

Towards a Better Forecast for Printed Electronics



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The 6th International Exhibition and
Conference for Printed Electronics

28 May 2014 — David Barnes, BizWitz

Innovations are rare because they are uniquely useful and valuable

Talk about innovation is cheap but realizing it is costly and difficult for businesses

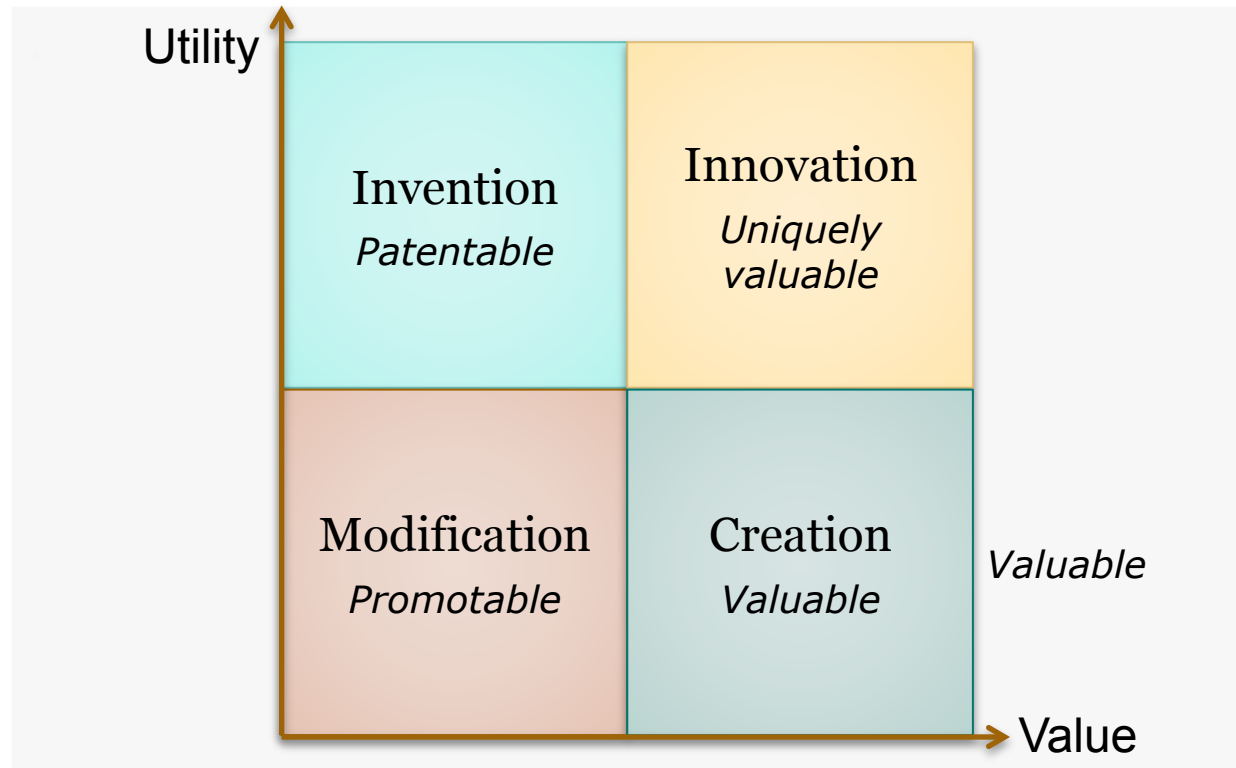
In most cases, organizations modify something or offer some novelty: a 753 ppi LCD

Value may be increased by creating a product line or range: a 4K TV sub-brand

Sometimes an organization has a patentable product: IPS/ FFS LCD

More rarely, an organization combines high-resolution with a sub-brand, FFS LCD and software and an apps store to create the iOS business, which is unique, useful and valuable

Utility-Value Matrix of Innovation



BizWitz conceptual diagram

Being approximately correct rather than being precisely wrong requires sincere assessment

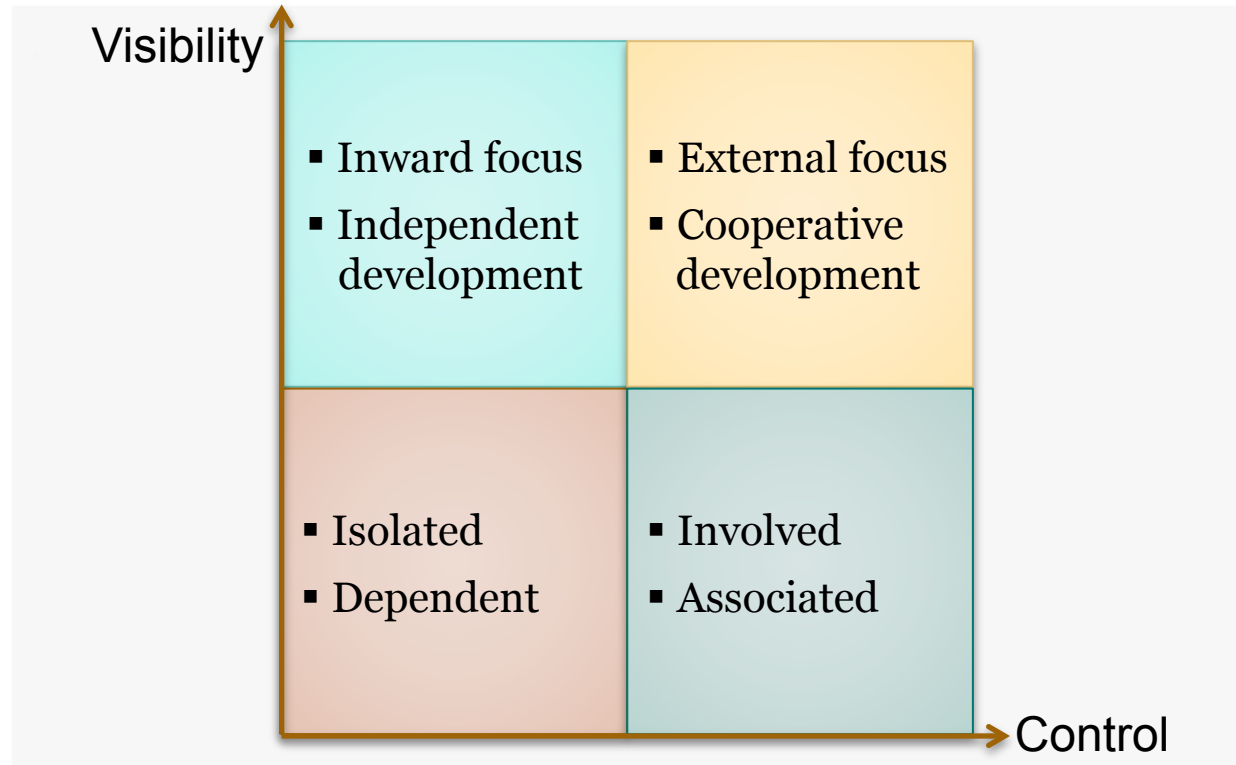
All organizations have limited visibility and control... some more than others.

