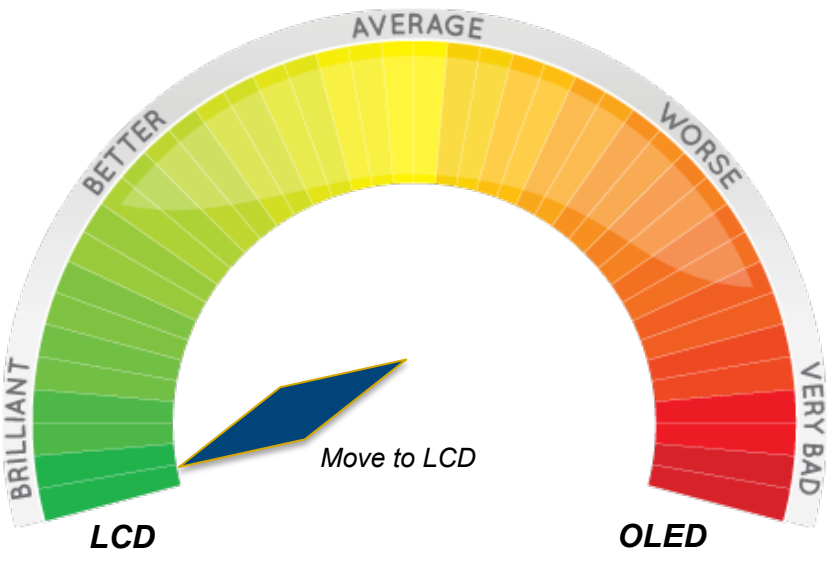


- Q4 and annuals not typically out until later in the year; so this is up to end of 2013
- 2014 picture through Q3
  - LGD and AUO: LGD pre-finance cash flow negative on the year (Capex > operating cash flow) and AUO better at $800m cash used to pay down debt since low capex. AUO+LGD now at zero line since 2001
  - Taiwan: AUO, Innolux did better on FCF basis since they stopped investing but the smaller firms (Hannstar, CPT and Wintek) did not do so well. Taiwan picture for 2014 still likely to be in the -$10bn to -$15bn range

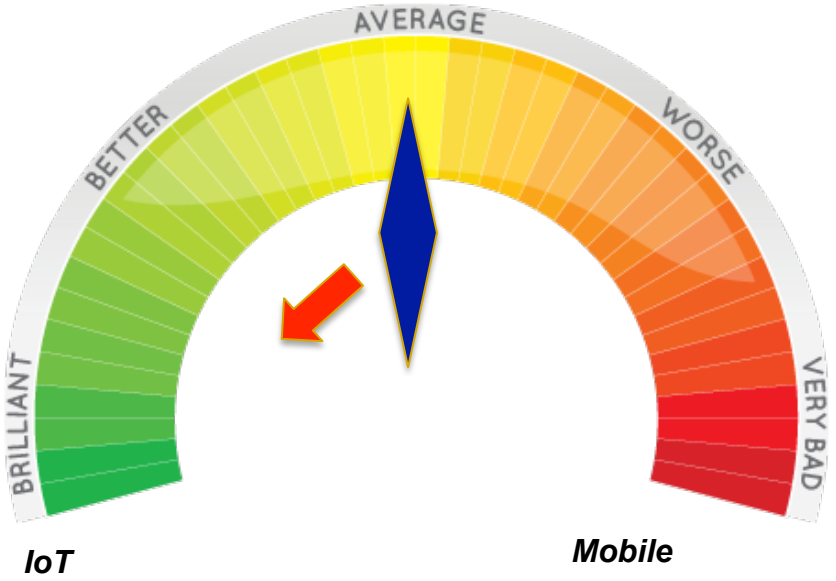
Source: HCL/BizWitz

One large scale pivot is largely complete while the other is just beginning:

LCD vs OLED



IoT vs Mobile



- LCD pivot for large panel close on complete: Samsung internally decided not to pursue large panel OLED. QD LCD a big feature of CES 2015. There is no consensus roadmap for OLED so Samsung and LGD going it alone really in small and large panel OLED respectively. Chinese are relatively more quiet on OLED also
- Those companies that really missed out on the Mobile opportunity (Intel, Cisco, Honeywell, AMD and others) really now banging their chests about the IOT. This is for now a set of niche opportunities but eventually could be large and will have demand for displays

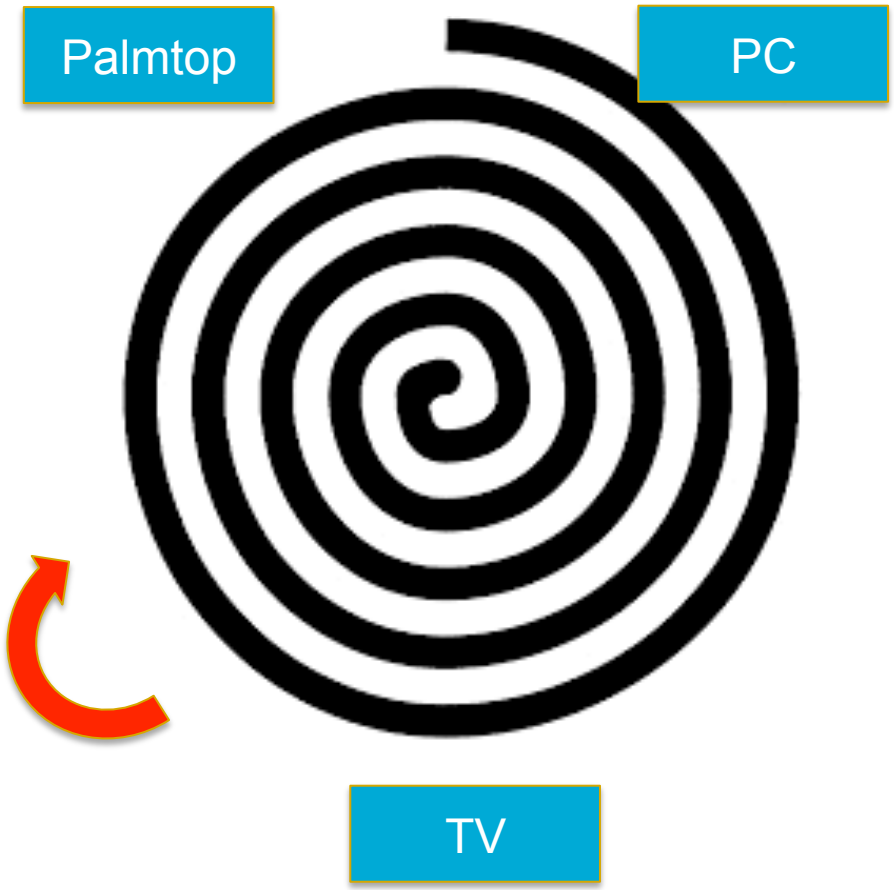
Source: HCL

This last pivot follows in the line of previous changes of direction for the display industry:

