



Executive leadership in optics: recent lessons & future contingencies

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Three Limbering-Up Questions for Self-Reflection



01

What is inherent to optics that often leads to rapid margin declines?

02

Does any accredited university offer a degree in climatology?

03

Is *Hamilton* the most overrated musical ever?

...Rest of Incredible “Finisar” Story



- Board sought advice from Broadcom’s CEO
 - > Hock Tan highly recommended Michael Hurlston
 - Key factor in selection & board left him free to function
 - Tan positioned to play marionettist
 - Hurlston alienated Apple with RF modem ASIC on price
- Hurlston now at Synaptics (“Finisar” redux)
 - > He lacks intimacy with its business
 - > Enabled by passive board
 - Low morale on engineering side & more than 20% layoffs in Bay Area

Historic Alerts in Optics Industry



Gradual Movement Away from Vertical Integration Since 1980s



- Scientific influence of Bell Labs, Bell-Northern Research, etc. slowly declined
- Large system vendors divested their component assets
- Siemens used to be massive leader in optical technology
 - > Mindset was that it makes the highest quality products in selling to AT&T
 - Lack of adaption from lengthy number of qualifications/time to create overly robust gear

Still Paying Price for Bandwidth Bubble at Turn of Century



- Many folks with strong technical background became long-term biz leaders by chance
 - > Some did very well or brought in P&L-savvy execs
 - Others didn't adjust for market restructuring (ex. NeoPhotonics and "Bookham")
- Since that time only 2 new big markets
 - > Hyperscale data center internal networks
 - Principally simple, point-to-point, high-speed plumbing
 - > Use of lasers in consumer electronics
 - Unfortunately, instantaneous bubble for 940nm

Maturation of Optical Communications Hardware Space



- Horizontal integration by Lumentum & II-VI
 - > NeoPhotonics moving in same direction
 - > Greater diversification in new optic arenas
 - Will go after low-hanging fruit
- Stout commoditization curve
 - > Hyperscaler push for disaggregated platforms
 - > Some value shift to software
 - > Optics increasingly not driver of solution
 - More embedded as low-cost enabler

Optics as Follower



- 5G support for leader, Verizon Wireless
 - > Touted as big opportunity
 - But Calix & “ECI” part of Ericsson OEM agreements
- GaAs future move to 8” diameter
 - > Driven by MicroLEDs
 - VCSELs come along for ride
- Cisco Systems can no longer squeeze players
 - > Through a lot of control of datacom industry
 - In face of cloud players & competition from China

