Kuehne+Nagel's **Inside Semicon**

Episode #1

Resilience in the Semicon Supply Chain

John (00:02.382) Intro

Hello and welcome to our podcast series, Kuehne+Nagel's Inside Semiconductors on the Semiconductor Supply Chain. I'm your resident host, John Desmond, and in this series, I will be exploring the complex world of semiconductors, how this affects our everyday life, and how we can manage resilience within the supply chain.

John (00:23.598) Intro to the Episode

So good afternoon, everybody. Welcome to the first episode of Insight Semiconductors. I'm your host, John Desmond. And today my co-host is Tom Mulders. I'd like to welcome Tom, a friend of mine and a colleague from Kuehne+Nagel, to this rather new setting that we have here in Rotterdam. We will be moving around, but we're now in a proper studio. So welcome, Tom. Thank you very much for coming today.

Tom

Thanks for having me.

John

I think one of the things we're going to talk about, Tom today, would be on Semicon and I think obviously with us both being involved in Semicon and high-tech, it's a good opportunity for us to explore what's going on in semiconductors and I think you raised an issue on resilience to me last week. What was that again, the issue you had?

Tom

Well, I think a lot of people don't realise how important the resilience of supply chains is for the semiconductor industry. I think a lot of the requirements of the semiconductor industry are so rigid that you really have to have a resilient and agile supply chain. So, yeah, that's my thought on it, but that's one of the reasons that we're talking here today, right? To talk about why is resilience important in the supply chain?

John

No, I think that's an important thing that everybody's talking about, resilience, but what does it actually mean? And I suppose...that's what I will be doing here today as well is actually showing how semiconductors have become an integral part of our everyday lives. I mean, they're in everything from washing machines to phones, even automobiles, healthcare

systems. And the reason for the resilience really is that without them, I think a lot of the everyday items that we rely on will actually take a step backwards. And because of that, we don't see how important because it's just something we've grown up with. Well, I'm old enough to remember a time when we didn't have phones and, you know, laptops were usually only used by, you know, high-ranking executives, business executives with a laptop. And even then, they were like bricks. So, it's quite hard to explain to somebody today what life would be like without. I think one of the issues we have as well is that people are not kind of realizing how small these things are.

I suppose one of the best things I have to show that where we've come from and where we are now today in terms of resilience would be, and I grab it here from my bag if you just give me a second.

John (02:45.262)

So, what I actually have here, for people who are also listening to this, I will obviously post this, but this is an original Sinclair ZX80. This was one of my first home PCs that had 1K of RAM. This is still working. I used to programme this in basic. So, you look at this now and compare this to an iPad, which everybody has, and that's happened in the last 30 years. So, this is quite a big step in terms of computing power, from where we are to where we are now today in terms of what you have in your phone has more computing power than what NASA used to get the man on the moon. You know, back in 1968, 1969, I think it was. So, we can see straight away that this is something that obviously is very, very important that now we rely on these devices. It gives us great access to information. But then with that comes the ability to falter because it's a supply chain. The resilience in the supply chain is not 100 % correct. If we don’t have access to this, then there are less cars, and there are problems with washing machines.

Tom

Well, there's less everything, right?

John

Correct. Yeah. And that's the issue that everything becomes, you know, slower. And if you don't have it, then all of our systems, which are reliant, suddenly disappear. So, home security systems. And we saw the impact during COVID to the automobile association. I think, but you, you know, you now have picked up your new electric vehicle and there was a delay on that. And you see it yourself when you sit into it. You see everything in there.

Tom

It is fully reliant on Semiconductors.

John

Exactly. I mean, back to I think it was 1972, there were nine Semicon devices in an average car. Now there are over three to four thousand. Even the item of when you turn left and turn

right in the old days, that tick, tick, tick, tick sound was an actual, you know, electromechanical device making the connection and now making it. But now it's all electronic. So, what you're hearing is...the Bose or the Nvidia power system actually replicating that sound. So, it's not there anymore. So, you're still fooled into thinking that I have an electromechanical device in the car, but it's actually not there anymore.