1998-1999	Japan transfers technology to Taiwan and pivots itself to LTPS
2001-2002	ODF is perfected leading to larger substrates and more panels per substrate
2004-2005	Column spacers and other innovations allow LCD TV to develop. CRT companies begin to fail. LTPS decline
2007-2008	Smartphones begin to appear. Panel makers move capacity into small medium and the touch race begins
2010-2011	Dreams for LTPS II (Samsung) and IGZO (LGD) drive bets. Tablets appear. “OLED TV will be next, I promise”
2013-2014	Panel makers begin to pivot back to large panel displays (4K) whilst still dumping capacity into smartphone displays

Source: HCL

The history of the display industry is of a spiral of changes of direction:



- One of the early major LCD markets was for “Portable TV”
- This pivoted into Notebooks and monitors (IT segment)
- This then moved into TV proper

- From this was a move back to “Mobile” (Smartphone)
- Now we see migration of additional functionality into notebooks and monitors (MVA-FFS etc)
- …and a pivot back to trying to find value in the TV market for 2014-2015

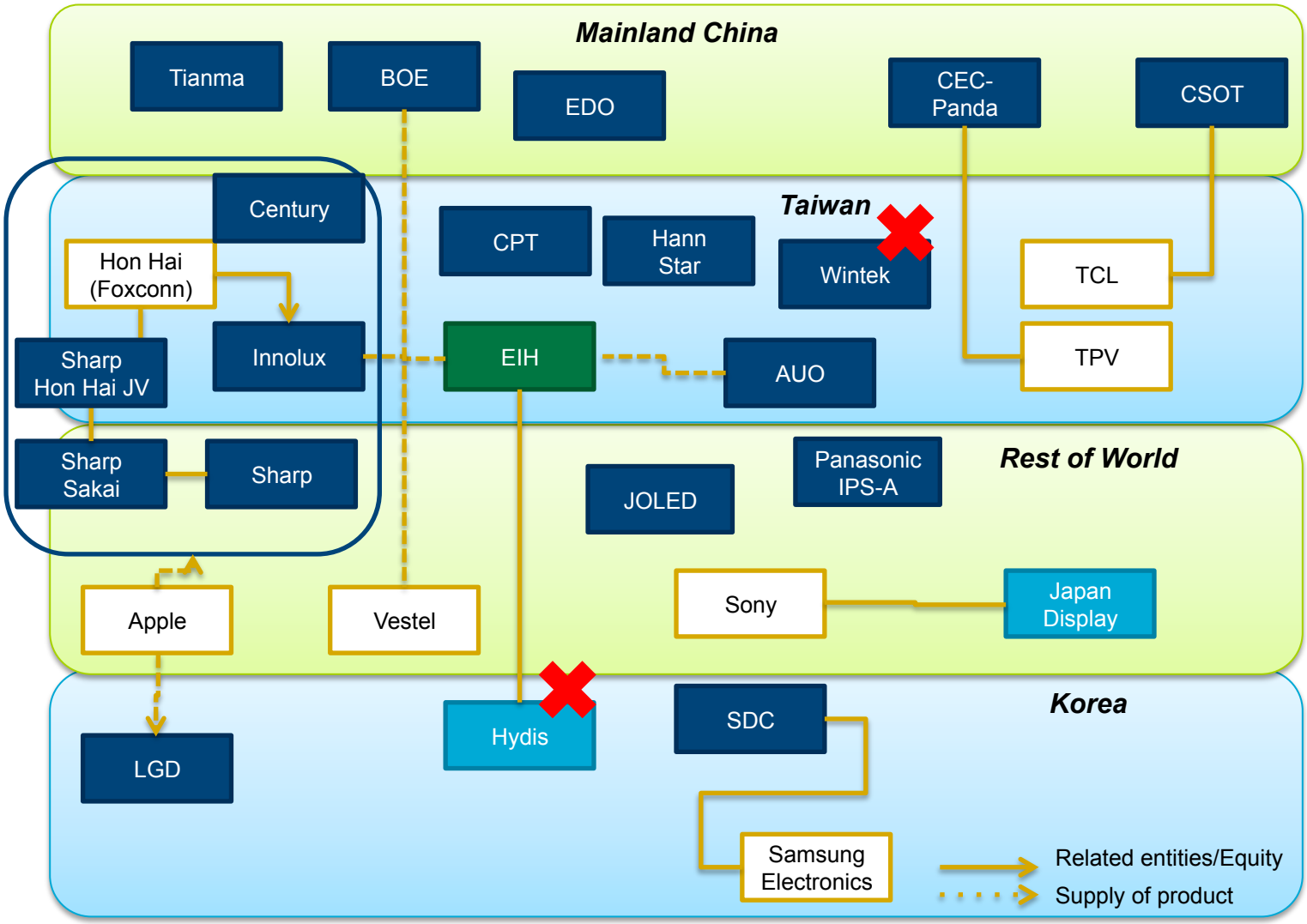
Source: HCL

The downward spiral of change:

"I have complete confidence that the company will pull out of this down spiral."