Few can sustain an external focus and coordinate co-op development, long term.

Ironically, materials suppliers are often isolated and very dependent on other tech or market developments, yet they often profit most from merging technologies.

A combinations of inaccurate mental maps, dependencies and untested assumptions lead to unfortunate forecasts for others assuming more visibility or control.

Visibility–Control Matrix



BizWitz conceptual diagram

The map is not the territory ... ways we fool ourselves into foolish actions



Johannes Vingboons, ca 1650

Logic Bubbles

... isn't obvious that_____?

- When an Asian businessman hears that a project will take a lot of capital, he says, “Good!”
 - More money will be, “spread around.” He will gain face.
 - Big projects are wanted for big populations.
- When a Western businessman hears a project will take a lot of capital, he says, “Bad!”
 - Investors want big returns on small amounts.
 - “Let’s make it R2R, then.”
- We all tend to think others know and understand our constraints... but they don’t.



Leapfrog ... so we'll jump way ahead of them!



- The history of US display and printable electronics provides many examples...
- After deciding finance, mergers, acquisitions or real estate was preferable to capex, US companies let others do the heavy lifting.
- But disappointed engineers dreamed of new things and it looked like they could jump ahead of slower-moving Asian competitors.
- This became a corollary to the US military's dual-use doctrine: US companies should work on advanced projects so they can leapfrog others.
- OK, but two questions:
 - Will others stand still long enough?
 - Can I vault high enough?

Shock and Awe

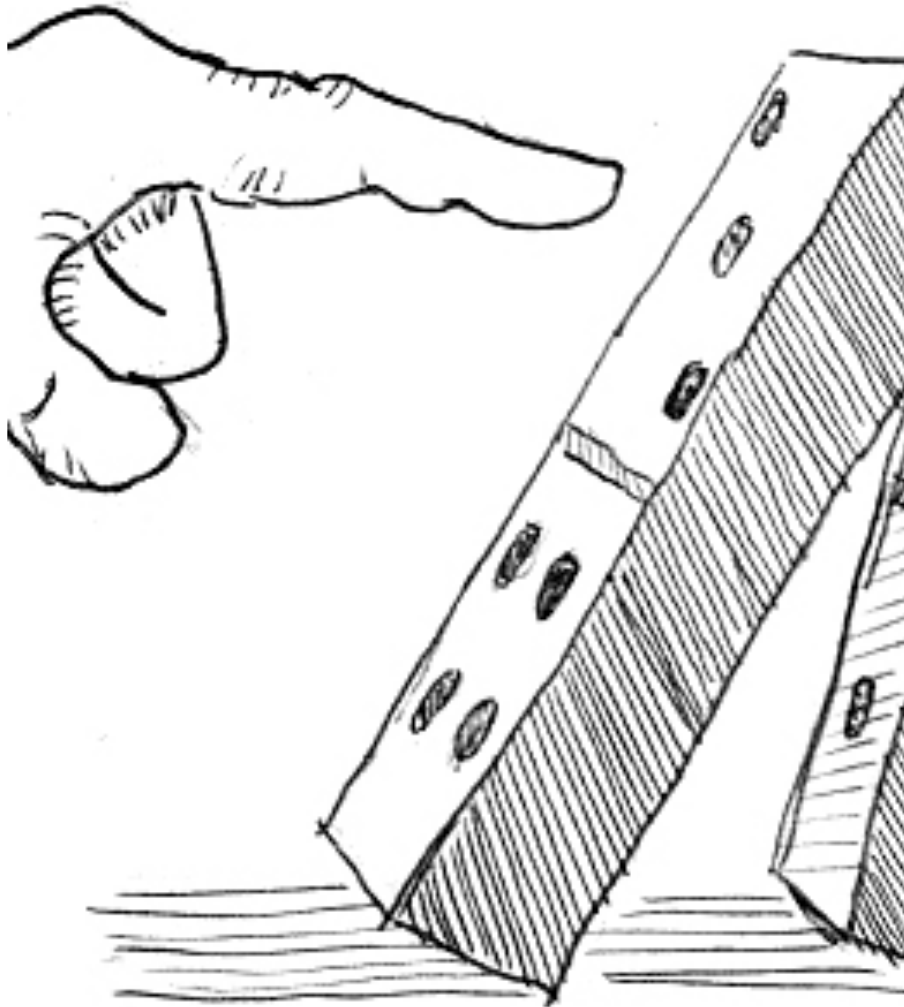
... our new _____ will change everything!



