Kuehne+Nagel's **Inside Semicon**

Episode #3

How fab is a sub-fab?

Tom:

Welcome to our podcast series Inside Semicon. And in today's episode, we will be talking all things subfab, what they are, how it's developed over time, and what the impact is of downtime.

So welcome to the third episode of Inside Semicon, podcast organised by Kuehne+Nagel. I'm your host Tom Mulders and I'm here with John Desmond. John, good to have you here again.

John:

Thanks Tom, good to be back. And I think today's episode is actually going to be quite interesting. It's something that a lot of people are not aware of, you know, that basically the sub fab and the fab are, you know, two sides to the same coin. So hopefully we'll go into I think as well has been a change for us both as well that we have now new roles within Kuehne+Nagel. So I'll go ahead and just update the people on what my new role is. So I've moved into a global role as VP of high tech and semi-con within Kuehne+Nagel. Being there to drive strategy and to drive further engagement and be more customer centric with the existing customers and obviously with new customers that we onboard.

which is obviously why this podcast is also so important because we need to educate a lot of people on exactly what this new semiconductor which drives, literally drives the cars and every piece of device that we have and why it's becoming so important. So I think this podcast will allow people and the layman, I mentioned that in the previous podcast, you know, to understand, you know, what we're doing and where we're going with Semicon. And I think the same for you, Tom, you've a new role as well.

Tom:

Well, first of all, congratulations to you and your new role. Yeah, I've also got a new role. I'm a global key account manager now for our high tech and semi -con customers. I'm very much looking forward to working in that new role. Great. And we'll be working a lot together as well now. Exactly. We will. will. It's going to be fun, I'm sure.

I'm pretty sure we'll have fun. So today we're talking about Subfab. Now, before we kick off, John.

Can you explain to me in layman terms, what is SUPFAB? What does it stand for? What is it? How do you describe it?

John: (02:44.375)

Yeah, this is a tie in a previous episode where we discussed the fab, which is the fabrication. In terminology, they've shortened it to fab, but it doesn't exist in a vacuum. And it does need a lot of resources to enable what happens, we call it upstairs in the fab. Going back again to this famous cooking cake analogy, it's like having the oven.

But you need electricity and light, need extraction, you need the materials all to allow the oven to make what it has to make. So the sub fab is the second side to the same coin. therefore without it, the fab wouldn't exist. It wouldn't get the materials, the heat, the power, the lighting that it needs. So all of these ancillary services that's required is what we call the sub fab. And that usually sits downstairs under the fab.

So that it's actually removed so that any vibration, noise and dirt that's generated from these heavier pieces of equipment, which are moving around lot of air and water and gases, doesn't affect the fab itself. So it is actually part of the manufacturing process, but referred to as a sub fab because it's beneath the fab itself.

Tom:

Okay. And John, explain to me, what would you consider to be sub fab? So you've explained the term itself, right? What is subfab exactly?

John:

Yeah, so I think the best thing here is I've brought in an old, another old piece of kit and I'll bring it up. So what I have here in my hand is one of these old Polaroid cameras. It's probably a good way to explain the fab and the subfab in one small package. So this is the old Polaroid camera where you take the picture and then you would pull out from the front of it the photographic plate and then shake it like a Polaroid as the song goes. Probably out of date by now. But then you'd peel off the layer and then suddenly an image would appear.

