HOUSE OF COMMONS

Business, Energy and Industrial Strategy Committee

Oral evidence: The semiconductor industry in the UK, HC 291

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Watch the meeting

Members present: Darren Jones (Chair); Tonia Antoniazzi; Richard Fuller; Paul Howell; Mark Pawsey; Alexander Stafford.

Questions 99 - 118

Witnesses

II: Simon Beresford-Wylie, Chief Executive Officer, Imagination Technologies; Dr Andrew Rickman, Chief Executive Officer, Rockley Photonics; Paul Williamson, Senior Vice-President and General Manager, Client Line of Business, Arm.

Examination of witnesses

Witnesses: Simon Beresford-Wylie, Dr Andrew Rickman and Paul Williamson.

Chair: We welcome Simon Beresford-Wylie from Imagination Technologies; Paul Williamson from Arm; and Dr Andrew Rickman from Rockley Photonics. Thank you for coming to speak with us this morning. My opening question to you is the same as to panel one. Could you just explain very briefly what your organisation does and how it fits within the supply chain so we have it on the record?

Paul Williamson: I represent Arm here today. Arm is a British success story. We license and design semiconductor IP, primarily processor technology. That is the microprocessor that you will see as the core or the brains of so many of the devices around us today. The most well known is the smartphone, but probably all of these appliances around us have an Arm-based processor within them. Over 225 billion chips have been shipped worldwide in Arm's 30-year history that include that technology.

The business model operates as a licensing structure. We are paid for the designs that we create, but we are paid a licence fee for the design and then a royalty when that design is used in the manufacture of a product. I should be clear that we do not manufacture ourselves. We license that technology to others. Either they have fabrication technologies themselves or, more commonly in the industry, they are what we call fabless semiconductor companies. They are designing the chip itself based around the technology that we license to them.

That is a very global business. In the previous panel there were questions asked about the percentages of the business. Perhaps I could give some recent figures for Arm's revenues to give you an idea. Our revenues for 2021 by region were $123 million in Europe; $807 million in North America; and $1 billion in Asia. Our UK revenues were under 1% of our total. That gives you an idea of where our technology is deployed and which companies in the world make use of it, and a view of the overall semiconductor business. It is a pretty good view of the semiconductor business, because of the prevalence of Arm's technology within advanced microprocessors globally.

Simon Beresford-Wylie: Imagination Technologies is a very similar business to Arm. We design and develop the intellectual property that sits on top of the chips; it brings the transistors to life. We are focused on rapid processing units, artificial intelligence, also known as neural network acceleration, ethernet packet processing and, more recently, RISC-V central processing units as well.

We are focused on three segments. The first is mobile and consumer, so mobile devices and consumer devices such as set-top boxes and OTT

devices. The second is automotive. If you think about the infotainment system that sits in the centre of the car or the digital dash, we help bring those to life. The third, more recently, is desktop and cloud. They are the three segments we focus on. We are a very global business, just like Arm, and we have a very similar business model.

Dr Rickman: I am Andrew Rickman, the CEO of Rockley Photonics. We produce photonic chips as opposed to electronic chips. Photonic chips are the optical analogy of microelectronics. They process, transmit and sense information optically.

Arguably, our technology is the most advanced semiconductor technology in the world. The applications of this technology are very broad. For example, the technology set to revolutionise the healthcare industry—such as the ability to measure your blood sugar level, your blood pressure and many other biomarkers continually and non-invasively, on your wrist—is enabled by this technology. This is going to change our healthcare system today, which is arguably a sick-care system, by allowing better preventive medicine and early detection of diseases, which will move us to a true healthcare system from a sick-care system.

The technology is also incredibly important for the future in applications such as quantum computing. It exists today in fibreoptic communications and in autonomous vehicles. It has a very important set of dual uses in the defence industry. There are opportunities there in chemical weapon detection, in battlefield triage and, very pertinent today with Russia's aggression in Ukraine, in air defence by stopping missiles and artillery shells.