- This is another US-centric motif but one that may resonate with veterans of EU Framework projects.
- While it may be tempting to think that incumbent suppliers might roll over and give up when you announce, they might not even pause their relentless progress toward more for less.
- Worse, they may alter course and change the playing field before you realize it.
- Getting to Bagdad is just the beginning...

Determinism

... all we have to do is _____.



- If we ____, then they must ____.
- This fallacy has some parallel to Marx's historical determinism... which might not be wrong, just late.
- It also intertwines with logic bubbles
- ... they must know that they have no alternative once we enter the market.
- If I had a euro for each cost forecast I've seen that showed Tech-X would beat all others because... I'd retire.
- Why do you assume they plan to be profitable, ever?
- The point here is that people have different constraints and preferences than you do and that you should not assume something is inevitable.

Magic

... and then, _____ will happen.

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David J. Schwartz, Ph.D.

- Leap of faith
... a noble thing at times but dangerous.
- “Presto” is nice to say but difficult to do.
- Magical thinking comes in two general forms.
 - Sympathy: A is similar to B so if I do this to A, then B will change also.
 - Correspondence: B changed when A changed, so C will change when D changes.
- Governments and organizations succumb to magical thinking frequently, so the only good antidote is a strong sense of history
... and remembering that correlation does not imply causation.

Example of a misleading mental map

... the rise and fall (and rise and fall?) of LTPS

A famous market research firm forecasted LTPS-based display sales would rise 141% a year from 1997 to 2002 and reach \$4,800 million.

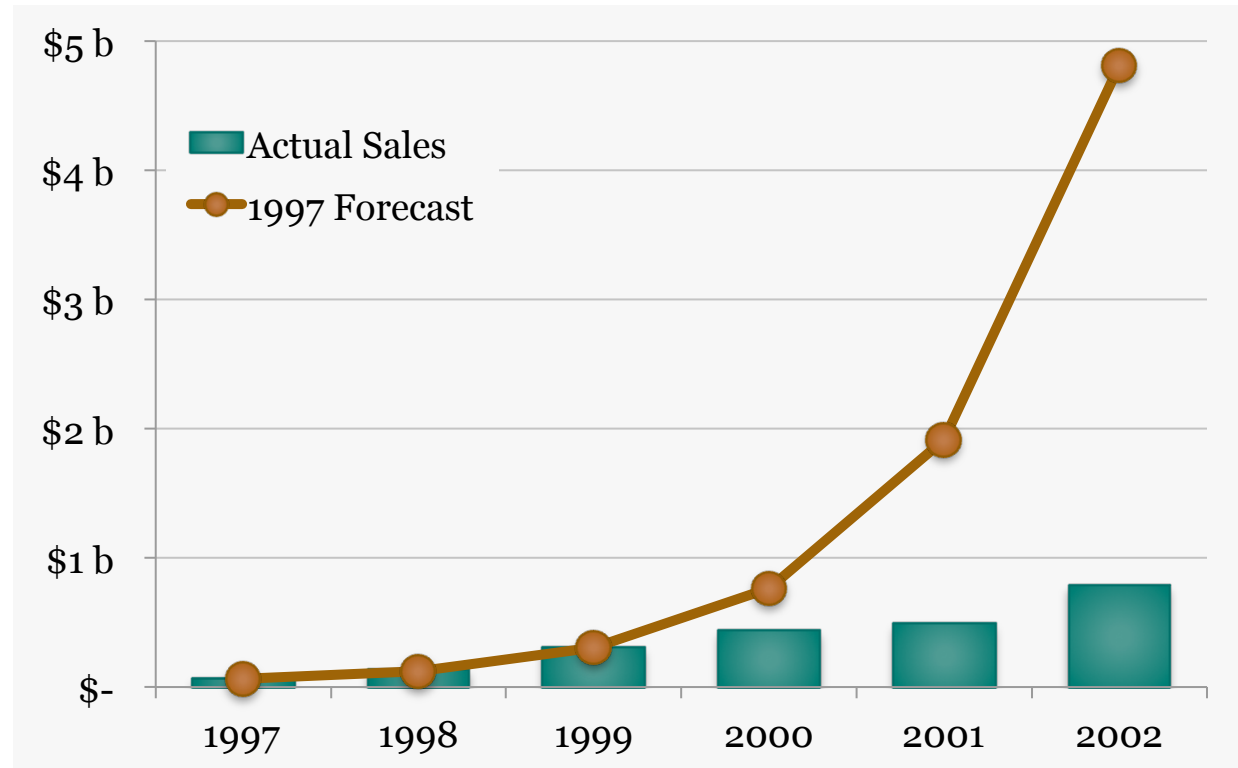
In hindsight, sales increased 62% a year to reach \$784 m.

The forecast proved to be 5X too high 5 years later.

What went wrong?

- Tools: no way to pattern IC resolutions at TV sizes
- Momenta: no way to catch-up with a-Si:H TFT
- Costs: on-glass integration more costly than parts (DIC)
- Values: a-Si technology was good enough for most things

LTPS Display Forecast and Actual Sales



BizWitz analysis of a Q2'97 report and a Q2'05 report by the same firm

Assumptions— Are you sure things will change quickly?