Tom

Yeah. I think it goes a lot further than just cars, right? I think literally everything that we own in an average household has a semiconductor in it or more, more than one. You know, a good example is your washing machine. Nowadays it's fairly normal to...use your phone to programme your washing machine. That requires multiple semiconductors right, to do that. That's just one example in our household. I think the chip shortage during the COVID-19 pandemic really made clear how overly reliant we are on semiconductors. It's part of our everyday life nowadays. It's not just one sector or one industry. It crosses all the industries that we know. Yeah, so that's something that I think, you know, the chip shortage also exposed that our supply chains at the time were not sufficiently agile, were not sufficiently reliant, right? We were having troubles, right, in making sure that the goods of our customers get from point A to B on the right, you know, at the right time, at the right place.

And that's something that, you know, for the Semicon industry is really important. Because of the geographical spread of how the Semicon industry is set up. I guess we'll talk a little bit more about that later, right?

John

Yeah, correct. I think it's also like a separate podcast there because when people think about, I just pulled one up here that I have taken out of an old computer. It's like the, what I'm looking at here is an old Intel microprocessor. So, you can see basically how many million billion transistors are in this, but people forget that to make this is like making a cake. This is the final product, but all the ingredients that come before this, for instance, that come into that application itself, to make that, you have gases, you have chemicals, you've got heat treatment equipment, you have all of this, which is basically, as I mentioned, you know, the same kind of idea as having an oven, but you've got to make the water and the cake and you've got to make the different ingredients. So, there's a lot more goes into just an end product. So, the supply chain for that as well and the resilience for that means you have to ensure that the products need to get to the wafer fabrication unit. So, the gases have to come in from wherever. I mean, the quartz silicon is mined out of Norway. So, you've got a mining operation, which is very archaic. You're digging stuff out of the ground and it ends up in a microprocessor in your phone. So, the resilience of the supply chain is not just about moving the end product to the customer. That's half it. The other half is ensuring that the materials, whether they be gases, whether they be physical substrates, or whether they be the actual capex, actually gets moved to the location where they're going to manufacture the chip. So there is a lot more in the supply chain than just... getting it to the customer, we have to produce it first. And that supply chain and that resilience is one of the reasons why the

European Chips Act and also the American Chips Act has now actually come into place because all of our eggs were literally in one basket. Before that, we had Silicon Glen up in Scotland. We now have the Silicon Alps in France. Ireland was very strong, so was the UK.

And then it moved to China and now it's on its way back to the Asian regions. And now it's on its way back because since everything was manufactured for there, I think the figures were 90 % of chips are manufactured or touched in that part of the world. There was a heavy reliance on that. But now by doing this in 2024, we now see that the expansion of the Chips Act, put in the US and Europe means that the likes of Intel and Wolfspeed and OK Medic and STMicro, the list is endless, are now...expanding and building new plants. So, by 2026, we're going to have our own ability to not be so reliant on Asia Pacific. And then the reliance starts building up, but that's going to take two years.

Tom

That's going to take at least two years, right? Yeah. And I think the analogy with baking a cake is good, right? Because it shows that it's not, you know, one thing in one thing out. I think a lot of people don't realise that it could take three to six months to produce one chip, right?

So, it's not an easy, you know, go safe process. And that just highlights how many ingredients are needed for this specific, you know, product. But specifically supply chain reliance, right, in the current setting, nowadays. Why do you think supply chain resilience is so important?

John (10:11.278)

The bottom line is it's got to do with the customer and the consumer. I mean, these companies are doing this to make a profit. If they can't get this into the supply chain, if they can't get this to the final customer, then they're not able to sell their product. So going back to the cake thing again, you've all this stuff sitting in the baker, but if no one's buying it and you can't get it out the door, then you're basically making stuff that's just going to sit there and age. And because the semiconductor industry is moving so fast, again, again if anybody knows about Moore's law, they're all probably...tired of hearing about that. And if you don't know what it is, it's that the amount of transistors on a chip will double. And that's like nearly exponential now every two years. It means that something which is two years is out of date. So you have to keep moving your product continually. And that's where that resilience comes in. So you need to ensure that it's actually gotten to the customer and that it actually is being produced on time. And as you mentioned, it does take a lot of time for it to produce these chips, but that's only the production element of it.

