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The Global Semiconductor Industry Analysts

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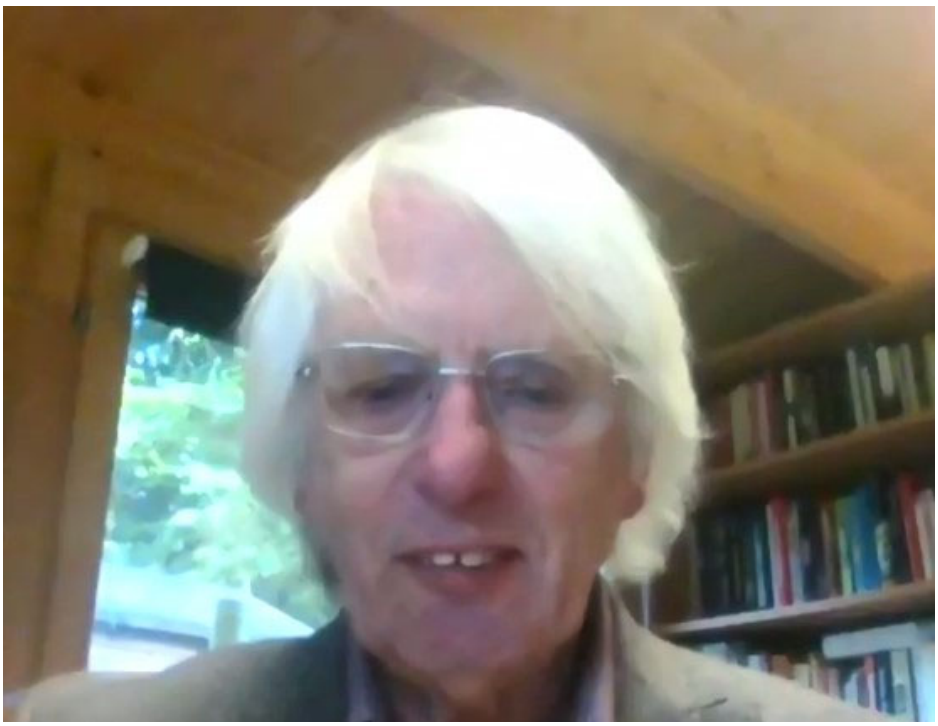
2021 Mid-Term Webinar Highlights



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Global semiconductor industry to grow 24.5 percent in 2021

The global semiconductor industry has been forecast to grow 24.5 percent, and reach $546.650 billion in 2021, as per Malcolm Penn, founder and CEO, Future Horizons, UK. In January 2021, the consensus average was 9.9 percent, vs. the company's forecast of 18 percent. By June, everyone was forced to revise their forecasts. Future Horizons has a bullish forecast of 25.5 percent growth and a bearish one of 22 percent for 2021.

As for the 2022 forecast, the global semiconductor industry could grow 3 percent to $563.137 billion. The bullish forecast is 7 percent, and bearish, -5 percent. There could be uncertain

supply-demand impact due to 2H-2020 capex increase. There could be supply surge in 1H-2022 due to 1H-2021 capex increase. Covid-19 fiscal support is also unwinding.

Today, market pull has been 1000x stronger than technology push. Good enough today wins, vs. perfect tomorrow. Technology push needs a strong market sugar daddy. Vaccines were not quite the silver bullet, but they were enough to restart the world. World GDP growth in 2021 is now 6 percent. The outlook for 2022 is 4.9 percent. Stock market volatility has been calm. There is also the climate change conundrum.

Looking at the IC unit sales by month (billions of units), the monthly run rate is now well above trend line. YTD annualized unit growth rate is 30 percent. Inventory build and double ordering are now likely. The 2021F is +25.9 percent. It is not quite the strongest, as 2000 and 2010 were stronger, but up there!

Wafer fab spending levels are now well above long-term trends. Wafer substrate shortages may render this new capacity pyrrhic! Tight wafer supply in 2018-19 triggered careful increased investment. Wafers sold out through 2021-22, and price increases/LTAs are common. There is little scope for increased capacity without greenfield investment. Wafer firms are reluctant to invest due to low selling prices and poor RoI.