David Sarnoff and RCA had a wonderful vision of TV sets you could hang on the wall ... and we could 50 years later. It took more than a few things to change.

It took materials, tools, many breakthroughs and euros.

... spent by many companies

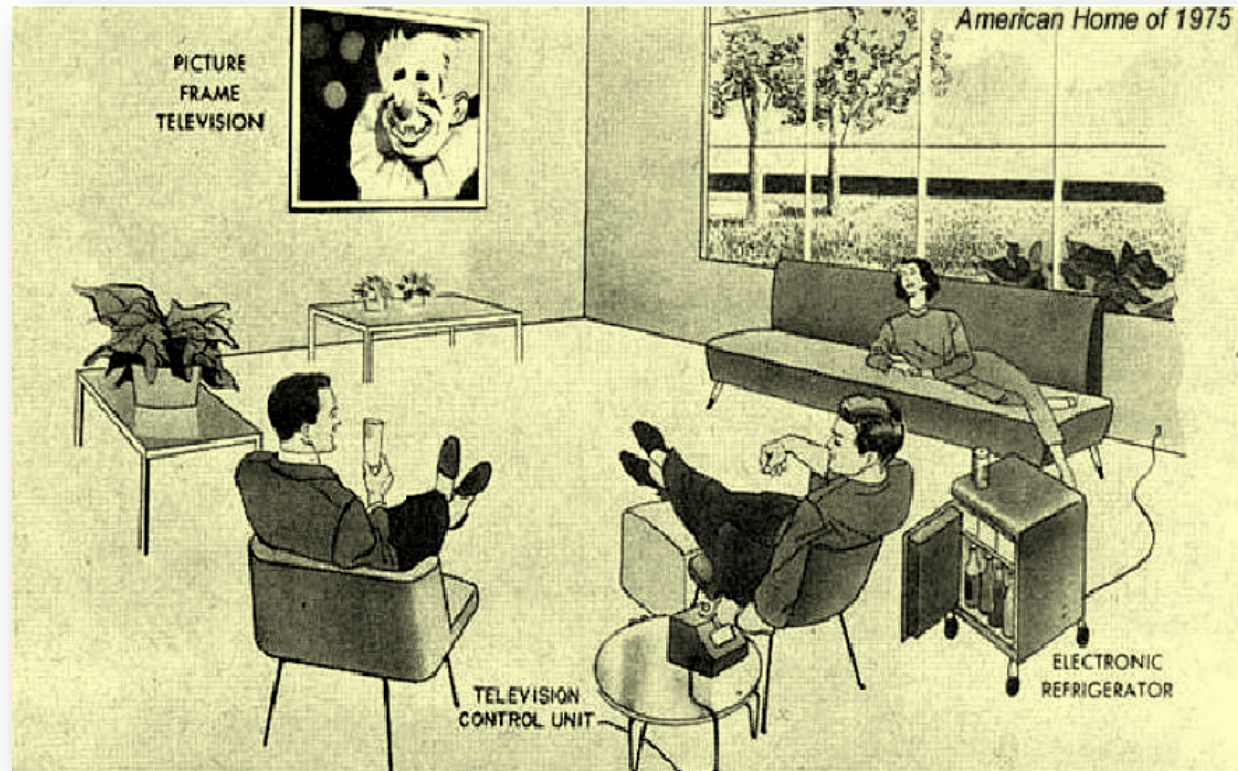
... over many years

... with some success

... and lots of failure

So today, we can say “nothing’s on” our TV made by companies that make no money for investors.

RCA's Vision of the Future in 1955



Source: Technician Magazine, Oct '55

Assumptions— Are you sure things will change slowly?

We live in a non-linear world
and momentum matters.

Aim where incumbents are
going, not where they are.

Study historical trends.

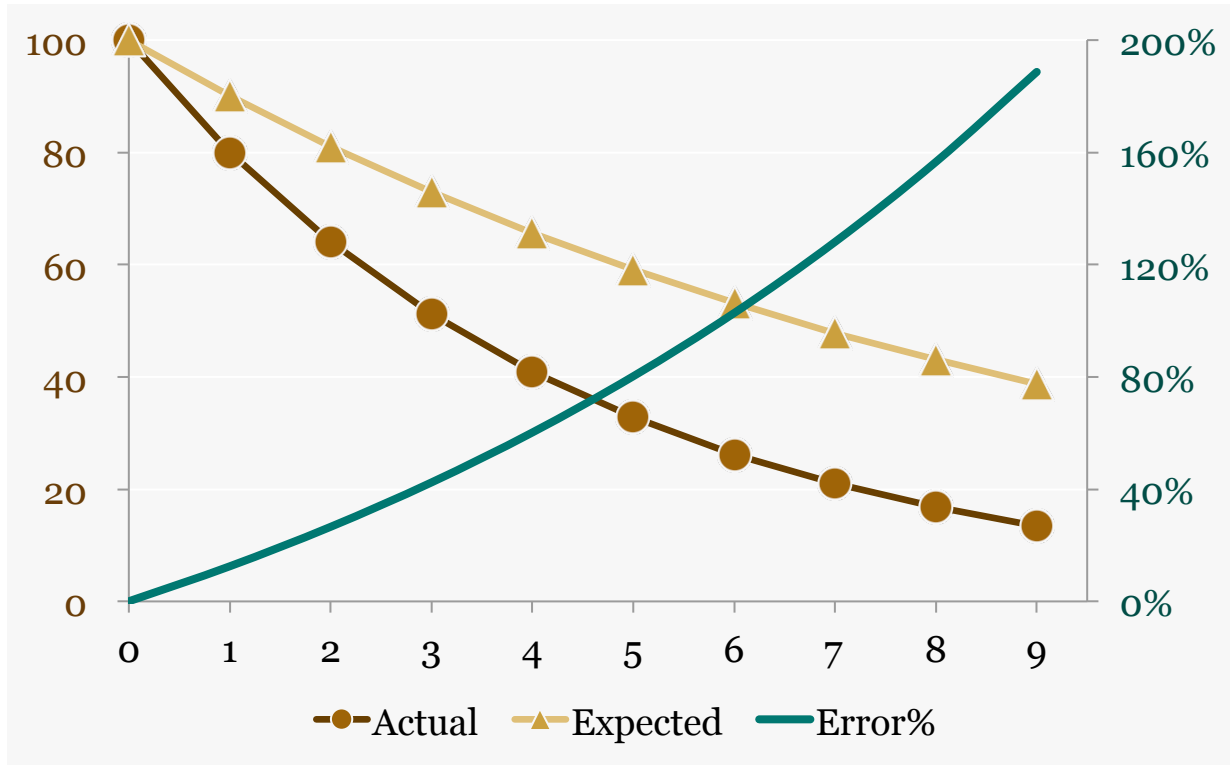
Question forecasts.