You then have the testing quality and that usually entails that it needs to leave one region like APAC and may have to go to the US for testing. It could even come back into Europe for packaging. And by packaging, I mean putting the actual integrated circuit with all the legs onto it, not just putting it in a box. So, it could travel the world five times before it's finally in a position to be sent to the customer. And at any one of those stages, if there is a geopolitical

issue or if there is a volcano eruption, for instance, that supply chain falls apart and it literally just stops until we can get past that geopolitical issue or we can get past the latest earthquake in Taiwan, for instance, even though it didn't do any major disruption, TSMC had actually shut down its operation for two weeks. So, there was a delay, but they were able to catch up on that. But if that had been a catastrophic one and the manufacturing plant had actually collapsed or had stopped working, That was a huge impact again to the amount of chips being delivered. So that then would impact some part of some other supply chain, but it was automotive or industrial or even to like severe space for the PCBs that go into, for GPS coordinating, for robotics. So it's quite important that we try to mitigate that. That's the reason again for the offshoring. So now that if something does happen in the East Pacific, we will have the ability, or say Intel, if I take them as an example, we'll have the ability to manufacture those chips here as well, and not just rely on having all those eggs in one basket.

Tom

Yeah. Now it's definitely interesting to see how that takes effect, right? Looking back at, you know, the old days, what was that like for the semicon industry? Supply chain-wise?

John

Because I mean I'm going back now to a time you know before this. You know, this box that I have here on the desk let's move it to the side there.

John (13:15.406)

So, if I look at going back before the supply chain of Semicon and before Semicon itself. And Tom, if I look here at my first Nokia phone, it had three hours standby, you know.

Tom

Is it actually your phone?

John

It is actually my phone. And it's the old SIM card in here. So again, with that kind of an old phone, you can see that the development and if you look at that next to the chip, you can see now, that the chip is probably 15 % of that phone and yet they didn't have that processing power in there. The industry was in, I wouldn't say a bad place, but it was starting out and every place has to start out somewhere. I mean, if you go back in automobiles, you look at the old Model T Ford, I mean, you know, so it was an open car made with heavy material, top speed, I don't know what it was, maybe some of the...people watching this could actually educate me there and what the actual top speed of a Model T Ford was?

But then you look at today, we got cars doing in excess of 300 kilometers. It's an exponential growth. So before the industry really got into Moore's law and really understood what was happening and that there was a demand for it and, you know, I suppose Apple was one of the first drivers of that because we had the Sony Walkman and then suddenly the iPod came

out and that was the first signals that people were willing to adopt new technology. And once that happened, it became an exponential growth of what people were expecting and they wanted more of this. And because they wanted more, it opened the floodgates. And then suddenly you had semiconductor companies popping up all over the place. And as it, you know, the world looking for us was, was injected itself into washing machines, cars. Then suddenly it became a lot more that it required and people got used to this level of technology. And there's a discussion I was having earlier with one of the people here watching the podcast with us that, when I was growing up, it was a case of, you know, when you organised to be someplace, you were there. Whereas now at the time that you meet people just go, oh, I'm 15 minutes late. It's just so easy to do that as part of life. So, this comes full circle now where we're actually heavily reliant on it. And then, with with the developments in material science, quantum computing now coming along, which is really a hard thing to wrap your head around. We see that AI is taking off. And again, I was reading science fiction books, you know, when I was 10 or 15 years old about robotics and robots and artificial intelligence. I was like, yeah, that'll never happen. And now here we are. And it's in existence. I mean, there's AI out there now that's quite intelligent and well able to actually you know, mimic and they've actually bypassed the Turing test, which is, in case listeners don't know, again, a test that was developed by Alan Turing, an English scientist, to ensure that a robot knew it was a robot. But if you can bypass that, then it's actually sentient. So now they're bypassing it. That's a bit of a scary item, but something else we can do in a later podcast. But that's where we've come to. And that's what's driving this continual development.

And that's also what's driving the need for these devices. But then on the other side of it again, you have the whole supply chain behind that. And without that, we don't have, it's like a symbiotic relationship. It's like the chicken and the egg. We need one to drive the other, but when did it start? And I think the whole thing started probably around after 2000. And that was when the proliferation of electronic devices, even from watches.