So what that does is the fab upstairs will actually be in very, very basic layman terms, taking pictures and it's putting those pictures onto a wafer die, onto an actual piece of wafer. But as you can see, it doesn't just stop there. There are other chemicals needed and there's air needed and there's light needed. And that's where all of those elements come together from the sub fab. So while the picture is being placed onto the wafer itself, what happens is the chemicals, the air, the necessary ingredients that are required to move things further actually come up from the stop fab and they're actually then brought into the bigger pieces of equipment, which are provided by the usual suppliers like CAM, KLA, and Lamb Research and Applied Materials, just to name a few. And then they all come together and basically you get your finished product, which in the Polaroid case is the picture, but in the case

Fabrication, the way for fabrication is the finished die. But the sub fab provides all the necessary ingredients to get up into the fab to allow that to process it to produce the final product. So it's an integral part. One can't exist without the other. It's the symbiotic relationship. The fab can't produce without the materials downstairs in the sub fab, but the materials in the sub fab are of no use if the fab upstairs is not using them. So it's quite an integral dense so to speak as you can only use certain materials at certain times from the sub fab but everything down there from the heat to heat extractors to water purifiers gas delivery systems vacuum systems even humidity temperature and

light control would be considered to be part of the sub fab okay and how has sub fab evolved over the last years

So while the basic tenants in terms of chemistry and so on is still the same, it's becoming way more, how do put this, efficient in terms of the power modulations and the power delivery systems and also the recirculation of heat. So before, obviously, the heat exchanger would just take heat out of the air to keep it cool, but now they're using that heat then to drive other parts of equipment in the sub fab the with the cooling, the same with the water. And it all kind of shows that the progression is on sustainability. So they are becoming more more sustainable. There are more and more devices downstairs that are constantly monitoring temperatures, constantly keeping items cool. So there is kind of a sustainable element going on down there. And that's the biggest, I would say, advancement in the last 10, 15 years. But also going back to when I was in the sub fab.

Literally there would be a board on a piece of kit and you would look at it and see what the temperature was from the boards. You would do your checklist in the morning. You would walk around to all of your pieces of equipment and you'd look at it and say, okay, that's within specification. That's within specification. And then after 10 years, suddenly there was a LED display and you could go through menus. You could get more and more information until eventually it's on phone. So then you can sit in your office and you've a, you know, your phone, your iPad. You don't have to do your 10 kilometer walk of the sub fab and they are that big to check all the pieces of kit, you could then see what's running good, what's running bad, what's running hot, what's running cold. And then you have in there such a preventive maintenance that allows you to see whether a piece of kit is 90 % on the verge of failure or is it still running normal. from there, you can see as well that you then have predictive maintenance and you then have predictive analysis to allow you to see if a piece of kit is going to crash, if it's going to stop working, and then that will affect equipment upstairs as well. So the technology has driven more technology. It's like a perpetual motion machine. Yeah. It's like a full circle moment, isn't it? Yeah. Correct. Yeah. Yeah. Interesting.

Tom:

What about security though? Is that a, an important part for sub fab? In terms of access control?

John:

Yeah. Because I mean, let's face it, you've got anything up to $150 million pieces of kit, one kit upstairs could be run by a keys of kit downstairs. That's worth 60 ,000. So a vacuum pump or a heat treatment pump or whatever. But in terms of access control, yeah, I mean, these are pretty high security sites. And obviously everybody's badged and you have to check in and check out because the damage you could do by not knowing what you're supposed to be doing, you know, or you're in the wrong area or God forbid, just a bad player in there that wants to come in and just cause problems. So security is paramount access control to certain areas as paramount to different levels, different layers of access that you can get access to. So you can't access all these, you don't have an access all areas pass, but you do are allowed to work within the area that you're A, qualified on and B, that you have the proper credentials for. So security in that way is also very, very important. But that also kind of ties back into the whole downtime. What happens if a piece of kit goes down in the sub fab. you could have, let's take God forbid a vacuum pump decides to stop working because you could have 10, 20 ,000 of these pumps and one of them could just decide, I'm not going to work today. It's Monday morning. I've been working all weekend, so I'm going to take a break. But that could actually impact the fab, which is producing wafers, hundreds of thousands of them, costing millions. And then because of one piece of kit, we have a problem with upstairs and then everything could get destroyed, but it'll also slow down production. So you can't afford that. So that's where this