Source: Cartoontock

The chess board has changed:



- The Hon Hai group has aspirations of its own fab but also perhaps with Century
- JOLED established as second INCJ display vehicle
- EIH pretty much stopping the activities of Hydis in Korea (to much noise in the Korean press)
- EDO launching OLED products
- Wintek in financial distress
- JDI using TDI subsidiary in Taiwan as beachhead to attack Chinese market
- Outside of LCD: Complete stoppage of PDP activities

Display Co | Corporate | Small panel LCD | Other

Source: HCL

Many changes occurred in the market in 2014: Rush into mobile and strength in the TV market. “Allocation created shortages”

Mobile including tablets

- Focus on the CNY 500 price point as being important for mobile
- Tablet market collapsing as whitebox market at low end takes share and phablets cannibalise tablet business
- Resolution race continues up to 700-1200 dpi
- Mass pile in of additional capacity during 2014

IT (Notebook and Monitor)

- Monitor: Use of FFS-MVA type technologies deployed into the monitor market
- Notebook: XP revision cycle as helped notebook demand a little. Many IT majors making a move back to core enterprise business
- A number of brands try to introduce their own proprietary operating system platforms (e.g. Tizen)
- Pricing increases here in some segments

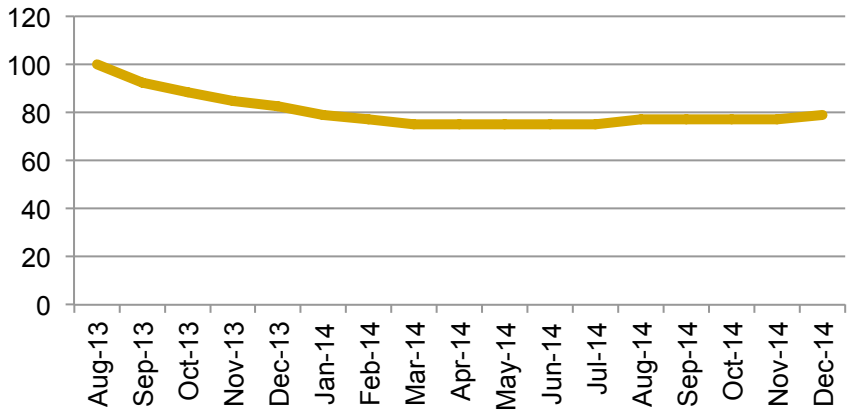
TV

- Improving price points through 2014 for panel makers; panel size average moving up
- QD announcements of 9 models at CES 2015
- TV set makers however seeing margins heavily under pressure
- Korean players pile into 4K to recover lost ground in 2013 to AUO and Innolux
- Allocation created shortages at some smaller panel sizes

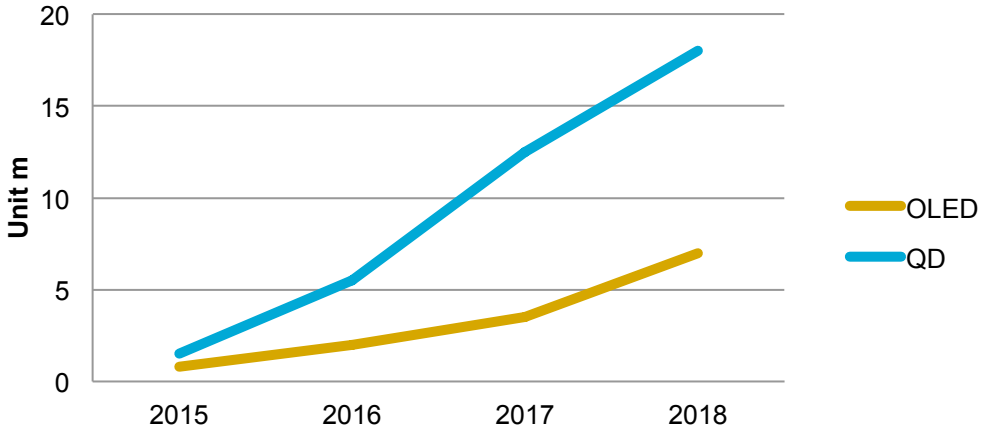
Source: HCL

The TV market has largely been the bright point in 2014:

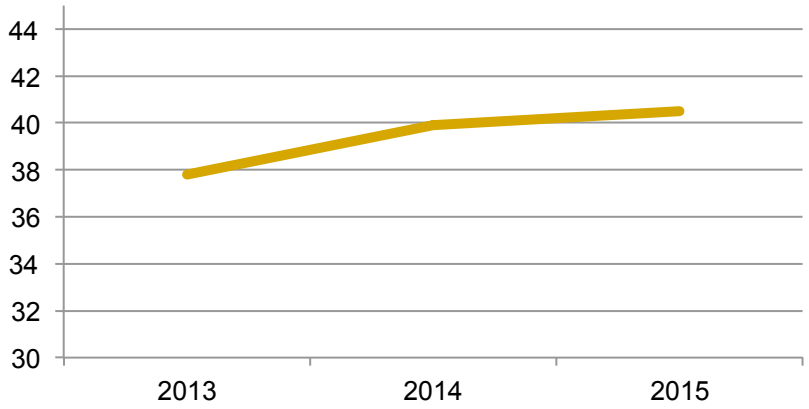
TV price index, like for like panel



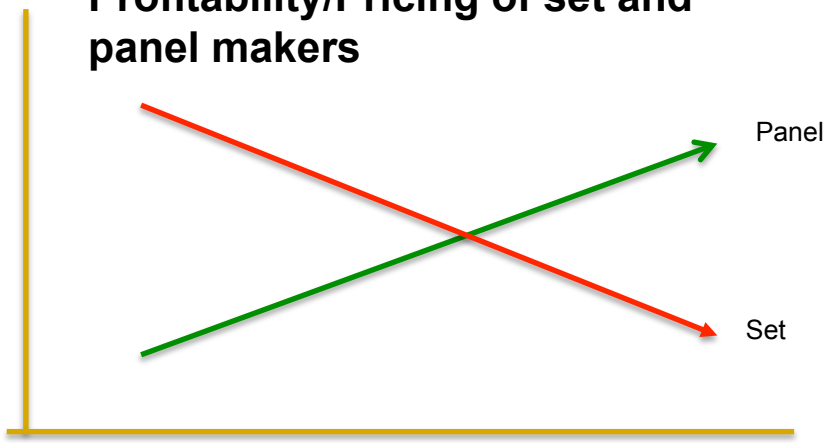
Shipment forecast



TV average diagonal inches



Profitability/Pricing of set and panel makers



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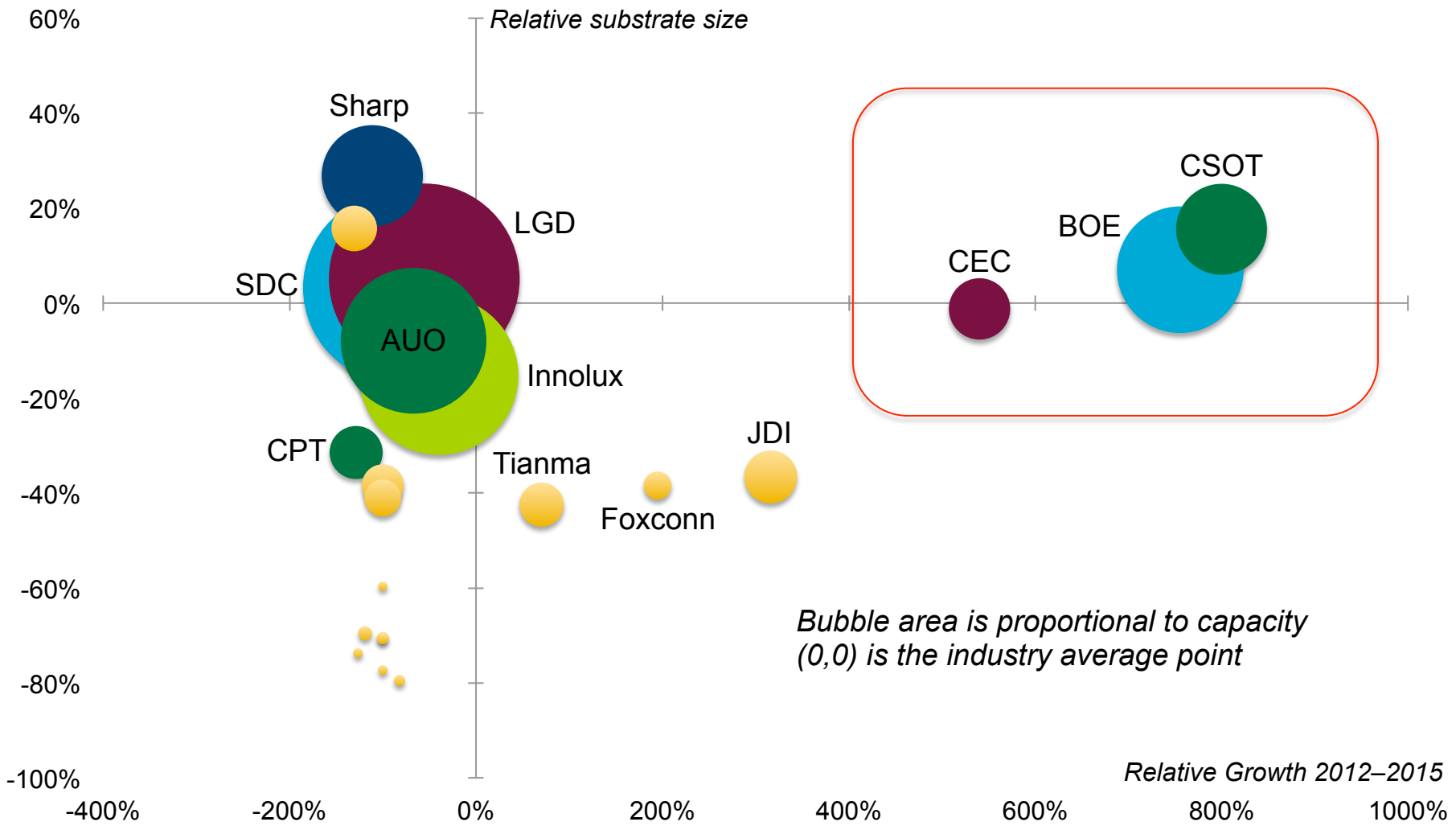
Source: HCL, DisplaySearch, IHS
QD-LCD particularly persuasive value proposition as it can be implemented with just a drop in film

But 2015 will be worse due to the build up of capacity in China:



Source: HCL analysis based on DisplaySearch data

…2015 may make all the display companies wonder what happened to the profits of 2014:

"I'm afraid there's a black hole in our finance department."