Ask yourself, what if we are a
few years (or quarters) late?

Think about industries or
markets as snowballs rolling
down hill.

Why will snowballs change
vectors if you ____?

Difference Between 20% and 10% Annual Declines



Source: BizWitz experience in display and IC industries, 1974–2014

Assumptions— The trend is your friend, until the end.

You can model the areal price of AMLCD with a simple sine wave riding on an exponential decay line.

The problem with this is you can find data to support any trend you want

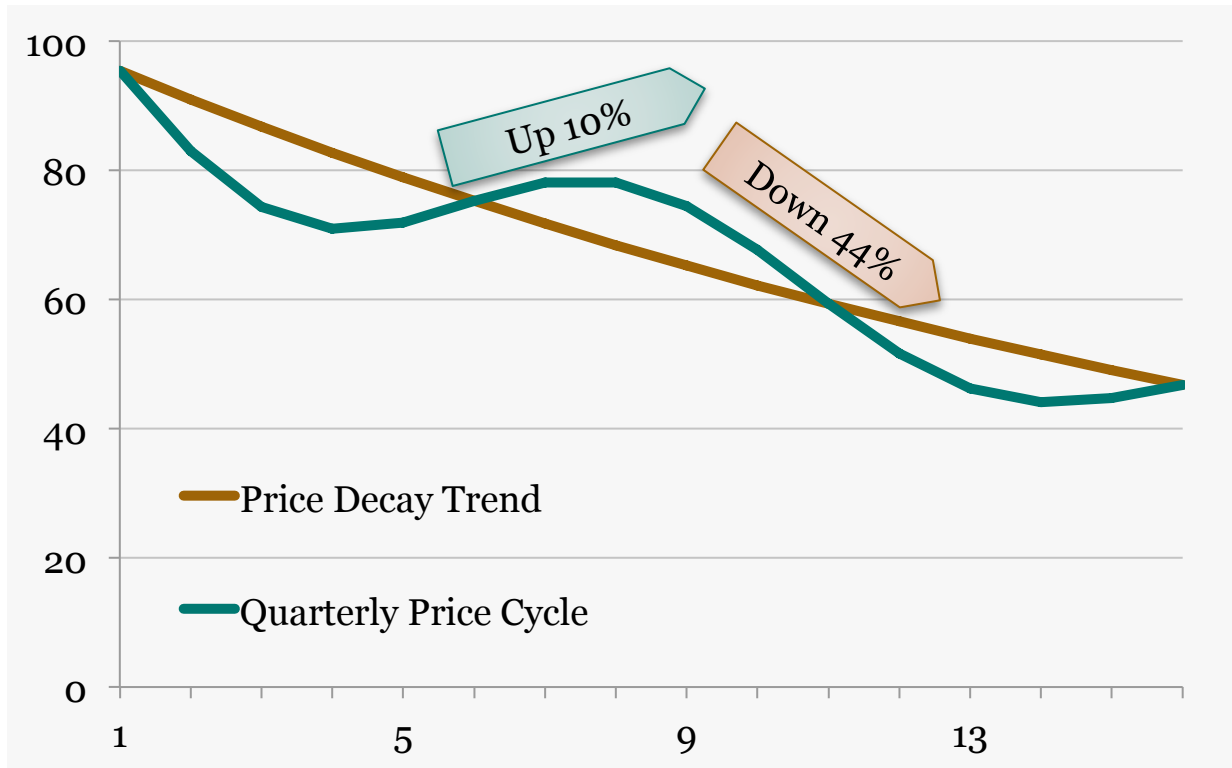
... if you think short-term.

The AMLCD industry has a nominal ten-quarter cycle based on capital and people resources, so you need to look back three or more years to see the real historical trend.

Momentum matters.

Are you moving fast enough
... in the right direction?