You know, it's everybody's wearing the Apple iWatch or Samsung or Huawei or whatever they have. Everybody's wearing that now. So, it's very few people will wear the old. Yeah. Just because of the fact that you want information and people need to see what information is coming. So, it has changed the way that we're living, but it also has brought about a whole differentiation in terms of, you know, pre-2000s. That seems to be the kind of area that we were looking at before that we didn't have the proliferation of devices that we rely on, which we do know today.

Tom

And, do you think the logistics industry has adapted to the needs and requirements of the Semicon industry?

John

Yeah, I think we had to because before when we were shipping devices that were quite rugged and could take a lot of knocking about, so to speak, now we see the need for either,

you know, humidity controls, temperature controls, vibration control, even pulling how many G -forces. This all now is getting, because as the chips get smaller and smaller and smaller, we were discussing it earlier. As you said, you were talking to your mother and trying to explain, you know, we're down to two nanometres and one hair is an average of about, you know, between 40 and 80,000 nanometres. And this is two. So, you've got to knock a lot of zeros off to get down to the level we're at. When you have that kind of, how to say, metrics in terms of two nanometres, then any deviation in temperature and heat when you're shipping can actually impact it. And the same when you're shipping capital equipment, you need to make sure that it is actually properly looked after, and that it is within certain regulations because the separation between different items within the CAPEX is even harmonic frequency of being on the road. You know those bumps can actually upset the equipment itself. And when we're shipping items that are used to develop the semiconductors themselves, if they're exposed to light, then they're also no good. So, the Semicon industry has actually provided a jumpstart in terms of the technology that logistics companies have had to adapt, to ship this equipment and to handle the raw materials that we ship to make it. So, I think it was a good thing that...we've been forced to re-examine and also to look at exactly where we want to be. And I think that working in partnership with the larger companies, the TSMCs, the Global Foundries, the Intels, the Nvidia, the NXPs, when you have a partnership with them and you know what way their R&D is going, then you can work with them. What you really don't want is that they say, oh, by the way, we have this piece of equipment. It weighs 400 tonnes. It used to weigh one tonne. Can you ship that? But if that's in development for two years, we can then plan the supply chain around that so that in two years we're ready to ship that piece of equipment. The worst thing for the resilience element of it, to get back to that again, is someone knocks on your door and says, we have this to ship. And you look at that and you think, we can't do that now because we haven't been developing in line with their technology to ship it. So, it's very important to have this partnership agreement and to understand where the next generation is going. Like ASML, for instance, you know, one is the leader in lithography. Their latest machine, which just went into Intel for two nanometre integrated circuits, I think that thing weighs probably 4,800 tons. And, as the EUV machine, the previous one, the DUV, deep ultraviolet, weighed approximately 1200. So that's a 400% increase. And then it has to be chopped up. Exactly. Because it's like shipping an elephant. You need to know how big the elephant's going to get.

But if you know that two years in advance, you can plan for that. And that's part of the resilience as well. It's a very important part.

Tom

Yeah. Yeah. I think there's this misconception that as the chips are getting smaller, the machines are also getting smaller. That's actually, quite the contrary, right?

John

It's the exact opposite. And that's the one paradigm that, as you said, everybody forgets, is that to make more and more chips and adhere to Moore's law, you have to pack even more onto the same footprint.

The only way you can do that is by having a higher resolution. So, you look at an old camera versus a new Nikon with so many resolutions and megapixels and et cetera, et cetera, et cetera. You need to have bigger lenses to get that in. And it's the same with the Semicon industry. Everything is getting bigger to make things smaller, which is kind of a hard concept to wrap your head around. But that's just how the industry works because we're dealing now with wavelengths like on the extreme ultraviolet wavelength that you now need to have companies like Zeiss, for instance, who would have done the lenses on photographic devices. They're heavily involved now in the partners with ASML that even for them to focus what's needed to expose the material to have the elements of the chip on there when you see the size of that, it's gone up seven, 800 times from what it used to be. And again, because everything is doubling, this is doubling, so it's getting bigger and bigger and bigger. Where the end will be, I don't think we can say, but it will need a new direction in terms of material science. It will need a new direction in terms of what we're looking at and even how to inspect it. I mean, as you mentioned, how do you inspect something that's two nanometres? You then have to build a bigger, I use the term microscope, but you have scanning electron microscopes. I mean, it scans electrons. That wasn't heard of 20, 30 years ago. So now you need something that can scan to two nanometres to understand how things are working and are things going where they should be, because you have to build these chips up from the ground. So, you need to be able to literally work with atoms. But to do that, as we know, like say, for instance, CERN, which has an atom collider, I mean, that runs around I don't know how many 50, 60 kilometres just to collect. And now we're doing that inside the wafer fabrication unit.