Juniper Networks & Cisco: Not Big Optical Threats

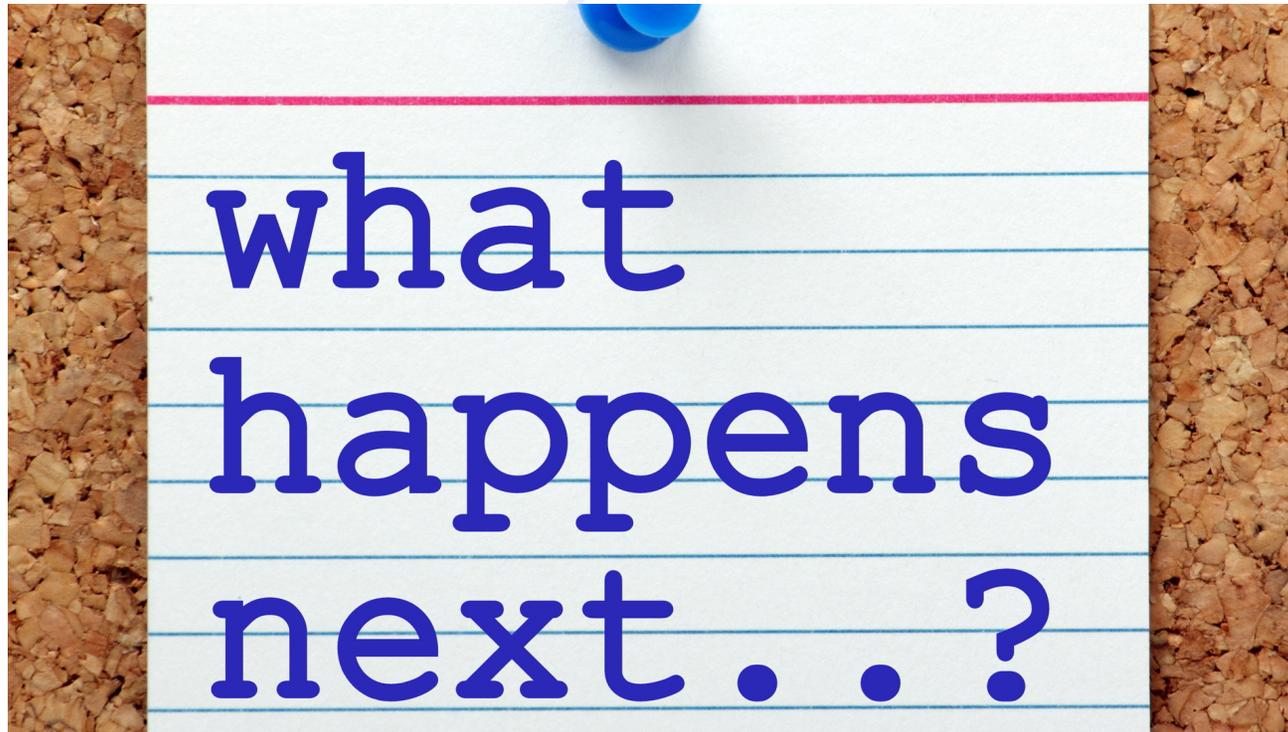


- Juniper has never excelled at optics
 - > Forte as core router company
 - Couldn't figure out how to dedicate proper resources to be leader in advanced optics
 - LR4 demise did not help with Aurrion
- Cisco's purchase of Luxtera was defensive move
 - > Kept it out of the hands of Broadcom
- Acacia action about lowering Cisco's internal costs

Formerly Accomplished Tech Leaders Using Up Credibility Capital

- **Infinera**
 - > PICs with never any cost advantage
 - XR Optics initiative not high priority for firm
- **Rockley Photonics**
 - > Third crack for CEO at silicon photonics
 - Looking at all kinds of apps with hope of just one permitting an exit
- **Lightwave Logic**
 - > Problems with justification for polymers

Upcoming Exigencies & Four Strategic Recommendations



Biggest Issue for Optics Leaders in West is Next Generation



- Typically those running firms are in mid to late 50s to early 60s
 - > Will eventually retire
- Lots of high levels of project investment in smart people from 35 to 50 are Chinese
 - > Substantial threat of firms taking over market
 - Goes beyond IP protection matters
 - Comparable brain power in west in younger age range far lower compared with 10-15 years ago

Example of Luminous Computing at Especially Cutting Edge



- Newcomer combining computing & switching functionality on chip
 - > Attracting funding from impressive sources
 - > Manufacturing maturity for optical computer concept a big question
- Visionaries/luminaries at firm
 - > Which optics space is in short supply
- High R&D optical costs can be better justified
 - > Perhaps volume for concepts on drawing boards

Suggestion I: Take Advantage of Two Big Holding Companies



- Business model based on reluctance to put large money in R&D (focus on financials)
 - > II-VI not traditionally considered in top tier
 - Dealing with Finisar mess
 - > Lumentum's leadership confined to small circle
- Establish viable, niche positions being ignored by larger vendors with innovation
 - > Of course, timing can be critical
 - Avoid getting chased down by the broader entities

Suggestion II: Staying at Optical Chip Level is Safest Bet



- No competitive pricing pressure from China
- Cisco move to chips, but low stress on optics
- Control of raw materials at food chain bottom, particularly if hard to build/produce
 - > Guarantees attractive margins
- If going upstream, don't stop in-between
 - > Usually struggle with component competition
 - > Fully integrated solution at high end with software, hard to replicate