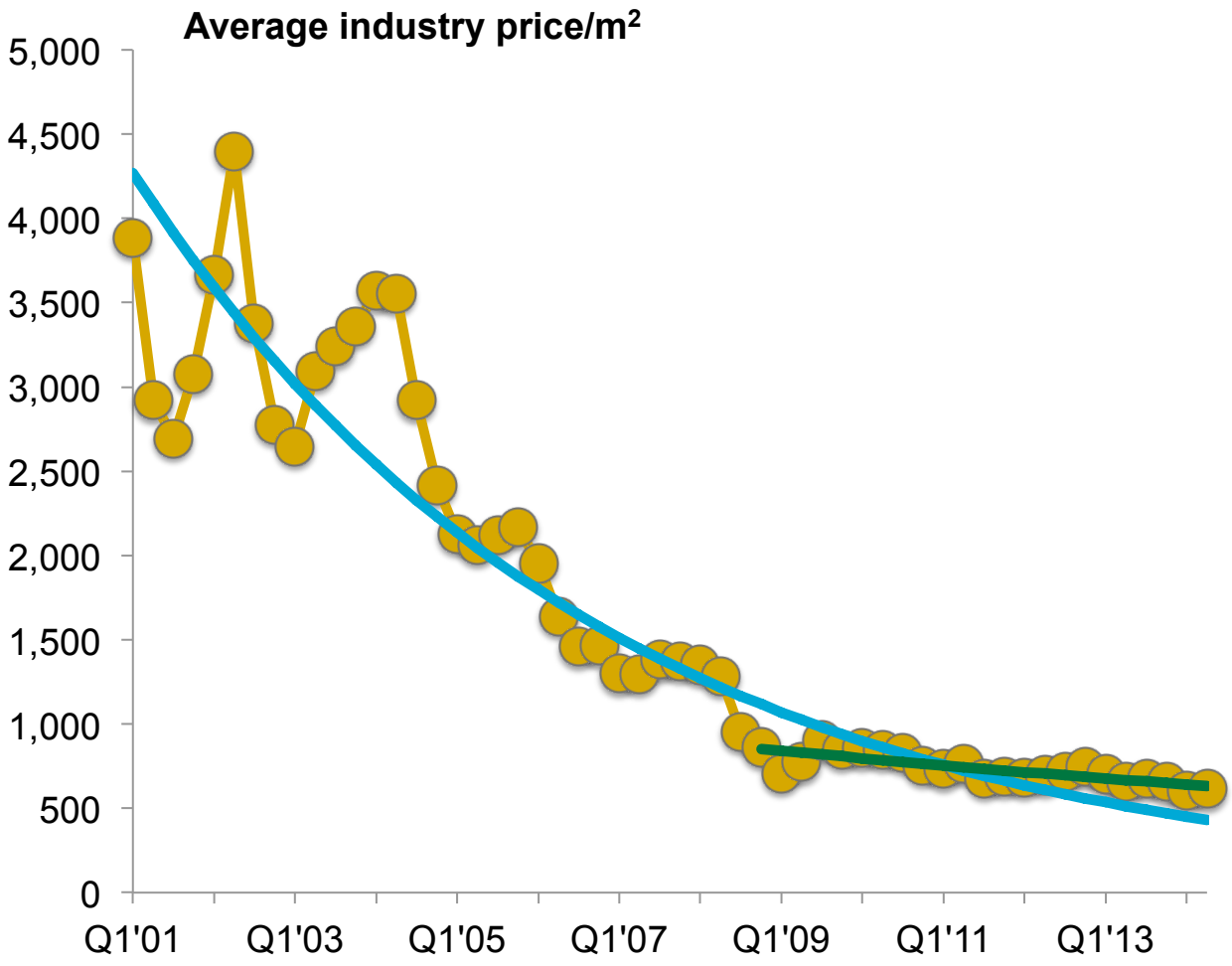
Source: Cartoonstock.com

Key forward looking prognoses:

- 2015 will be a tough year with prices under real pressure
- LTPS commoditisation and Metal oxide slow progress
- Upside for the industrial market
- Some new market opportunities for premium plays
- Players will need to adapt: LGD well positioned
- Elements of the next pivot

Source: HCL analysis

2015 may well see dropping prices especially in China where the capacity build up is so strong:

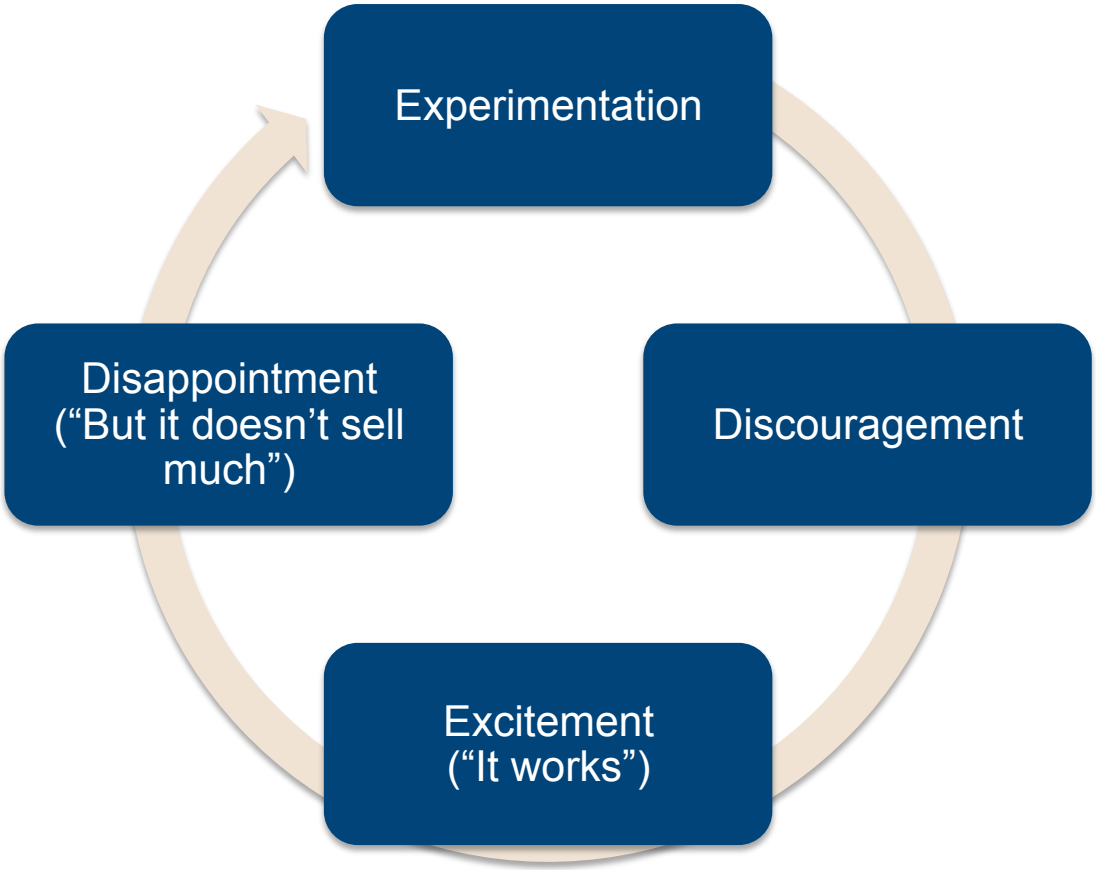


- Interesting question of how prices might develop
  - Will we see a price separation in the Chinese and ROW markets?
- Could we continue to see close on 20% price decline per year in China
- "How low can it go"
  - Chinese government supporting the development of a local materials industry
  - Materials players have to give up all of their profits to lower the price floor but this is a different notion in China

Source: HCL analysis based on AUO +LGD reported data

Technology perspective: LTPS will commoditise, metal oxide will be slow and technology angst will continue:

- LTPS commoditisation especially given a small number of high resolution platforms
  - Still below Gen 6, the demonstration from the Chinese entering LTPS shows it is relatively easy
- Metal oxide adoption continues to be really slow due to completely different physics on the semiconductor interface
  - Recent stories out of Taiwan that Sharp is having renewed problems with IGZO
- Otherwise display angst cycle continues for many "promising technologies"
  - Line of technologies from ferroelectric, OCB, Blue phase….



