HL Influencers: Digital Transformation

TRANSCRIPT

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Leo von Gerlach	Hello everybody and welcome to another edition of *The Influencers*, our podcast conversation on digital transformation and law. I'm Leo von Gerlach, and with me today is Andrea Roccheto and Giovanni Trabucco. Andrea is a very impressive figure and in fact, one of those academics and entrepreneurs from Europe that make us shine. He has a PhD from the University of Oxford in algorithmic models in quantum mechanics and he is now, and this is the reason why he's here, the co-founder and CEO of Ephos. Ephos is a fascinating company specializing in the design and manufacture of glass based photonic chips for the better performance of both classical and quantum computer systems. And Giovanni, in turn is a dear colleague of mine from our Hogan Lovells office in Milan advising Andrea and other clients on issues of technology and data law. Andrea and Giovanni, welcome to the show.
Andrea Rocchetto	Great to be here. Thanks.
Giovanni Trabucco	Great to be here now.
Leo von Gerlach	Wonderful, Andrea. Let's start with you and your story with and about Ephos. Just tell us what inspired you to co-found Ephos and what the business rationale of Ephos actually is?
Andrea Rocchetto	Short answer. We are a pivotal moment in the history of science and technology, where profound ideas like quantum computing and artificial intelligence, among several others are turning into technologies. And their journey from science into technology is one of the most exciting things the human being can do. So that's why I originally started Ephos -- to be part of this process of turning the science into a technology. But as you start working as an entrepreneur, you realize that you need to optimize metrics that are easy to measure, and generation of capital is a very effective and easy-to-measure metric. So now we're very much focused on building products that our customers want, and in our case, these products are photonic chips, so I'll be happy to tell you more about that.
Leo von Gerlach	Photonic chips is quite something. So photons, subatomic elements, and combining them with chips sounds already like quantum computing and quantum chips. Perhaps, tell us a little bit of how that works in very rough terms. So what's the relationship between those photons, those chips, and are they

	somehow related to qubits quantum computing? So how does it work from a layman's perspective?
Andrea Rocchetto	So you mentioned several key concepts here, so let's try to divide them. I think that for this conversation, there are three broad categories that really matter. One, the photon category, the one is the chip category, and the third is the qubit category. Let's start from the qubit category. In quantum computing, there exist several hardware platforms that you can use to build a quantum computer, and quantum computers are made of qubits, which are the equivalence of the bits that are used in classical computing. Qubits can be, as I was saying, built with different hardware platforms, for example superconducting qubits, the type of the technology or modality that Amazon, IBM, Google are using. You could use the iron traps as the listed company Iron Cube is using. You could use neutral atoms as the curer, as the Boston based startup is using. Another modality is photons. So what are photons? Photons are the particles that make light, of which light is made. With respect to the other qubit modalities, photons have some advantages and some disadvantages. The main advantage here is that they can move around without being much affected by the environment in which they move. So for example, you can have photons travelling in an environment that is at room temperature and we will not be disturbed by the by this temperature. The other qubit modalities instead will require very cold environments. So that's, that's the main advantage of the photons. The disadvantage is that it's hard to have photons talk to each other, and for building the computer you want those particles to talk to each other. Now let's move to the third category, which is the chip. It is just a tiny piece of material, which in our case is glass. In the case of our competitors, of silicon, where you have photons traveling and interacting in the controlled fashion and you do that in the tiny space, as opposed to having these types of operations performed in the larger system. When you start to miniaturize all those components in a tiny piece of material, again, silicon, or in our case glass, you have a chip. So photonic chips are chips that persists, meaning that you can change the properties of light or photons because light is made of photons.
Leo von Gerlach	Wonderful. That's very interesting. So I understand you -- in a sense the big advantage is that you can keep photonic qubits at room temperature, which is a big issue in quantum computing, and that it is also manageable to keep them in check, and I somehow understand that it may also be possible to scale them well. So with all those positive aspects, just remind me once again where are the drawbacks here? What makes this a little bit more difficult than perhaps all the other types of qubits you were just referring to?