preventive maintenance and this intelligent tooling comes back into play again, where you're constantly monitoring all of the equipment itself. And by doing that, then you're able to do a bit of predictive maintenance to say, piece of kit is not operating optimal. It's still operating within the bandwidth to produce wafers and to keep the machine in the fab running but we better take it offline and swap it out and swap a new one in. And then you have the whole logistics of taking out equipment and putting in new equipment or putting in a refurb equipment. But you can imagine that happening for a couple of thousands, say vacuum pumps, but then you have that across the water purifiers, the ion exchangers, the heat treatment, you know, there's a lot going on. There's a lot of movement. The logistics of this is quite important and you always have to have a spare on because you can't take a piece of kit and a fab down for an hour when it's producing maybe say 100 chips in an hour and each chip is worth, I'm just giving you a figure, 800 each. I mean, that's 80 grand an hour. No one wants to have that down. And it actually goes up exponentially the more complex the chip that you're developing is. So the preventive maintenance.

You know, the whole interactivity, the dance between the downstairs and the upstairs, the fab and the sub fab is very important. And like any good tango and any good dance, two partners need to be working as one. If they're not, it just doesn't work. So so that's a dance analogy as opposed to a cake analogy that we're always using and trying to take people away from thinking that we're going to be talking about cake again. So we're talking about semi -con and actually not building cakes, you know.

It's very interesting and I think a lot of people that think about semiconductor logistics, they're imagining wafers and capital equipment, know, the big machines, the very expensive machines. But actually it's the sub fab that's also included. It's an integral part to semiconductor manufacturing. You can't produce anything without a full running sub fab. Yeah, correct, correct. So in terms of sustainability,

I sent you an article recently about how one of the semiconductor manufacturers is working to be more sustainable in their sub fab. Can we mention a name? think we can. Yeah, can. So was Samsung Semiconductors in Korea, where they had a water purifying installation. Back in the day, they would purify the water and basically push it back out into nature. But nowadays, which I found really interesting, is they're actually measuring the temperature of the river and making sure that the water they put back into the river is exactly the same temperature. And because it's been purified so many times for semiconductor manufacturing, it's pure water, purer than the water in the river. So actually it's contributing to more sustainable environment.

Tom:

Yeah, yeah. But that's just one example. how do you think, how do you see that sub fab can contribute to a more sustainable environment? is sub fab becoming more sustainable?

John:

Yeah, I think that article that we were discussing actually over the weekend on Samsung in particular, it just kind of reflects the sustainable approach that a lot of these mega corporations are actually implementing. And I think for the environment, that's also very important. But I think as it goes forward, the technology gets more intelligent. As you mentioned, instead of just putting the purified water out, they're now even measuring the temperature. they now have the, you artificial intelligence, if you want to put it that way, but they have something constantly monitoring what's coming out. They don't just release it. They're now actually chilling it before it comes out so that it is acceptable to the environment and even better than the environment. The same with the air. They're constantly cleaning the air as well. So then when they release that air, that's even cleaner than the air

they're taking in. So it is a big, it's a big industry, obviously, but there's also a whole element of it that needs to continue development. But since the semiconductor industry itself is developing every two years we're blue in the face and hearing about Moore's law. But because of that law and everything doubling faster and faster and getting better and better, it takes more energy and it takes more power, which gives off more heat. So the sustainable element of it and the heat exchanging element of it and the cleaning element of it also has to keep up. So I think there, this new material science has been constantly researched to see how do we handle the pollutants.