We have developed this technology with about $500 million dollars of investment. We developed the processor technology in Newport Wafer Fab. We have a team embedded in Newport Wafer Fab. We have part of the production line control in there, which is our production line, and the remainder is essentially a foundry service offered by Newport Wafer Fab. We have developed the technology there. That is the status today. We are now scaling manufacture, but that is elsewhere in the world.

Q99 **Chair:** Paul Williamson, you gave us some figures about the global exports of the designs that you put together at Arm. When we have to think about the Government's national security considerations, there is a question about IP leakage. You might design something fantastic and cutting edge here in the UK and then export it to China, for example. What controls are in place around IP leakage where there are national security concerns about the stuff that you are designing?

Paul Williamson: There are two aspects to that question on IP leakage. We need to protect our intellectual property and the designs we create. We form strong commercial partnerships with the companies we are operating with.

They rely on our capability, our intellectual property and our knowhow not just for that one thing they take from us but for every generation of product they create in the future. We build binding and positive legal arrangements between the businesses that allow us to continue to operate on a basis of trust and have a business relationship in the long term. We do not typically find an issue of IP leakage in the form of commercial damage to our business, because people are buying in based on the need for future development.

You asked a second question, which was around concerns about exports. At Arm we comply with all export controls. We work closely to ensure that, wherever export controls are applied to our technology, we meet those and take care of the distribution of our technology to companies around the world.

Q100 **Chair:** Some businesses not in the semiconductor industry have said to us in the past that the use of export control licences has been expanding the definition of dual-use technology—what is a consumer or a defence concern. Are you finding that the Government are increasingly trying to put restrictions around the export of some of the things you are designing?

Paul Williamson: From Arm's perspective, we have had increased export controls over recent years, particularly in relation to China, as you mentioned earlier. We have fully complied with those. They often relate to the design origin of the technology—the percentage of the design origin within the technology.

In the case of the US, which has been more expansive in its controls, that has placed some restrictions on what we have been able to export to individual named entities recently. We have not found a global expansive programme or that the UK Government have been driving a more constrained behaviour in relation to our technology specifically. The challenge for us has been more about named entities.

Chair: Is that the same or different for either of you?

Simon Beresford-Wylie: It is very similar. The export control regime here is a good regime; it is very tightly and narrowly focused. A number of our intellectual property items have gone through the Export Control Joint Unit.

The only observation I would make is one of pace. They take an awfully long time to go through. Part of that is just a bandwidth issue within the ECJU. Frankly, that has caused considerable frustration on our part and we have made that clear. The pace of the sales opportunities is such that they move much more quickly than the export control regime. The net result of that is that we have lost quite a number of sales to competitors.

Q101 **Chair:** Which competitors?

Simon Beresford-Wylie: Competitors in North America, in China and even in the UK.

Dr Rickman: We have not been affected by the UK, but we have been affected by the US Department of Commerce putting one of our Chinese partners on the entity list, which stopped business with it.

Q102 **Paul Howell:** Moving to a slightly different part of the discussion, disruptive technologies, Dr Rickman, you talked about optical chips and things. What do you see as the big disruptive technologies that will change the semiconductor industry in the next five to 10 years? There is also a second part to the question. Does the UK have the skills to remain competitive in that space? Could you wrap that into the same answer?

Dr Rickman: My two colleagues here represent about half of the semiconductor industry. Half of the semiconductor industry today is CMOS technology. It has become a very layered industry in some respects. CMOS is a commodity, though the leading edge of CMOS requires an enormous amount of investment to make transistors smaller and smaller and smaller. There are a very limited number of companies in that area. This Committee must appreciate that, in terms of processor technology, this is not an area where the UK is going to catch up any time soon.

It is a great question. Let's not look in the rear-view mirror. What is coming up next? From my perspective in the field of photonics—basically, photons are niftier than electrons—the future is extraordinary in things like quantum computing. If we filled the entire universe with CMOS computers, the promise of optical technology and quantum computing is such that we could fit all of that competing power into this room. You are looking at industries here in the UK, where we do have an extraordinary lead, that really can make a huge change.