Andrea Rocchetto	The main challenges in building photonic quantum computer is that you need to have the photons interact with each other in order to generate what is the magic source of quantum computation, which is entanglement and the generation, at scale of entanglement among photons is something which is hard to achieve especially, it's hard to achieve with good enough quality and with a fast enough rate. Once you have a sufficient capacity to generate entangled photons of high quality and at higher rates than scaling the photonic quantum computer is easier than other qubit modalities.
Leo von Gerlach	Okay. Somehow this entanglement, the spooky action at a distance is still difficult with photons, perhaps we don't go further down into this because that may simply then overstretch my own capacity, and those of those who listens, and just perhaps jump to use cases and ask the question: what would be the typical use cases for quantum computers, but more specifically, of course now, for photonic based quantum chips?
Andrea Rocchetto	So first important to clarify that a quantum computer is a quantum computer, no matter which hardware platform you use to build it. There is absolutely no difference from what the computer does. So, what are quantum computer good at? So we know a few areas where they can have an input but I think the good answer here is that we don't know where the biggest impact is going to come from. Ultimately, we need to build them and we want to build them because these are fundamental tools for understanding our reality. The world in which we live is a quantum world in its essence, and quantum computers are powerful instruments to understand the world around us. By understanding the world over and over and over over time, we built amazing technologies. So we should see quantum computers as another extremely powerful tool in our toolkit for understanding the world. So for me, that's the primary reservation for building a quantum computer. Then I can go and share some of the things that we have identified so far but again, I'm sure we'll find more stuff over time, as it happened in the early days of computers. And the computers were built to make calculations for designing the atomic bomb and for decrypting the secure natural communications during World War 2. Do you use computers for these stuff these days, yeah, but it's a tiny, tiny fraction of the use. We use them in our phones, we use them to power this podcast. Similarly, quantum computers will do way more of what I'm about to say. So the two key applications that have been identified so far as most promising quantum computers are number one, breaking the most commonly used encryption tool. An encryption tool is, or a cryptographic algorithm is, a protocol that allows two parties to share information security. So this is the technology that we use when we buy something on the Internet using our credit card. We need to share the numbers of our credit card with the vendor and we must be able to do that securely by sharing this information over the Internet. In order to do that securely, we need to encrypt the information and we'll do that using an encryption algorithm. The most commonly used of these algorithms can be

	broken by a quantum computer, and this is why in the early days of the field most of the money to fund research in this space came from the defense departments of the United States, because it's such a critical capability to have. If you want to attack an adversary you can disrupt other secure communications.
Leo von Gerlach	Yeah. No, just being fascinated because you draw the parallel that the traditional computer was based on considerations relating to defense, and now the quantum computer is also built in the first place for consideration from defense and finance, for code breaking and encryption key breaking, but that there may be other use cases that still need to be figured out. I would actually still like to go back to the photonic aspect of your product, and just ask again with that doubling down on the photonic qubits, would you anticipate some use cases that are particularly suitable for the photonic version of the quantum computer, which is your kind of flagship?
Andrea Rocchetto	Again, I think once we build a quantum computer it will make no difference whether it is powered by super-conducting qubits. They are all the same once the computer is built. In the earlier days, there might be applications that benefit them more from one platform with respect to the other, but these applications are so niche and so confined to the simulation of other physical systems that are being, that I think, yeah, they are relevant for a wider audience.
Leo von Gerlach	That suggests that the real difference than between the different types of quantum computers lies in the way and the cost, the efficiency you produce them, and you give the stability and the energy you may use to run them. Would that be a fair description of why there's so many different systems around and trials to bet on different types of quantum computers?
Andrea Rocchetto	Yeah, I think in the future what you said is correct, in the present I would say we have so many different modalities because each one of these modalities has challenges to build a true quantum computer. Perhaps is important to clarify that today, quantum computers do not exist. We have the prototypes that implement some of the features we would want from a quantum computer, but not all of them and each qubit modality has some shortcomings. And every team working under the quantum computers, trying to fix them, and they're all backing that they're going to come quicker to the solution of all the challenges that they have with respect to the other teams. But then there are other... there's going to be one team that comes first, then other teams will come. Perhaps we'll see more than one technology getting to build the quantum computer, perhaps not. It's still a space that has lots of research and development going on so it's hard to make estimates at this stage.

Leo von Gerlach	Perfect. Which leads me to the final question of how long do you think it will take [until] we will have actual quantum computers, and what are the main roadblocks still in the way?
Andrea Rocchetto	So the only thing that I feel like I can say with certainty with high probability is that we're not going to have quantum computers in the next two years. Above that timeline, I think yeah, but the lines are more blurred and technology is moving so [much] faster. If I think about the last five years, I will not be expecting that much progress. I think this opinion is widely shared among my colleagues, not expecting that much progress. So the advances in quantum computing have been greater than the one we expected. So similarly for predicting the future, I don't know. I mean, at this stage, it could come in five years. I think most estimates still look at beyond 2030, if you look at the roadmaps at IBM, Amazon, Google put online, they all have timelines that stretch into the 2030s for building a fully functioning quantum computer. But again, technology is moving so fast, and as artificial intelligence, if it continues to develop, ups the pace it's developing, is going to have an impact in the development of quantum computing as well, because we're going to be able to automate more of the R&D process that is behind building a quantum computer. So very, very hard to make predictions at this stage.
Leo von Gerlach	Very interesting. Giovanni, just now we heard so much about the technology - and where there is technology, there are legal implications. I even heard that Stanford University has now founded an Institute for Quantum Law. I have honestly no idea what they are doing, but maybe you have an idea of the emerging legal topics around this fascinating technology.
Giovanni Trabucco	The first issue that comes to mind was something that Andrea mentioned himself: that is the use of quantum for breaking current cryptographic standards, and that is something that is widely shared as a potential risk, at least in two areas of the law, so data protection and cyber security. Now we have seen in the recent years an increasing number of regulations in this field, and the main risk is that the standard of care that companies need to adopt when quantum computing becomes a reality is higher. They would have to develop quantum-proof technology protection measures. Just to mention that the GDPR provides that companies have to include security measures that are at the state of the art, and that have reasonable costs. And the first question is really that I wonder, when will the state of the art require quantum-proof cryptography for protection? A second aspect is again tied to something that has already emerged, that is the potential dual use of quantum technologies, given also their capacity of being used against cryptographic standards. Quantum technologies have been identified as particularly strategic in a number of fields, and therefore companies working in this area might need to consider export control measures so the possibility of selling materials that have [been] used in defense and the various regulation that affect these instruments. And as we all know, this is a particularly