Why do chip firms constantly beat substrate suppliers down on price? Paying a few more dollars per wafer would increase substrate profitability and guarantee long-term investment in supply. Contracts and supply agreements add little value. Right now it's a seller's market. Customers will sign anything just to guarantee supply. Do watch out for the big LTA bonfire, once supply exceeds demand!

IC ASP cycle has shown fast decline, followed by slow recovery. ASPs are now at the start of the cyclical rebound. Long-term ASP growth trend is zero! The economy is still hostage to the pandemic, but there is strong global support. IC units are seeing growth spurt in progress, and holding up strong. Fab capacity is sold out, with no near-term relief in prospect. In ASPs, recovery is in full swing.

The global forecast is 24.5 percent growth for the semiconductor industry worth $546.650 billion for 2021. Forecast is at the high end of the January 2021 prediction. If bull wins, the boom will stay strong during 2022. If bear comes to fruition, 2022 will go negative. USA is leading in semiconductor sales, while Europe is lagging.

There may be uncertain supply-demand impact (due to 2H-2020 capex increase), supply surge in 1H-2022, Covid-19 fiscal support unwinding and not much upside potential. Shortages through 2021, could be possibly longer. The stage had been set by 2020's strong second half performance. By June, everyone was forced to revise their forecasts in line with Future Horizons.

Growth drivers

Key industry growth drivers have been AI and neural networks, robotics and automation, bio and e-medical, quantum computing, alternative energy, home automation and infotainment, games consoles, automotive and transportation,

Smartphones and consumer, 5G and IoT. EV vehicles have been gaining traction and upending the automotive segment. Climate change could be the next downstream disruption.

Computing power is now so cheap. Previously unthinkable products can be produced at home by the 'maker' community. SBCs (single-board computers), such as Raspberry Pi or Arduino can automate huge number of tasks. Chinese firms are offering top-class PCB manufacture and board-loading at a tenth of European prices for the custom bits. Electro-hydraulic actuators complete the toolset, allowing one or two person companies to automate areas too small for large companies.

EVs upending market

EVs are upending the market. It's not just about replacing an internal combustion engine with a motor. It's accelerating the transition from a vertical to horizontal model. Platform-based model to model solutions and across different suppliers was already quite common. EV is the final nail in the transition. Horizontal business model will challenge the car industry's traditional vertical-driven world. It opens the door to sub-contract manufacturing and economy of scale. Apple and Foxconn could change the auto world! EV is the means to that end!

Tesla has taken a massive lead. There are 2x260mm2 in-house designed SoCs. It is developing in-house — from ICs and software, to electric drive systems. With fixed aerodynamics and limits on energy usage, Formula E is designed for companies to compare their electric motor, drivetrain and chassis technologies in competition. Elon Musk stated that he wants engineers focusing on manufacturing efficiencies and improving the road car. Many partner with an established race company, as could Tesla. Is Tesla's lead not that advanced or secure after all?

Foxconn is the Android of automobiles. It will have 10 percent of the global market for EV platforms by 2025. The first EV hardware and software open platform(MIH) was unveiled in October 2020. Open platforms greatly shorten development process and lead time. The first Foxconn open platform EVs are expected by 2022.
It has also been a supplier of key components for Tesla and BMW since 2007.

In January 2020, Fiat-Chrysler partnership was formed to provide electronics know-how. There is a JV with Taiwan's Yulon (#2 after Hotai Motor) to develop EV. In June 2021, there was 5 percent stake in DNeX as part of its bid to buy the Malaysian SilTerra fab to make power ICs.

There's a lot more to a car than an engine and power source. Vehicles have to pass huge number of safety regulations. Chassis control software is more complicated than engine management, anti-lock braking, stability control and lane sensing, etc. Security, communication and Infotainment are highly complex systems. UK is the world leader at security with Thatcham, NXP and Infineon (Freescale) working on it there. Huge amount of semiconductors are required for the industry.