I have mentioned the healthcare dimension. This is ginormous. The defence element is incredibly important. A question was asked earlier about how all of this is justified. You cannot just look at the industry on its own. You have to look at the industry in the context of our healthcare system and our security and defence. If you look at any one of those, you will see that these new technologies coming along are fundamental to our security and the health of our population. Our public spending in these areas would benefit greatly from investments in these areas, which would increase our security and our health and wellbeing.

Simon Beresford-Wylie: To add to that slightly differently, if you look at the net value of the semiconductor sector, it generated about $600 billion of revenues in 2021. That is forecast to grow to $1 trillion or thereabouts by 2030. Behind that is the digitalisation of everything. Every sector is experiencing a transition or disruption. For us, that brings considerable opportunity.

One of the wonderful things about sitting next to Arm is that today the UK is a real leader in IP, in the IP business model. There are four large companies globally, and two of them are based in the UK. As we look at the opportunities that the disruption is bringing, it moves us from being a point provider of IP, for example into the infotainment system that sits in a car, to working with robo-taxi companies and saying, "It is a bit of a mix and match, heterogenous compute. We can provide intellectual property for graphics; we can provide intellectual property for graphics compute; we can bring acceleration through neural network accelerators; and we can bring the connectivity through our EPP solutions". Nowadays that is referred to as heterogenous compute. Our customers are looking more for solutions than point IP.

There is incredible disruption for the likes of Imagination and, I expect, Arm. There is a tremendous opportunity to build on the great heritage we have here of designing and developing IP.

Q103 **Paul Howell:** Just to go back to the second part of the question, does the UK currently have the skills to remain competitive in that space or to develop that space?

Simon Beresford-Wylie: I absolutely believe we do. We are doubling down here. We have opened two new offices in the last 12 months, one of which we have had to close and move into a larger premises. While I would like the pool of talent to be larger, for the engineering talent around IP, what we do, the UK is demonstrably a world leader. Many large US companies, the hyperscalers and so on, have opened offices here and are competing for the same resource. Ironically, they see us as a low-cost country in terms of engineering costs.

Paul Williamson: I would perhaps build on that and reaffirm that, for me, specialised compute is the disruptor of the next period. We are going to see people bringing together analogue techniques, BiCMOS techniques and compound semiconductors with conventional semiconductor CMOS techniques to build things that are application specific. You are bringing the type of compute you need to solve the problem that is there and building a solution for it.

Simon has put it very well. The UK is in an exceptionally strong position to feed and build the foundation we have in the design end of the supply chain here, by building the latest processor technologies and intellectual property that will form the foundation of those compute solutions as those specific applications are emerging.

The investment around the Cambridge cluster, for example, with major global companies bringing their offices to Cambridge to pick up on that talent, is positive. It is also something we should be aware of in supporting companies in that cluster to recruit and retain the talent locally in the UK, rather than see it move back abroad, and to give them the opportunity to bring global talent into the cluster and further strengthen it over time.

Q104 **Paul Howell:** You have talked about us being very good at the IP and design stage. What about the next stages and the further parts of the supply chain?

Paul Williamson: There has been a lot of discussion today that I find very interesting around the security of the supply chain. That is a very challenging thing to answer as a UK-only or UK-centric proposition, given the complexity of the devices and the cost of investment required to create them. These specialisms are needed globally.

As was described, it takes a very complex supply chain of many geographies and many companies to assemble a device as complex as this. The idea of consolidating that within one country is exceptionally hard to imagine. We have become a globally interdependent supply chain.

I agree that resilience in that supply chain is of strong importance, but would we be able to centralise in the UK all that would be required to supply Jaguar Land Rover—that was the example given earlier—with the sensor systems it needs to build a full car? There are so many elements in that supply chain. There are at least 13 or 14 companies involved in creating just a sensor cluster. It would be exceptionally challenging to think we could make it fully resilient.

We have the talent to lead in the design segment, which brings perhaps the highest value to our economy. It is something we can build on top of.

Paul Howell: The consideration in my head, anyway, is that resilience is not necessarily about being able to do everything but having enough levers to make sure you are part of a chain. You do not do everything, but somebody else is relying on you and, therefore, you have mutual need.