And not necessarily the actual pollutants in terms of what we would think of, but releasing hotter water than what is normal. It could be only two or three degrees, but an ecosystem for fish and birds and whatever, three degrees is quite a big difference. So that's what they're actually measuring to make sure the water going out is exactly the same temperature as what the current environment is. So it's a whole ecosystem there. But the logistics side of it as well then, that's where I think is also important because when we're moving product from let's say they're buying a heat exchanger and it has to come from Germany to Italy. How do we get that there? doesn't just, we're not at the science fiction where we can just beam me up Scotty and move it from one location to the other. We've got to put it on our plane or a train or even a barge, which obviously being on water is probably the most sustainable we have because then we're not using air fuel. We have sustainable air fuel, but also electric trucks then can we actually move these on trucks? And this is something that's coming up a lot more. Customers are asking for this is that, and we're listening and we have our own fleet now of electric trucks and on some particular supply chains, some of the lanes we do use electric trucks, vehicles to get from A to B. And that's part of it as well. So how do we contribute when we're finishing, or sorry, when we're setting up the initial sub fab, which is like building a house, you build the foundations first. And then once the foundations are in, then you can build a wall and so

So the sub fab in terms of the foundations needs a lot of old world, old school technology. still using rebar metal in the concrete, in the foundations. You're still using older materials such as concrete and so on to build this. So that needs to be moved as sustainable as possible. So that whole element as well is something that needs to be continually developed. And we're getting there. And I think over the next three to four years now, especially with the new fabs coming into Europe.

We're going to see a lot of new sustainable measuring devices and methodology is being used because building a new fab is not a small undertaking. know, it's hundreds of billions of dollars to get one fab up and running. And it's a number of years, three or four years before you even start producing. So there's not that many new ones being built. And it hasn't been over the last number of years with the new CHIPS Act for the EU and also with the US. We see that more more sub fabs and fabs, you know, at the end of the day are being built. But I think is what takes us back. now see Samsung investing across my feet, Italy, ST Micro have announced, and we know in Korea, Japan, they're putting a lot of money in. So right now is like a boom time for these buildings. So they are going to carry us through the next 10 years.

Tom:

Yeah. I think it also ties in well with what we in logistics already know to be just in time delivery, right?

It also, if you connect the dots between the preventive maintenance of the already existing fabs, right, it's up to us as Kuehne+Nagel to make sure that we do everything possible to get it there on time in the most sustainable way, right? Yeah. So sometimes a barge or a truck will be, you know, the preferred option, but in some cases you can't, you have to put it on an aircraft, right? And it's great to know we can then use sustainable aviation fuel instead of normal aviation fuel and thereby also

reducing our carbon footprint. And that ties in with the SPTI targets that our customers have. right. There are certain elements of that as well that when you look at it, you will always have, again,

I'm Irish so I can say this Murphy's law. They'll always have Murphy's law will happen. I mean, you plan for the best, you know, in a fab and a sub fab, have the spares necessary, but it could be that you have a spare and you use it and you break it, you know, and that's the spare. And then the next one you get is the wrong material. It's not a wrong color, It's, know, you need a Teflon screw, but not a stainless steel screw. And then you have to get that part in, you know, and the only way to bring it in from the manufacturing facility. So you could be less just take it could be from Dublin and Ireland and let's just say they need it in Israel. So two intel sites there and the manufacturing is in Dresden. I mean, you're not going to barge that because it'll take six weeks probably to get there and then you're not going to put it on a truck because you're driving three, four, five days, 24 hours a day to get there. So you're right. then you need that part.

Otherwise you're losing, as I made a reference earlier, know, minimum 80 grand an hour, 80 ,000 euros an hour. So you want it there tomorrow. And that's one of you know, the great things about working in this logistics industry, you're presented with these challenges. At the end of the day, you do need to air freight it in. Sometimes it's a hand carry. It's literally a guy getting onto a plane with a bolt, you know, and getting on and getting off the plane to hand it to a taxi driver who then takes it to the engineer on site. And that can take anywhere from a couple of hours, you know, from A to B as opposed to a couple of days. So sometimes you are stuck using, you know, these kind of logistics methods. You have to use, you as you said, the aircraft, but we will use sustainable air fuel on that. And this is few and far between. And they really are challenge because then suddenly, you

John: (20:54.079)