	changing moment in that area, where the geopolitical landscape is really evolving, and so that would need to be taken into account. And finally, coming back to my specific area of knowledge, there are a number of fascinating aspects in patent law that deserve attention for quantums. So on the one side, there is a perception that quantum technology is particularly complex, and so is particularly complex to explain to the level of degree that an invention is sufficiently described. So sufficiency of description is a key requirement for patentability. And another aspect that has been often touched in the literature is that quantum technology and quantum physics are now being the object of patents, and it is wondered whether these early patents that have been filed concern more abstract ideas and mathematical methods, as opposed to technical inventions. We just have to keep an eye out to how the technology develops, to further refine what the legal issues and pinpoints are.
Leo von Gerlach	That's particularly interesting what you mentioned at the end regarding patentability, and it reminds me what Andrea said about the parallel to the early computers. Now you have the parallel to the early problems of patent law about computers, when you ask the question, is that pure math, or is that actually a solution to a technical problem? Fascinating. Poking further into this, would you expect anything specific from the European legislator to either support the development and proliferation of quantum technology, or perhaps more specifically, the proliferation of that technology by European entities and companies and businesses?
Giovanni Trabucco	There have been a number of EU projects in this field. One of the most well-known, it's called the Quantum Flagship Initiative, which was launched already a few years ago. The European Union has issued a declaration on quantum technology, again, a few years back, and there are currently a few MEPs that are suggesting the need to introduce specific legal provisions. So in particular, Henna Virkkunen and the Commission designated for Tech Sovereignty has issued a European Quantum Act proposal, which is not really formalized, but it's an interesting thought piece on where this field should go. So there are a number of moving pieces, but we are still in the infancy on sector-specific regulation in quantum.
Leo von Gerlach	So perhaps meaning that in addition to these nascent pieces of regulation, it would be simply good to have a legislator who is well versed and well educated about these topics. Which brings me to my last question to the two of you and staying for a minute with this European theme, and this theme of supporting businesses in Europe, is there anything that you would expect or wish from the legislator or the governments to do more in terms of supporting frontier businesses based on frontier technologies like ethos and a few other extremely advanced businesses?

Andrea Rochchetto	In a way that is opposite to what Giovanni was just describing. I mean, rather than a Quantum Act, we should just have less rules. I think that's the number one issue that a policy maker should be concerned of when thinking about promoting innovation in Europe, both at the national level, but at the EU level. Thankfully, we're seeing that trend to removing, or at least starting to think that things like GDPR and the AI Act are just very bad ideas for promoting innovation and or at least, had very negative externalities for innovation. I keep telling this to you policy makers and national policy makers as well. It's all about less rules. You should be concerned only about that. The money will come, you take care of removing rules.
Leo von Gerlach	Okay, "Deregulation," full stop. Giovanni?
Giovanni Trabucco	As a lawyer, I don't necessarily share such a blunt view, but I do hear that excessive regulation is often perceived as a major roadblock in Europe. Also perhaps due to the fact that the European Union hasn't been really marketing and branding their legislative activity in the right way. There might be good aspects of regulation, and regulation might also promote or structure complex fields. But I do hear that this is a common issue that is felt from entrepreneurs. And then again, with respect to Italy in particular, I think one pinpoint in which we are seeing an evolution is access to private capital. So Italy tended to have a quite conservative environment for investments, but there is a growing startup culture in Italy, now Milan is certainly a hub for this idea, and perhaps also hoping that the mind the big innovation area outside of Milan that was built in the outskirts of the city after the Expo in 2015 will be a pull for innovation. And that's also where Andrea and his company currently are.
Leo von Gerlach	Andrea, Giovanni, that was wonderful. Thank you so much for this eye opening journey in the fascinating world of quantum qubits and quantum computers. And thank you everybody for listening in. And I hope you will join again for the next edition of The Influencers, which is coming up soon, but for now, take care. Goodbye.
Andrea Rocchhetto	Thank you very much.
Giovanni Trabucco	Thank you