Paul Williamson: Understood, yes.

Paul Howell: We could talk about that for a while, so I had better go. I will come back with other questions later.

Chair: He is up in a second.

Q105 **Richard Fuller:** Dr Rickman, some have said there is a slow response in the UK to the challenges of the semiconductor industry, because the Government do not know really know much about semiconductors. Is that your observation?

Dr Rickman: We need a clearer framework to understand it all, because there are a range of different segments. As I mentioned, the CMOS area that these gentlemen are building their IP on top of—they are a very valuable part of that industry—has structured into particular layers that are spread out across the world. It represents about half of the industry today. But then there are things like the photonics field and other

semiconductor devices that are growing at a much faster rate than the CMOS area, which have this promise for the future.

As a way of analysing the industry and thinking about it from a UK point of view, you really need a table. You need to list these individual sectors and to understand each step of the supply chain associated with them from the specific wafer that you might use for that process right the way through to the IP element, the design, the test, how that gets built up and the value chain that is on top of that. You can represent that across each particular sector and you can analyse it in terms of this country's strengths and weaknesses.

You will find that there are some areas where we should not invest in the whole chain but we are very strong, such as in the IP element of digital CMOS. There are other areas where there is a huge opportunity, specifically in some sectors of the compound semiconductor industry where we are world-renowned for our technology, to have much more of that value chain.

The key point about that from the point of view of national prosperity, investing the taxpayer's money et cetera is that those areas can have many more jobs and bring much more of the value to the UK. The further point is that, as you do that analysis, you see where these individual parts of the chain hit things like national security, defence, important things in the health service and other aspects of our life in this country.

The justification for subsidising an industry is not about subsidising an industry. We are spending our money on defence; we are spending our money on healthcare. How can we be smarter in joining that chain up and getting a better return for our taxpayer's money?

Q106 **Richard Fuller:** So we should have this table that maps this out.

Dr Rickman: It is up to you guys to do the table.

Richard Fuller: That is what I was about to say. If I were to walk into the Business Department and go to room 6—and maybe rooms 7 and 8 because it is a big table—has it been done? Are you aware of whether the Government have done it?

Dr Rickman: What I have just described I have not seen. I presume that this is exactly what your task is. Then you quantify a lot of the things that have been said here. You put it together in a quantified form; you understand how much value is brought by the IP industry. You understand in the future how much value other parts of the semiconductor industry could bring to the UK.

Simon Beresford-Wylie: If I may, the industry is waiting for the frankly long-delayed semiconductor strategy from DCMS. I hope that brings clarity to how the Government see the future of the sector here and where they want to be focused. Without wishing to sound conceited, if I think about that from a business perspective, ideally in that strategy I

would hope to see a vision, a strategy for the sector supported by key objectives, key performance indicators, an execution plan and engagement with industry to ensure there was course correction.

Q107 **Richard Fuller:** What other countries have done that effectively? Please do not mention China.

Simon Beresford-Wylie: I cannot speak to semiconductors. I have been a chief executive six times since 1995, and I have lived and worked in Singapore, India, Finland, Germany and most recently Korea. The level of engagement between the German Government and German industry, and the Finnish Government, when I was at Nokia, and industry there, is sharper. There is a greater appreciation of the need to focus on certain sectors. It is a different type of engagement.

Q108 **Richard Fuller:** It is. It might be a worse type of engagement from the point of view of the economy and the people we represent. Is there, clearly and obviously, a country that has done better specifically on semiconductor mapping?

Dr Rickman: Yes, Taiwan has driven this through ITRI and its industrial policy over many years. I have been a visiting professor at one of the semiconductor institutes in China in Shanghai. I know for a fact they have a very well thought through strategy to put it all together, understanding all the elements I have just described.

As we look at the US, the strategy is primarily being driven from a defence perspective. That was the origin of the semiconductor industry. That drove the initial semiconductor devices. We can see things in other countries that are joined up but in slightly different ways and in different locations.