The display technology "Angst cycle"

Source: HCL

There may actually be some upside for industrial displays: In the experimentation phase with new technology, deals are available

Technology Trickle down

- In general there has been an acceleration of the application of FFS-Advanced IPS and MVA technologies to other segments including monitors (e.g. 4K-5K monitors recently)
- Might expect to see more high end technology end up in industrial and automotive displays

Availability of capacity especially in Taiwan

- Taiwan needs a new capital markets story
- Taiwan has sought to restrict the flow of technology and people into China but has been fighting a losing battle
- Taiwan now has capacity available and quite some talent to serve industrial markets
- Reduction in NRE charges?

New display innovations

- New display innovations, like “Free form” displays from Sharp
- May be greater availability of industrial displays with wide colour gamut, enhanced BLU, QD-enabled or with new Corning glass LGP (Could reduce thermal load for automotive displays)
- Increase in pixel count at minimum

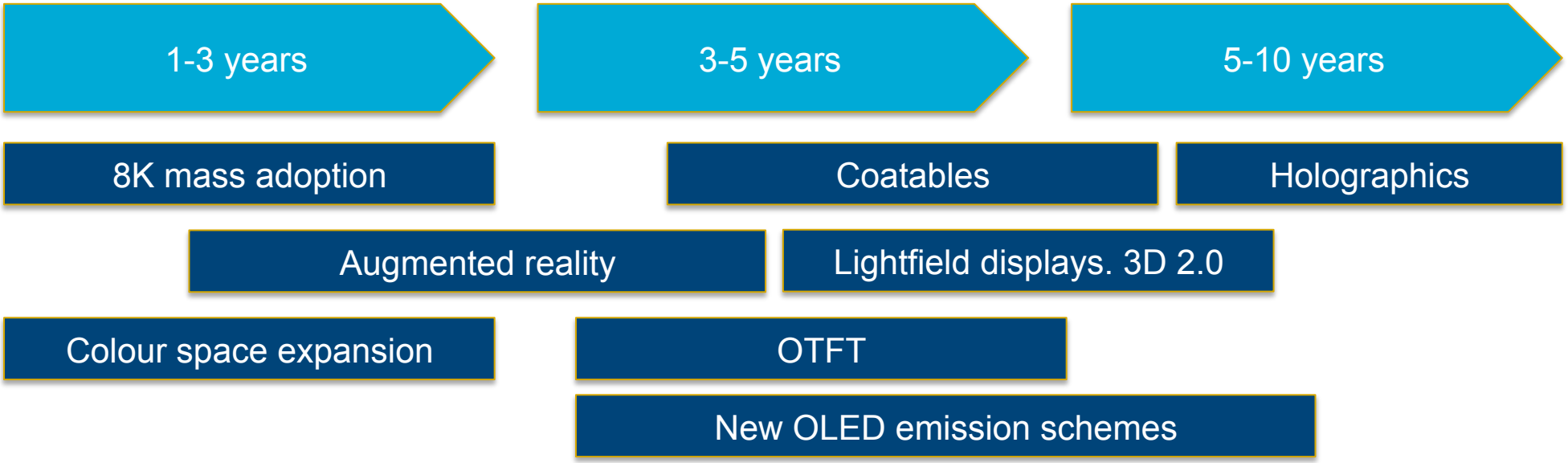
Source: HCL

…after the tough 2015 there may be a path to new opportunities:

"In an effort to make this sales meeting more pleasant, I have taken the liberty of rotating our sales graph counter clockwise a full ninety degrees."

Source: Cartoonstock

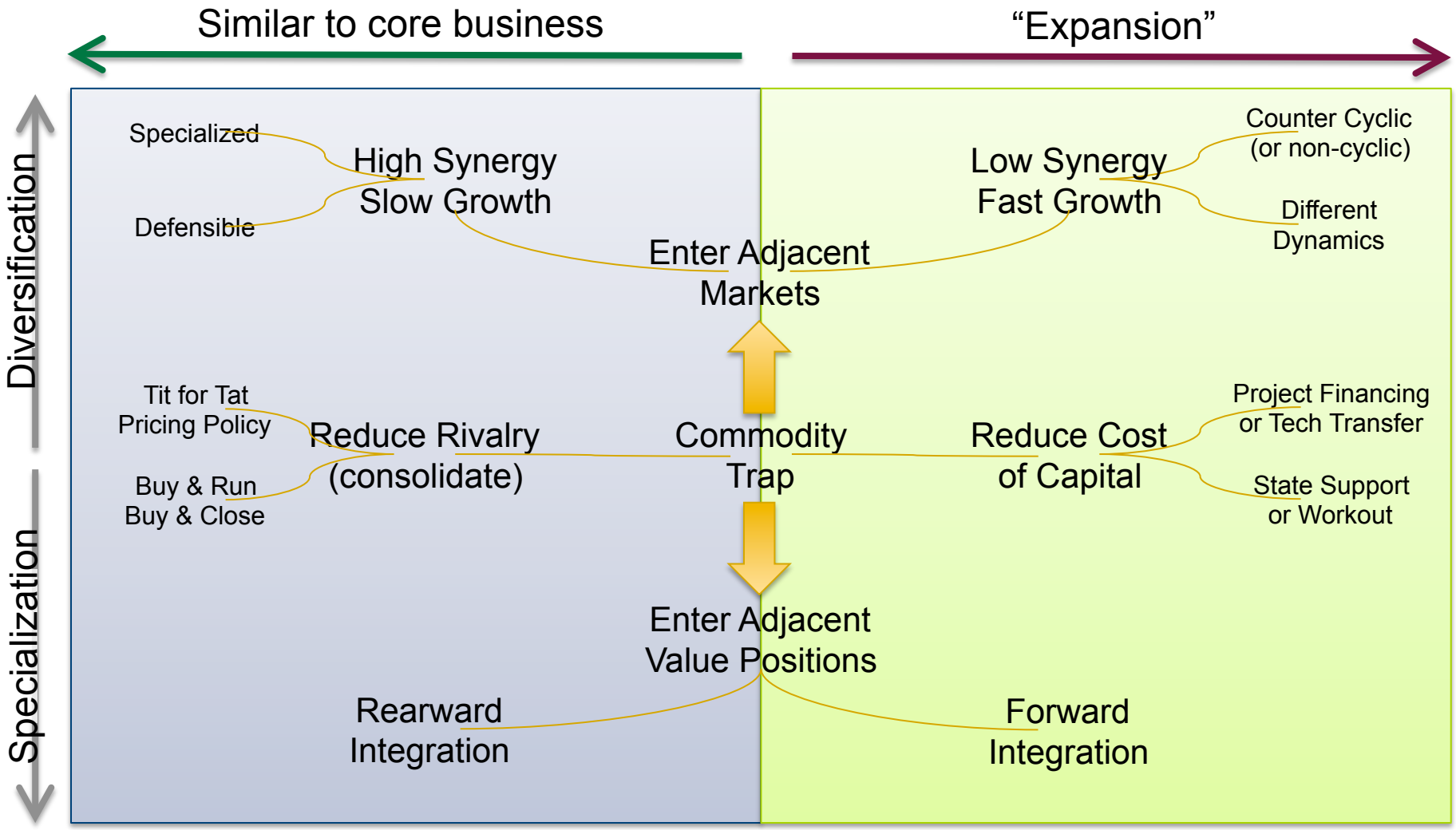
But within a few years, one the brighter side there may be some new display opportunities, some in microdisplays:



- The display industry knows how to sell pixels (Apple even gets a premium for them) so expect 8K to be a serious push. May be linked to beam-steering-based auto stereoscopic 3D
- The QD push is well under way and we think this could be really big: think about a large portion of the premium TV market being QD enabled
- Despite really challenges with Google glass, we think that augmented reality may well become important in B2B applications. Training is the key issue to get over adoption concerns
- Could see an emergence of greater discussion on OTFT and coatables despite factory rebalancing questions

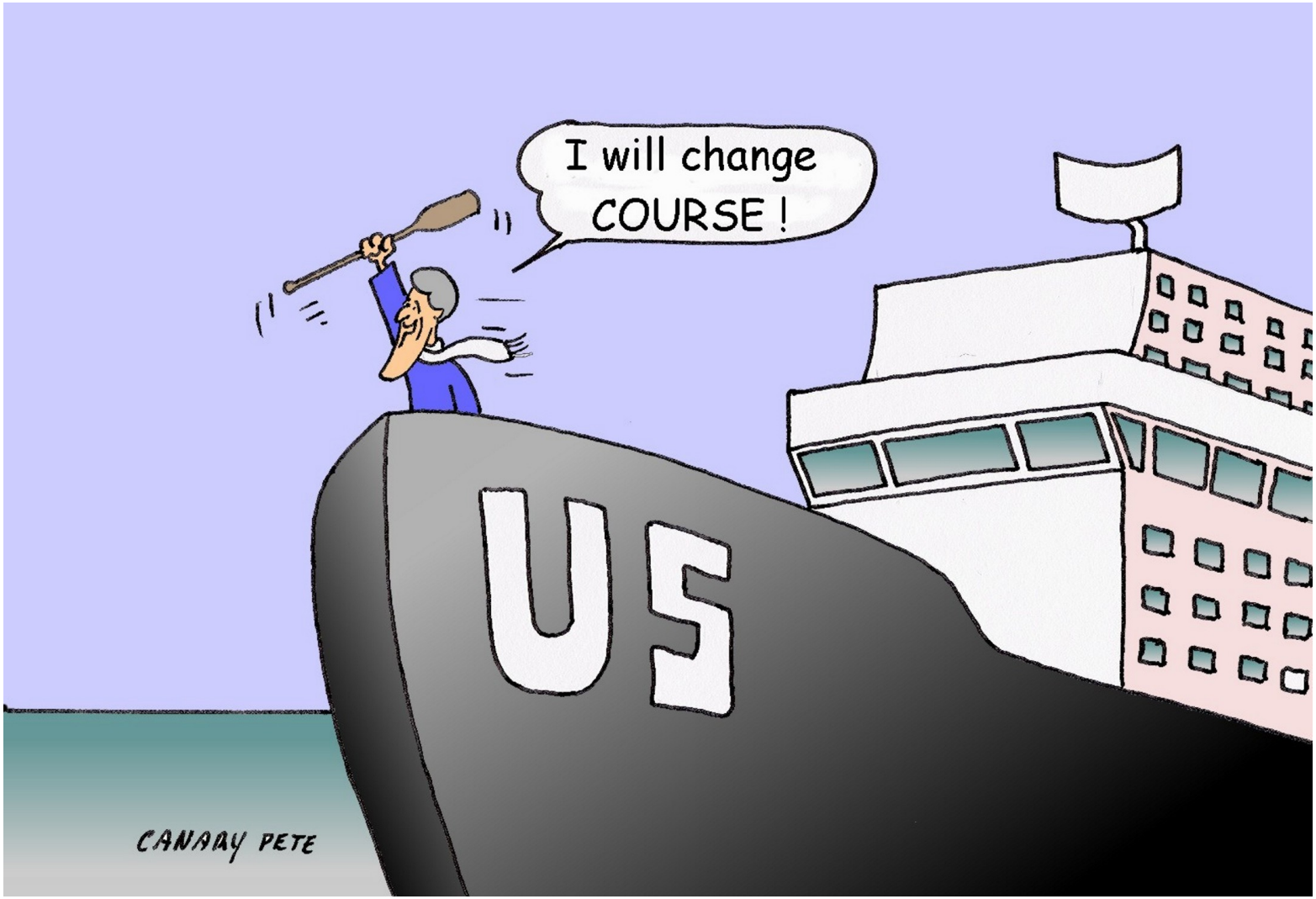
Source: HCL/BizWitz

Display players will clearly need to adapt



Source: HCL

…and as we know, our industry is not so strong at this:



Source: Cartoonstock

There may be some premium market opportunities based on new materials innovations in the supply chain:

Materials sources of innovation

- Nanoparticles (especially acting as optical function)
- 2D semiconductors
- Graphene or silicides
- Glass- and polymer- based new substrate materials and for LGP
- New OLED emission schemes
- New LC modes perhaps
- Encapsulation

Display related sources of innovation

- Subpixel rendering
- Light field displays and next gen 3D
- De facto standard for metal oxide
- Coatable processes not vacuum based
- Self assembled material schemes to reduce reliance on photolithography
- Flexibles
- R2R eventually

"Down stream" (based on innovation in ICs or set)

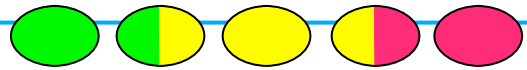
- Holography
- 3D 2.0
- New touch/camera paradigms

Source: HCL

LGD for now seems among the best positioned:

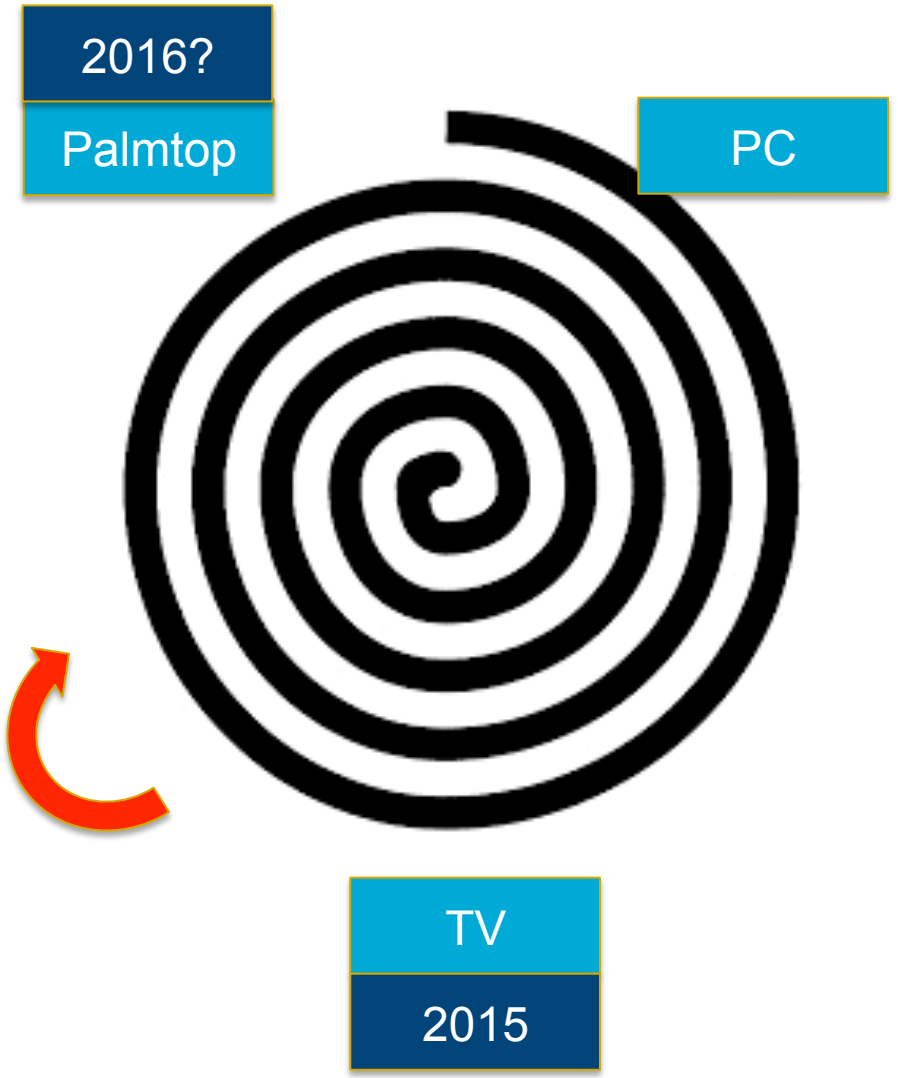
	Mix	Customer base	Specific company risk	Summary
LGD				Strong partner to Apple with innovation story to tell
SDC				Carrying some near term small panel OLED risk; China risk
AUO				Starting in OLED but weak small panel business. Low capex means good CF
Innolux				Small panel management team was hollowed out previously now recovering. Hon Hai risk remains
Sharp				Sharp did amazing job of corporate turnaround but IGZO risk remains and China exposure
BOE				Have amazed the display world but can they manage so much distributed expansion
CSOT				Quite an interesting firm and making strong strides into small panels too

Source: HCL



Strong Weak

So what is in the next pivot?:



- 2015 will probably be the year when TV innovations feed through and commoditize
  - TV will be a blood bath in 2015 with heavy price pressure and 4K mass pile in

- The obvious place then to look next is to Palmtop portable devices:
  - A rejuvenation of the iPad space based on rumoured stylus input?
  - Autostereoscopic/lightfield related small displays?
  - New motion, gesture and touch concepts?
  - New category from Apple or other?

Source: HCL

Summary:

- 2014 has been a relatively good year for the display industry
  - Most of the display players solidly in the black even though the industry is still net cash flow negative since inception. Samsung is the poor performer of 2014 which is unusual
- 2015 will be a much tougher year, based on substantial capacity investments from BOE, CSOT and CEC Panda
- LTPS will continue to commoditise; metal oxide development will be slow
- There may be some very real upside for industrial displays
  - Technology trickle down of FFS-IPS
  - Availability of capacity especially from Taiwan: they need the new capital markets story
  - Automotive is particularly doing well: with freeform displays from Sharp and improvements in colour and BLU quite important in driving forward an innovation agenda
- Display players now need to radically reform their business to cope with the deepening water
  - LGD for now looks like one of the few well positioned with Apple in their pocket
- But some longer term options on the table as upside
  - 8K is a slam dunk, OTFT, Augmented reality, application specific and lightfield displays all options
- For us in Europe: New materials opportunities for Merck, Henkel, Evonik, BASF and others. New upside for industrial and automotive. Not a bad story while the Asian players evolve and adapt

Source: HCL

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