Tom

So, you've told me before you've worked in the Semicon industry as an engineer. Great. What's your take on the importance of the supply chain, of the goods being there when they're needed? Do you have any thoughts on that, on how that's perceived within the industry? How important that is?

John

Yeah, no, that's a good question as well and that's another element is that there's equipment basically being used to make this and no matter how high-tech the equipment is, there are nuts and bolts used to keep it together and there are certain items and measuring devices or thermocouples or whatever used to control heat and temperature and humidity in there but because it's still a device it can still break down.

And then you have obviously the whole support of this. So go back to the oven again, you just see the oven and people just see the oven. But behind the oven, you have all the cables coming in, you have the heat extractors, you've got the fans taking away the heat. You know, you have all this. So that's that can be comparable as well to a Sub fab, you know,

which is basically, there to support the machines made by ASML, Lam Research and KLA, etc, etc. And those machines are providing the vacuum which is needed or the nitrogen or the gases is needed. But again, these are very heavy pieces of equipment dealing with physical constraints of gases and air and water and so on. But without them working, it doesn't provide the power that's needed to the ASML or the KLA or the Nikon or whatever piece of capex is upstairs. So, it is quite important that you always have spares on hand. And if you don't have it, people say, yeah, but you can wait a while.

John (25:13.838)

But if you're producing a 12-inch wafer with so many hundreds of chips, each worth 800 euros each or $800, whatever your currency is, times a thousand, and you're down for one hour, you're talking possibly millions. Because then once the piece of capex comes back up again, it then has to be recalibrated and made sure everything is working so you can afford literally no downtime. And in terms of resilience there, how would you overcome that? And the way would be to always have spares, but you don't always have spares because there are so many different moving parts. So sometimes it will happen that maybe you put a spare in, but it fails because it was kept at the wrong temperature or it was dropped or it was exposed to whatever medium, you know, a dirty medium before it got to the location. So, then you do need to have the ability to make a phone call and have something flown in from somewhere, or, you know, road it in from a different site. So that whole supply chain as well on the Subfab is a whole other discussion that we would probably have to get into as well in a separate podcast to understand how the resilience there is different to the resilience of the fab upstairs.

Tom

Yeah. I like the analogy of, you know, the oven and the baking. One other analogy that I hear quite often talking to customers is, you know, the automotive sector, right? When you're producing a car and for example, you're missing the mirrors, well, you can still produce the car, you can still paint it, you can still put the engine in, et cetera, et cetera, you can put on the mirrors later on. In most cases, that's how it works. However, with semiconductor production, it's a different story. You can't skip a step, right? You can't go back and do that step later on in the process. So there really is a big implication if something is not working as it should, or if...certain materials are not there when they are needed. I think that really highlights how important it is for the industry as a whole that the supply chains are reliable, but also agile. How do we deal with a volcano eruption? How do we deal with the earthquake in Taiwan? How do we deal with piracy issues? I guess it's our job as the logistics industry to make sure that we're aware of what's going on, aware of what our customers want, and also aware of a plan B and a plan C when needed. That we have the options, that we have the opportunities, and that we're not overly reliant on one or two go-to methods.

John (27:39.502)

You're correct there. And that's one of the main areas that we're heavily involved with because, as you mentioned, it's a very linear process. You can't just continue the production,

then bolt on a mirror later because...you need to have everything very linearly. It has to be exposed and it has to be developed and then it has to be etched and then it has to be cleaned and you cannot bypass. It's a very linear process, which is why it takes so long and any disruption to that will cause an issue. And you mentioned like, because these are quite, how do I say it, sought-after devices, you really need to look after the whole security element of it again and that can also cause pain.