Q109 **Richard Fuller:** In the last panel and this panel we have talked a lot about skills and skill shortages. Are you aware, Mr Beresford-Wylie, of any education initiatives here that are working well to help the sector?

Simon Beresford-Wylie: First of all, let me state that there is definitely a shortage of engineers here. While there is a great pool of talent, we have 161 open vacancies at the moment, and I do not expect to have those all filled this year, sadly.

Q110 **Richard Fuller:** Why is there an absence? Why do we never have enough engineers?

Simon Beresford-Wylie: There is a war for talent here. I have been in the tech and telecoms sector for 40 years this November. I have never seen anything like this in my career in terms of the demand for skilled engineers. The salary inflation around that is interesting, as you might expect.

As I noted, you have US companies coming here looking for talent, the hyperscalers and others. There is just a shortage. At Imagination, we are contributing. We are doing what we can with schools and universities to

get students excited about STEM careers and engineering careers. Some of the initiatives that are being taken by the Government, such as scale-up visas, the Global Talent Network and so on, are great, but they are not going to address the challenges we have overnight. We are on the right track.

Q111 **Richard Fuller:** Would you say that those challenges are everywhere? If the Americans are coming here, they do not have enough engineers.

Simon Beresford-Wylie: Yes, they are everywhere in the world. Last week I was at an automotive electronic conference outside Stuttgart. One after another, I heard the German automotive manufacturers talking about the dramatic transformation that is happening in their sector. They are all looking for thousands of engineers in Germany. There are not enough there.

There are not enough in India, interestingly. We have struggled in Romania and Poland; we could certainly increase our resources there. It is a global problem, and it is not unique to the semiconductor industry.

Paul Williamson: I would broadly agree with what Simon said. The competition for talent is exceptional at the moment. Something that we have in the UK as a huge differentiator is the level of talent we have built around our core semiconductor design segment. That has attracted companies here, but it is getting intensely competitive.

Dr Rickman: We have found in south Wales that we have been able to attract people from all over the world. Where we have had shortages here, we have been able to make up for them by drawing across the whole of Europe, Taiwan, China and the US. People seem to love coming here.

Q112 **Paul Howell:** In going back to a subject that I nearly touched on before, I am going to start with you, Simon, if that is okay. There was a report between Global Counsel and your company where you suggested that we should not focus on onshoring the semiconductor industry but rather play to our current strengths and integrate in the current market in a competitive and sustainable way. That is largely what I was starting to talk about before. Could you just be a little bit more precise about what should be onshored and what should not?

Simon Beresford-Wylie: To the earlier question about billions of pounds of taxpayers' money going into investments in big fabs, I do not think we should do that, quite frankly. I really genuinely do not. I would be looking at where we have comparative advantage. That is in what we do. There are around 110 design companies here. That is clearly a great strength. As someone relatively new to the industry, I have started to tune into compound semiconductors. As we heard this morning it is nascent, but there is a tremendous opportunity for us there.

Dr Rickman: When we think about the incredible costs associated with building CMOS fabs today, we all agree on that. It is limited in certain

areas. We do need to make sure our allies are active in this area. If they are not, that is a huge worry to us.

When it comes to the compound semiconductor area, it is not about this drive for miniaturisation, down to 2 nanometre transistors etc., which has driven the industry. That has been incredibly important, and it is incredibly important that it continues, but it is about a different set of wafer-scale manufacturing technologies. If you are smart, you do not need billions and billions of dollars, at least not today, to build factories to build this stuff.

If the capacity in the UK was available to us, which it is not, in the foundries in the UK, we could produce millions and millions of devices, for example, for consumer devices a week without any problem in the UK, not with billions of dollars of investment but hundreds of millions of dollars of investment.

Q113 **Paul Howell:** As I understand it, your particular business is a good one in terms of controlling the design and manufacture from the start to the consumer, with full vertical integration of the supply chain.

Dr Rickman: Yes, exactly.

Paul Howell: How good is the UK at catering for your needs specifically regarding the manufacturing?