There is the (cleaner) hydrogen alternative. It can lead to the ultimate green automobile (plus trains and planes). This is good news for semiconductors as even more electronics will be needed. Look for Asia to be the market drivers here, with the presence of Toyota Mirai, Hyundai Nexo and Honda Clarity. The hydrogen car has been forecast to win the Le Mans 24-hour race around 2025.

Key apps to watch would be bio and e-Med. Apple is positioning itself to be the dominant player. But, so is Imec! It is interesting that Apple is one of the few companies without a major presence in Leuven.

The connected world could become a hacker's paradise. AI/ML is a blessing and curse. Both improve monitoring, detection and prevention of threats/attacks. But, they can be probed and manipulated by bad actors. There are deepfakes, and only AI can detect differences. It can be used to manipulate public opinion and fool facial recognition. Security systems are also vulnerable, unlocking smartphones to fake IDs.

Future outlook

A perfect storm had been brewing! The automotive industry had only itself to blame. They ignored industry fundamentals and lessons of Fukushima. There is the high-tech industry ecosystem. We need to better harness this value creation if the industry is to thrive. Just throwing subsidies, grants and incentives won't turn the tide. Eg., India has offered $1 billion reward to every chip maker who 'Makes in India'. The EU aims to double chip manufacturing amid fears of digital sovereignty. There are ways to do it properly!

Right now, there is no desire from IDMs. Board/investor pressure is meant to be towards fabless. Neither is there demand from system houses, so, no local production favour. Likewise, there is no appetite from the OEM directs.

The semiconductor industry supply chain has always been adversarial. Customers seek the lowest price / zero commitment (from wafers to ICs). In times of undersupply, the roles are reversed, with customers forced to sign long-term agreements and agree to price increases. Shippable WIP is purged during month 3 to maximize the quarterly revenue. Month 1 is spent rebalancing the line.

Now, 2020-21 was a normal semiconductor year. Covid-19 was just the trigger. There has been no slack in the supply chain. Semiconductor cyclicality was not dead or over. Massive pent up end-user demand – from cars to holidays and everything in-between. Remote working, voice activation and video conferencing have been permanent changes. There has been massive acceleration of personal health and medical. EV is causing a seismic automotive industry disruption.

Also, 2021 shortages were foreseeable and classic industry behavior. No one was actually paying attention! There are disappearing onshoring and supply chain pressures once shortages end. It's a long-term strategic problem, beyond any government's attention span. The current capex explosion will overshoot and trigger the next crash. Enjoy the current super-cycle, as it will eventually end in tears!

There is no shortage of technology. Moore's Law is not dead (or sick) either. The semiconductor fundamentals remain sound, and need keeping a firm eye on them.

However, structural issues abound! These will keep executives awake at night. USA-China friction is not just about trade, tariffs and unlevel playing fields. It's also about emotions, global status and pride. There is an over-concentration of semiconductor manufacturing in Asia plagued by Taiwan-China conundrum. How can we reverse two decades of de-manufacturing

and outsourcing? How long will long-term supply agreements (LTAs) last once the cycle turns? When exactly will the current boom turn to bust? It is time to rethink the semiconductor supply chain business model. We need to enjoy the super-cycle, as boom will turn to bust, with soft landing unlikely.

We need to watch out for the supply side. 2020 saw modest 'reactionary' capex increase, with on stream starting Q4-21, perhaps. 2021 saw more robust capex increase, with on stream starting Q3-22, maybe!

Ignore at your peril, the chip industry DNA! We need to survive and thrive within these 'set' boundaries. If the industry starts to deviate, some correction will follow. Each sector and sub-sector has a pre-defined 'budget'. The only way to increase each budget level is to move up the value chain (go vertical).

Long investment (12-24 months) and production lead-times (4-6 months) are needed. Low levels of inventory / just in time, does not work in semiconductors. We need to secure supply minimum 18 months before parts are needed. Back in the day, a market boom would have been the cue for a 'sales meeting' In Hawaii!

Technology trends

Customers' scaling roadmaps will continue. Apple appears to get exclusive access to each new node at TSMC for a number of months. This helps TSMC debug a new process as running a single design that makes memory fabs efficient. Apple orders over 500,000 wafers per annum for iPhone processors, and more for Mac processors and other ICs.