Sine-wave Model of AMLCD Area Price by Quarter

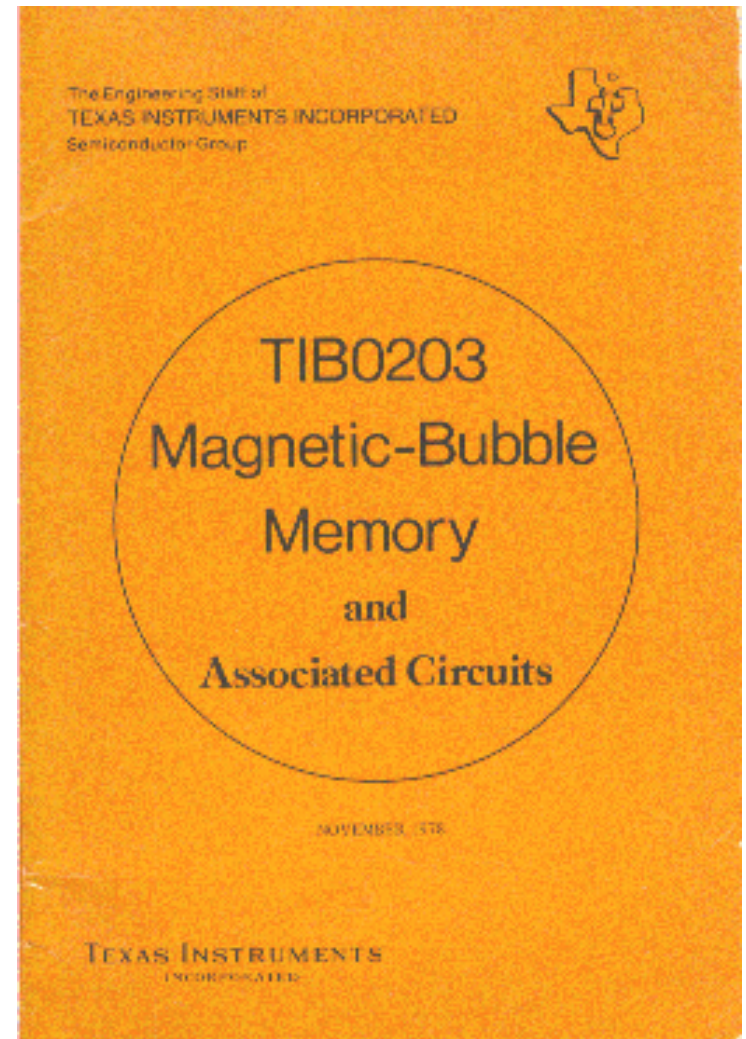


BizWitz analysis circa 2006

Assumptions— Are you solving the right problem?

The problem is how to get rid of mice, not how to catch them.

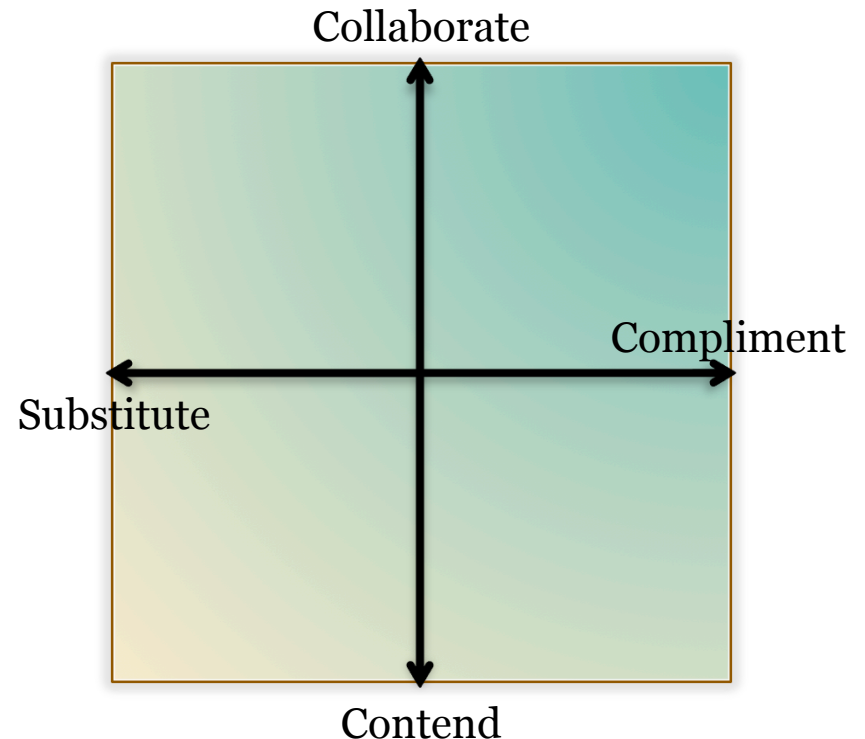
- Bubble memory was the better mouse trap of the 1970's.
 - TI introduced a 92 kb MBM in 1978.
 - By 1979, Rockwell, IBM, TI and Intel had over 500 engineers involved.
 - By 1981, all projects were abandoned.
- EEPROM was better, faster and cheaper.
 - It evolved from conventional IC technology.
 - It required less design and production infrastructure change.
- The problem was how to keep data, not how to write data.