Yes, stuff is costing the hundreds of thousands every minute is down. So you need to dare as soon as possible. And it'll always be the one thing that happens that year that everybody will talk about for the next three or four years. It sure doesn't happen again. Yeah. Yeah, that's true. And also when you look at semi -com manufacturing in general, you can't just push a button and have everything running again, right? There needs to be certain quality assurance because the threshold for mistakes is so, so small that you have to have those quality steps before you turn on the machine or turn it off. it's not just the downtime of the actual machine, it's also some additional time to make sure that everything's running as planned. Yeah, a good example of that time would be if your car stops running, you just turn the ignition and it starts up again. But within the fab and the sub fab and the wafer fabrication, if something stops running,

you then have to make sure that everything is purged, you know, back to a zero state because you're really going to have to reset. Now there are certain steps you can take. If it's a multi -stage tool and it's in stage B, you can pretty much put a door between stage B and stage A so that you don't have to do the stage B again. But you do have to clean out stage A and make sure stage C is also...good enough to keep the production running. But then if the problem is in the sub fab, well then that whole line that goes from stage A all the way down to the sub fab, well that maybe have to be purged, that has to be rechecked. So you could be talking a two hour time from when you actually restart the equipment downstairs and then it gets up to upstairs, then they have to do their tests to make sure there's no contaminants and then they have to check the wafer. So there's a lot going on there. It's not just a matter of turning the car on the key and everything starts up again.

It could be a couple of hours process time before you're actually back running again. Which is why, as I mentioned earlier about the progression of the sub fab in terms of how it's progressed, everything now really is monitored. Everything is looked at. You're looking at the rotations within the equipment

you're looking at. The power draw, how much power is it drawing? Because if the power starts being drawn and starts going higher and higher, then you know that that piece of kit is struggling.

You know, it's trying to get up the hill and it's still operating within, you know, limits. But you can see it's just starting. So then you have to try to arrange a schedule to take out that equipment so that you're not affecting the equipment upstairs. And as I said, it's a dance and it's constantly going on. So both partners have to work in parallel with each other, know? Yeah. Yeah.

Tom:

So just to recap now, we've talked about what is SubFab. We talked about how we think it's going to evolve over the next years. We talked about sustainability aspects and reliability aspects and how that's evolved over the years. Is there anything else that you want to add to this?

John:

I think, no, I think what's going be very interesting is that we'll be keeping an eye on the fabs, especially within Europe, because obviously we're based here, but obviously globally there's a lot going on. But I think next two years is going to see a big change in terms of logistics, going to big change in terms of what we ship, how we ship, sustainability, we'll take a big aspect on that, resilience, because now we're going to have anything, I think it's like 20 to 25 new plants and there's new ones being announced all the time. So it will change the landscape of logistics within Europe. I think we see a lot more electric vehicles being

I think we'll be looking a lot more to see how supply chains interact. Central gravity studies and all these tools will be used now, especially within Europe, especially within Semicon, because there's just going to be an influx of companies here all drawing on the same resources, not only from people, but from planes, trains and automobiles, road networks. So it's going to be an interesting, very interesting time in the next two to three years when these plants start coming online.

So we need to, I think, just be in our feet. But that's the great thing about Semicon. It's constantly changing. It's constantly giving us challenges. And some of them we can solve straight away, but we will get there eventually, which is why we keep developing, keep pushing. You know, the whole infrastructure and the whole ecosystem with that is Semicon.

Tom & John Outro (25:39.377)

Yeah, and what I'm really interested about is the recent developments in AI, right? Which is also...major driver for the semi -conductor industry. But that's something we're going to be talking about in the next podcast. That will be a complete separate because that's a whole thing going on. Exactly. yeah, just want to thank you again for sharing your thoughts today. Really enjoyed it. And I'll see you next time. See you next time. Thank you very much for having me again, Tom. Thank you. 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.