Suggestion III: Focus on European Players



- If public-private partnerships are a must, follow ADVA Optical Networking's model
 - > Market-driven entity should be in charge
- Sell practical, stable, predictable cash flow to investors (private equity, bankers, incubators)
 - > Incremental/evolutionary growth not subject to wide cyclical changes & based on business reality
 - Avoid high-risk, large-crowd hyped, VC-funded apps
 - "PHOTONICS FOR MANUFACTURING AND TESTS" can frequently fit in well

- Needs to get beyond funding mainly to just research stage or early productization
 - > To reach next phases of investment
 - Focus on very specialized products
 - Gradually return to being a dominant photonics leader in the world as the case 20 years ago
- TRUMPF is example to follow
 - > Large, private, company that excels in high-end, industrial lasers/gear (moved up in value chain)
 - Probably more customization & less commodity-like

Suggestion IV: Sensors Have Biggest Upside for Most Startups

- Still can obviously be risks as with any market
 - > Different technologies providing sensing function (Ex. cameras rather than lasers in automotive)
 - > Design cycles can be long in certain adjacents
- Desire to control/characterize environment
 - > Safety/security for consumers, military, etc.
- Use of photonics is in early stage
- Points made by Frank Levinson in March '17
 - > Can be fables, avoid physics limitations, etc.

Optics & Automotive Space is Exception



- Auto industry arguably much harder to penetrate than telecom/datacom sector
 - > Former looked upon too much as savior in optical realm
 - > Automotive is completely different environment than traditional markets
 - Highly industrial
 - Extremely risk adverse
 - Used to simple communications interconnect
 - LiDAR has significant cost/spoofing issues

Industrial & Biomedical Sectors



Optimal Combo is Sensors in Industrial Space



- Such as for utility monitoring
- Attractive margins in industrial in general at least for now
 - > Not necessarily best-run companies
 - IPG Photonics, Coherent, MKS Instruments
 - > Taking big hit in China with tariffs (IPG's recent layoffs)
- Geosensing type of app exception
 - > Precedent for PO dangling for at least 2 years

Biomedical Opportunity



- Requires lots of patience before revenue
 - > Waiting for regulatory/qualification approvals
 - > Challenging to build entire business around single product
 - Better as add-on
- Long-term benefits
 - > Extremely high barriers to entry
 - Can milk solution for entire product life cycle
 - More attractive margins

Obstacles in Large Volume Production



Co-Packaged Optics Craze



Pluggable Availability

Speed	Now	Comments
12.8T	X	Rate could hang around longer than expected
25.6T	X	Microsoft's sole focus is this solution for 400-gig
51.2T	X	Despite some rhetoric to the contrary at ECOC 2019
104.2T	?	Requires PCBA interconnect breakthrough

Microsoft's Three Other Baffling Network Ideas



COLORZ

Better defined 100G IMDD "ZR" for Inphi would have been very successful

COBO

Dead on arrival

MMF

Irrational resistance to VCSELs for collapsed data center plans

- Exited optical components space years ago
 - > Devoted tremendous resources to SiPh
 - Transceivers as loss leader to hyperscale operators (vendor played big role in datacom ecosystem collapse)
 - Lately brought on additional talented technologists
 - Looking to leverage SiPh for on-chip interconnect for fast communications on PCs/motherboards
 - Eventually shipped a few hundred thousand 100G CWDM4s to Facebook after many years of trying.
 - Difficulties in transitioning to 200G/400G

Acacia Only “Positive” Use of SiPh to Date with DCO Modules



- Not on datacom side & very specialized
 - > SiPh only works based on surrounding electronics
 - Drivers, TIAs with lots of high-bandwidth peaking
 - > Likely decent margins for DCO devices
 - Formerly being de facto merchant DSP leader
 - Unknown development cost for SiPh
- Inphi will do likewise with its 400ZR
 - > Although severe price competition expected
 - Particularly from InnoLight

100Gbaud+ VCSELS



- Promoted by Vertically Integrated Systems (VIS)
- Conventional wisdom of only coupled cavity VCSEL able to reach this speed
- Apparently complex concept to carry out
- IEEE 100G SR study group just began
 - > 100 Gb/s (50 Gbaud PAM4) VCSEL project
 - Principally for server attachment apps

Thank You!



Q & A

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