How you ship them and how they're tracked. And on the other side and flip side, then you also have to look at the raw materials because right now, if you look at the rare earth minerals, so we're looking at the likes of say, cobalt that's used in the batteries, there's only a few companies in the world are actually controlling that. Same with lithium iron. So for lithium ion batteries, you've got lithium and they have a monopoly on that. So, there's also that whole aspect to be very careful of if...anything happens in that supply chain in particular, then the rest of it falls apart because it's a very linear process. You know, you can't bake your cake if you're missing the eggs. And there's one or two guys controlling the whole egg supply. You need to make sure that their supply chains are open and also that they are actually providing what they need. But if anything happens, as you mentioned, let's say a volcano or an earthquake, they can't get the process out, then it just stops. You know, there is nothing left to develop. You have to literally wait for that individual ingredient to come in before you can restart your production. So, something that's always on our mind, we're always looking for how can we get the product from A to B. Yeah, we can fly it. I mean, but let's just say there's a volcano eruption in Iceland and we can't fly stuff. What's the next option? On sea. But as you know yourself, Tom, it's a case of you put it in the ship, it's going to take a lot longer to get there. And then you're actually looking at cost versus reward.

John (30:02.67)

Will we wait 21 days or could possibly the volcano stop and air clears up in the next 21 days so we can get ahead in 15 days? Or do we take the risk and still ship it via sea or sea and road and to get it from A to B? And unfortunately, you can't hold these products in a warehouse for very long because they do have a short life expectancy but a life period where they have to be used in a certain period of time, especially on the more developed stuff like the substrates. I mean, the gold, the titanium, so on, can be, but then you don't want a titanium brick sitting in a warehouse because it's worth a fortune. So that's also an element of the supply chain. That's something that we have to look at as well going forward.

Tom

Well, I guess that's a good example why, for example, sea or sea air is something that is really coming up lately, right? Customers are really thinking of, okay, so if we ship the first leg, with in a container, right? Move it to a certain hub and then fly the rest. Might seem illogical, but in general, it's the best of both worlds. And it allows for their supply chain to be more agile. You can select certain containers that you want to move that way. You can skip a port. You're way more flexible than when you just put it in a container and wait for it to arrive at its destination.

John

That's actually very true. And also that ties into sustainability. I mean, obviously flying things via airplanes, you're using a lot of air fuel, a lot of aviation fuel. And obviously, going via sea is actually better, in terms of sustainability, and the CO2 footprint, sorry, it's actually a better way to ship, but then you have the time with it. But then devices that they're making are there to reduce the amount of power. So, we now have, you know, power management systems, which are all semiconductor-based. So again, we're into that chicken and egg where we're trying to reduce footprint, but we need to see our two footprint and we need to get the material there to allow us to reduce the CO2 footprint. And by having that, then we can reduce the CO2 footprint further because then we got power management systems, power management devices. And if we can do it, you know, as you said, you know, with either road or sea or sea air, then it would be a lot better for us to move that way.

John (32:28.558)

Yeah. So, Tom, I think today, we've covered a lot of topics in a very short period of time and that allows us also to delve into the beginning of this podcast, which we'll elaborate more on each topic going forward. But what are your thoughts on what we discussed today?

Tom

Well, I think it was very interesting. We discovered our reliance on semiconductors, the importance of the semiconductor industry, the growth, and also how important it is for their supply chain challenges to be managed and for their supply chain to be resilient, right? And to deal with all the challenges and issues that we see in the world nowadays. So yeah, it was very interesting. Thanks for having me.

John

Thanks very much for coming, Tom, and we look forward to having you hopefully back in here again soon. We discuss the next aspects of Semicon and the resilience and drive further into Inside Semicon and what happens within the chips. So thank you very much for coming today.

Outro

Thanks for listening to today's podcast, Inside Semiconductors and the Semiconductor Supply Chain.

If you found any of the topics, we discussed interesting and you want to find out more, you can find me on LinkedIn at John Desmond or go to Kuehne+Nagel's website.

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