Precedence and Dependence

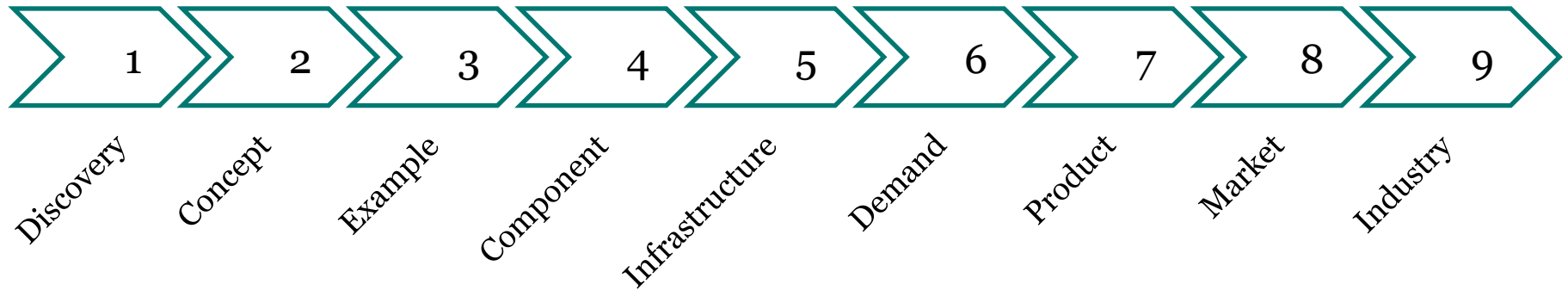
... another way to say visibility and control

- No organization is an island.
- Each must decide
 - ... to collaborate or contend with incumbents;
 - ... to compliment existing products or to replace them with new ones.
- In general, if you cannot find and defend a market segment for contending and substituting ... then you should seek one in which you can collaborate and compliment.
- The following slides show phases of development any new technology passes through on the way to market



Speaking of dependences

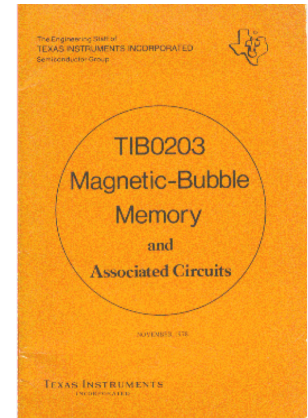
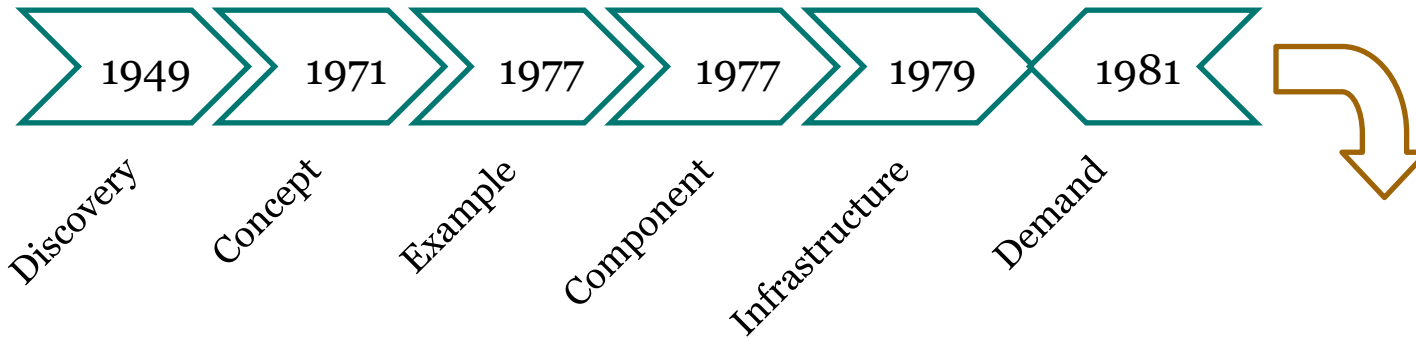
... here are nine phase gates to negotiate



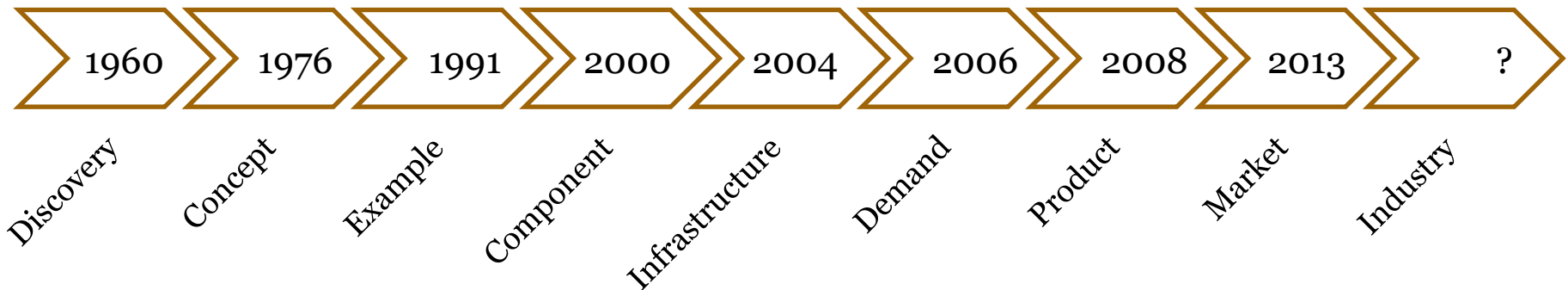
- Revolutionary technologies must go through all nine steps to commercialization.
 - Bubble memories
 - LCD
- Disruptive technologies may start at the point of demand (6), developing a business model or value proposition, and build on existing infrastructure.
 - Small disk drives
 - OLED (?)
- Evolutionary technologies may start at the point of finding a new product “carrier” or identifying a new market (8). IGZO might be an example of this.