MEMS are everywhere! They are in new cars, washing machines, motion sensors, energy usage monitoring, security, etc. Compound semiconductors are becoming a big thing, partly, but not exclusively, thanks to EVs. Optoelectronics has grown to being present in almost every smartphone.

Intel's plan

Intel's new CEO stated they intend to regain the lead in semiconductor processing by 2025. This is possibly achievable with the introduction of high-NA EUV and GAA transistors.

TSMC and Samsung have tended to be followers in introducing new ideas, but then move faster to higher production volumes and better yields. Intel has the advantage of being one of the few companies not selling ICs by area, but on value. A new, but low-yielding, process technology could be moved into production early to claim 'leadership'.

For Intel to regain leadership, it will need to get one of the first deliveries of high-NA EUV machine and have a process technology ready and waiting to be moved into production on very low volume, but high-value, Xeons. Will Intel succeed? It's hard to predict, but it certainly isn't a one-horse (TSMC-led) race any more!

And, TSMC's?

Things are more complicated now for TSMC. Long-time customers Nvidia and Xilinx will probably accept early deliveries of thousands of ICs, but Apple expects 20 million units each

month. ASML has not yet shipped any high-NA machines, with unconfirmed rumors of a delay. To get to smaller nodes, companies will need to use double or quad patterning on more layers.

Beyond the N3 node, these smaller nodes will also need more patterning layers to create the more complex GAA transistors. So many more EUV machines will be needed, yet, ASML only makes about 9 per quarter. If there are no High-NA machines, will TSMC's N3 'full node' become a third 'tune-up' of the current N5/N5P/N4 node?

TSMC's roadmap has been truly impressive. The N5 was available in Q3-2020 (full node). N5+ was due in Q1-2021 ('half node' N5 tune up). N4 node is expected in Q1-2022 (further N5 tune up, 'last' of the FinFETs). N3 node will be available in Q3-2022 (full node and GAA structure).

Compound and organic

Compound semiconductors is becoming a major area. There is market pull from 5G, automotive and photonics. Organic/printed electronics have been progressively developed since late 1980s.

Cambridge University is still driving development based mostly on carbon, rather than silicon materials. Components and interconnects printed onto film, glass or ceramics are using ink-jet printers. Density has increased, so, now, a complete ARM processor can be printed.

Organic displays, originally commercialized by Cambridge Display Technology, have been used in many smartphones, but are no longer printed in the same manner. The EPSRC is funding new research in UK to incorporate graphene into methodologies. The problem is: silicon solutions keep taking over apps targeted as 'ideal for printed electronics'.

Lithography update

The EUV machines are now shipping as fast as ASML can make them. Smaller nodes are already needing double or quad patterning, plus more layers require EUV, rather than immersion patterning.

Intel, TSMC and Samsung will have ordered every machine they can get. This means, the various proposals for new fabs are going to be frustrated by the lack of EUV machines. Given the 'gaming' nature of semiconductor manufacturers with their equipment suppliers, ASML is unlikely to build another manufacturing site in case of cancellations resulting from any future downturn. They may also need to expand or duplicate the mirror polishing area at Zeiss.

Delivering more machines is a problem. It Takes 2x747s to ship one, and lots of engineers to install and commission it. It's not as though ASML tried to be a monopoly. Others just gave up or backed the wrong horse! The EUV roadmap of 0.33NA and 0.55NA is expected to drive scaling beyond the next decade. Also, immersion lithography is still required.

Imec thrives!

Where would the semiconductor industry be without Imec? Imec covers the whole spectrum of requirements with a roadmap stretching 10 years in the future. Without imec, the big three chip firms would have to duplicate research without full access to lithography, processing and materials.

The G450C Project at Albany did make a good effort, with plenty of advanced research targeted at 450mm, now in use at 300mm. Eventually, major players decided to leave due to politics. The advantage of imec: You don't have to use them, but you'll be crippling yourself if you don't!

Malcolm Penn

15 Sep 2021