Dr Rickman: We had intended to manufacture at Newport Wafer Fab, and we built part of the production line in there. The rest of the production is within the foundry element of Newport Wafer Fab. Newport Wafer Fab changed hands, and the current owner, for business reasons known to themselves, does not want us to manufacture there. They have honoured our relationship with them with regard to the development contract. We have had to move the volume manufacture elsewhere.

Q114 **Paul Howell:** How easy is it to do that? I assume that "elsewhere" is outside of the UK.

Dr Rickman: It is very difficult. In this industry, you have to have dual supply chains. There is all this supply chain stuff that you are talking about. Fortunately, we created a global dual supply chain to protect ourselves against this situation, but it is frustrating. We will ramp up not only the alternative foundry that we have in the US; we will find a replacement for Newport Wafer Fab in due course. If the UK had that capability, we would be very happy to use it.

Q115 **Paul Howell:** Paul, one of the major reasons for launching this inquiry was the reaction of OEMs not being able to create their products. How much engagement do you get with the OEMs? Has this changed through time? With the current shortage, are they aware of the importance of the role of people like you?

Paul Williamson: That is an interesting question. Arm has always had a very broad ecosystem. We work all the way from user requirements and

OEMs down to the manufacturers of the technology and the tooling that goes behind it. That is probably because we have such a long design cycle. We are designing for three or five years out to work out what people will have in their hands in that timeframe. We have always been working very closely with them.

It is very true to say that there are a couple of trends in the industry at the moment that are making OEMs more acutely aware of the fact that the semiconductor content of the product is increasingly defining the user experience and the capabilities of the devices we use every day. Their investment interest in the design and specification of semiconductor products has increased over the last few years to the extent that they are taking on the development of the chips themselves.

An example of that would be Google. In the smartphone world, Google has gone from being a company that we know for search engine and operating systems to building its own chips. It does not fabricate those; they are fabricated elsewhere, but it is specifying the design of those chips. OEMs are getting much more interested in the semiconductor industry.

On the supply side, another area that Simon mentioned was the automotive industry and how much, from his conference last week, it is adjusting to this world. Increasingly, the user experience of a vehicle is now defined by the semiconductor content, whether that be the infotainment that is in front of you or the underlying autonomous drive systems and intelligence that is coming into the car. Many industries are adapting, and OEMs are becoming more aware of silicon as a key differentiator or definition point in the value of products and their capabilities for the future.

Q116 **Paul Howell:** Thank you for your insight. I am conscious that we are getting tight on time, but is there anything that you guys would like to add, to contradict or enhance what Paul has just said?

Simon Beresford-Wylie: No, I agree with everything Paul has said. I just note that, as we look at these transitions, including in automotive, we see a world of opportunity. Frankly, with autonomous vehicles, Imagination's cunning plan is to have our intellectual property, our heterogenous compute solutions, in as many of those as we can get.

Q117 **Chair:** Clearly there is a commercial issue that you need to figure out with Nexperia about manufacturing capability in Newport. Was there any rationale given for why the previous owner was happy for you to manufacture kit in Newport and the current owner is not?

Dr Rickman: For the previous owner, the strategy was this open foundry capability and this marriage of compound semiconductors on to silicon, which enables a vast array of new opportunities, of which photonics is one. That was the objective of the facility.

As you know, there was a hostile takeover of the facility for contractual reasons that could not be avoided. Business is business. Nexperia now owns the site. It is a power semiconductor company. That is the low end, the commodity end, of the semiconductor industry. It wants it full of those types of devices.

My understanding is that the existing customers of the facility, prior to the takeover, buying that type of product are driving the demand within the facility. They have a different set of business objectives. This is aligned with their business as a closed foundry making power semiconductors and not offering the services originally intended to be offered at the facility.

As I say, business is business. They have honoured the situation. We have a large team embedded in there. We have our own clean rooms inside the facility. They have given us time to make the transition out of the facility.

Q118 **Chair:** That transition has gone to the US now.

Dr Rickman: It has not completely gone. It is still ongoing. There is still a considerable period of time to go for them to continue to support us and to be consistent with the contract.

Chair: Thank you to all three of you for your contributions. We are very grateful for your time.