For example, computer memories

Core Memory — Forrester, MIT



Tunneling Junction — Giaever, GE

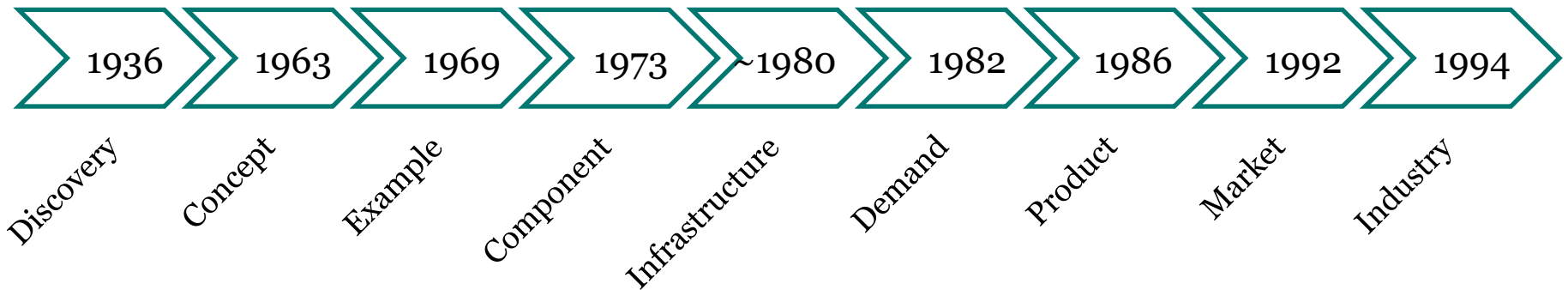


- MBM got as far as a manufacturing infrastructure before demand failed to appear. The IBM project met all its targets but DRAM, EEPROM and Disk Drives had evolved too far.
- MRAM sales of \$190 m in 2013 leads to forecasts of 67% annual growth into 2019...

... and AMLCD

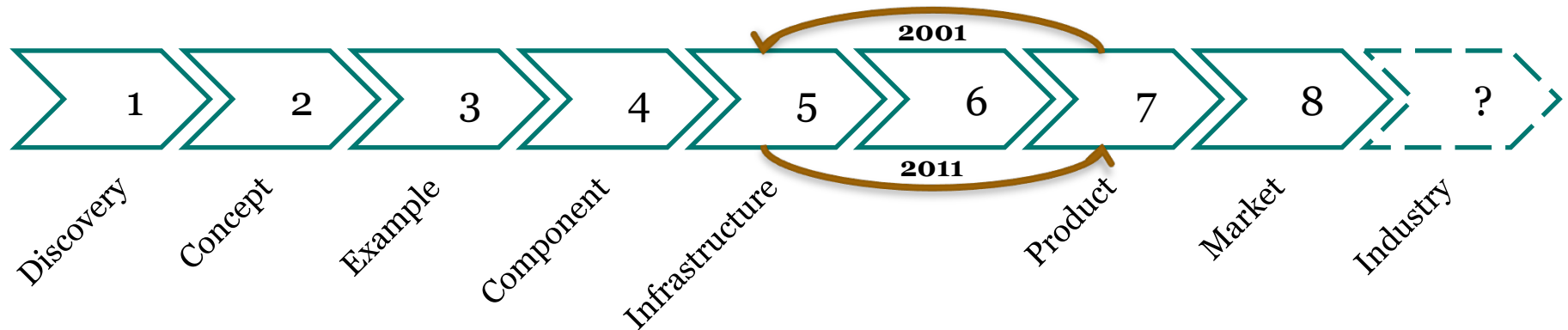
Industrialization can take 27 years, or more.

Liquid Crystal Light Valve — Marconi



- Marconi patented the LC light valve concept in 1936 but the TN mode wasn't developed until 1969.
- It took billions of dollars and MITI (Japan) coordination to build AMLCD scale and infrastructure.
- NEC introduced the LCD notebook PC in 1986.
- The modern AMLCD industry was not in place until 1994... thirty years after RCA developed the TV on a wall concept on the work of Richard Williams.
- Affordable LCD TV you could hang on the wall did not appear until 2003–2004... forty years after the concept was announced at Rockefeller Center.

LTPS is an example of a rebound ... or perhaps not.



- Even an evolutionary technology like LTPS (p-Si AMLCD) can hit a barrier.
- The incumbent technology does not stay still, so if you aim for where it is today...
- Tomorrow, the incumbent technology will be faster, better, cheaper.
- LTPS lacked a “killer app” to carry it into the market. Handheld TV wasn’t it, until Samsung funded the AMOLED smartphone (that used LTPS backplanes).
- In 2001, LTPS producers found themselves competing with AMLCD producers who have a better cost structure and mature infrastructure.
- In 2011, (Galaxy) AMOLED smartphones became viable products but we wonder when Samsung will industrialize AMOLED TV sets.

Summary

There are two ways to slide easily through life:
to believe everything or to doubt everything;
both ways save us from thinking.

— Alfred Korzybski

... who also said:

The map is not the territory.

Flex/Displays is a difficult business...

BizWitz analysts are here to help



Growth

- Market entry
- Business structure
- Phase gates, R&D

Performance

- Price position
- Cost reduction
- Portfolio balance

CapEx

- Factory plans
- Tool selections
- Plant conversions

Sourcing

- Make/buy
- Value chains
- Supplier selection

Technologies

- Market sensing
- Market & IP value
- Consortia synergy

Alliances

- M&A candidates
- Partnerships, JVs
- Integration plans

Plans

- Strategic audits
- Investor insights
- Business valuation

Materials

- Pricing policies
- Market strategies
- Licenses, royalties

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