BEIS Questionnaire Response

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I am the founder and CEO of Future Horizons, the premier global Semiconductor industry watcher with over 55 years' of semiconductor industry experience covering all aspects of the business including new business development, management, manufacturing, marketing, and design.

I studied Electronics Engineering at London's Southbank University in 1962, graduating with an honors degree in 1966 and have worked in the semiconductor industry ever since.

Future Horizons provides market research and industry analysis services to industry and governments all over the world and is a recognized and highly regarded industry expert, renowned for its analysis accuracy and industry credibility.

1. What is the current and future anticipated demand for common products built with semiconductor materials (e.g. computer chips) both in the UK and globally?

1. Globally the global semiconductor (chip) market has consistently grown at a compound annual growth rate (CAGR) of 8 percent per year in <u>unit</u> terms for as long as meaningful industry records have been kept (over 40 years) by bona fide trade organisations such as the World Semiconductor Trade Statistics (WSTS) body. Moreover, this growth rate has been far less volatile than the equivalent rate measured in market (revenue) value and has rarely been negative, just five times in the past 40 years.

2. What has changed over this time period is the precise nature of the chips being made, from the simple logic chips of the 1960s, containing a small handful of transistors (the chip industry basic semiconductor building block), to today's most advance products, e.g. the graphics processor designed by Graphcore based in Bristol, UK, cramming over 60 billion transistors onto a single chip. This is equivalent to packing 700 million transistors into an area no bigger than the head of a pin.

3. This industrialization trend has enabled products like a Smartphone from e.g. Apple or Samsung to pack in over 100 billion transistors is an affordable pocket-sized product that would otherwise have required the space of 60 Football pitches and cost over 100 billion pounds, quite a remarkable achievement.

4. This industry growth has been fueled by the industry's ability to constantly reduce the transistor's size, cost and energy consumption whilst at the same increase its functionality and performance making products ever more useful and affordable and creating new products and markets that were impractical or unaffordable using then existing techniques.

5. Whereas early applications and markets were limited to e.g. mainframe computers and telephone exchanges, today's applications touch almost every aspect of our private, academic and business lives in fact it is hard to think of any product that does not either directly or indirectly depend on a chip for its functionality or existence.

6. Yet to most people outside the industry, no-one really knew they existed, let along what they were although today, since the current semiconductor shortage hit the headlines in 2020 due to a particularly vocal response from the automotive industry, the average person has now at least heard the terms 'semiconductors' and 'chips'.

7. As a world leading industry analyst and expert, with over 50 years of industry experience, dating back to the first commercial IC, there is no reason to believe this 8 percent unit growth rate won't continue given there are a plethora of new applications in prospect, from automotive (driver assist to full automation), telecommunications (5G/6G), AI, Robotics, Energy conservation and so on … there is no shortage of market opportunities.

8. When measured in value terms has been much more volatile due to supply and demand economics and the difficulty in matching supply to demand. Chip factories take a long time to build and come on stream (two to three years minimum) and the production process to make the chips is also very complex and long (at least four months plus the queuing lead time). The design process also takes typically two years making forecasting demand and balancing supply very hard to predict, especially two to four years out. This has caused the average selling price (ASP) of chips to fluctuate wildly over the years and created periods of over and under supply (this current market shortage is the 16th in the industry's history) so the industry growth measure in value has varied from + 60% to -40% on an annualized basis.

9. The average number of chips produced and sales revenue generated per unit area of production has been remarkably constant over the industry's life with just a 1-2% productivity gain, meaning the average market growth when measured in value has been around 6% per year. Again, there is no known reason why these factors are likely to change anytime soon.

10. From a UK perspective, the picture is not so bright. At the end of the last decade, Europe accounted for just over 20% of the chip market (i.e. where the chips were sold and built into end products), more or less inline with its share of global GDP. The UK represented one third of this total, slightly ahead of its GDP share. Today, Europe's share has dropped to just under 9% overall with the UK's share under 20% or just under 2% of the global chip market.

11. Its share of total chip production (i.e. where the chips are made) has seen an even more dramatic fall, from a similar 20% share of the total to around 6% for Europe and under 1% for the UK.

12. To a certain extent this has been caused by the reduction in market demand (market pull) but mostly it has been due to a policy decision at the public (EU and local governments) and private (industry and the financial community) levels. The rise in popularity of outsourcing (offshoring) over the past 20 years has been predominantly financially motivated and not technology / science driven.

13. The UK chip industry's research and R&D activities have all been extremely well-supported by broad and effective government policies via e.g. its IntellectUK and Clusters programmes but the UK has seriously lagged behind the US and Far East, including China, in turning all this accumulated scientific know how and world-class expertise into manufacturing prowess to secure the UK's global market position and strength. There is no reason why, given a supportive national strategy, the UK cannot reverse this situation.

2. What is the UK's semiconductor supply chain and is this secure? If not, how can this be improved? What specific strengths does the UK have to contribute to regional or global semiconductor supply chains? How competitive is the UK within the global context of the semiconductor industry?

14. When the chip industry first started all firms had to make all the elements in the supply chain, including the materials and production equipment, but as time went on, the supply chain disaggregated and specialist firms focused on different parts of the chain. This resulted in both an acceleration of progress and the economic benefit of scale. As a result, the chip industry supply chain today is one of, if not most, complex and disaggregated in the world.

15. For the most part it has been relatively secure, other than times when an earthquake has destroyed a factory which transpired to be the global sole source for a particular plastic resin, but equally industry as a whole, not just in the UK, has taken supply chain security as a given. The recent conflict in Ukraine has however shown supply chain security can no longer be taken for granted.

16. Popular, often government inspired as with the US and EU Chip Acts, solutions to solve this have proposed onshoring as the answer but these options will generally prove both impractical in practice and lead to excessive duplication with the associated financial consequences.

17. Given the complexities involved, any practical solution needs to be on a trusted partnership strategy not on a self-sufficiency basis.

18. At the end of the day, industry must take responsible for its supply chain security, either individually or collectively as a consortium, advising government on where deficiencies exist and what political support is required.

19. The UK is generally not viewed as a global chip industry powerhouse, but it has demonstrated and attained global dominance in several key areas, e.g. ARM and Imagination Technologies chip design IP and GSS, a Glasgow University spin out, recently acquired by Synopsis, the world's leading chip design automation supplier, in advanced transistor modeling techniques. INMOS, whilst unsuccessful as a chip firm, developed world-leading IP that is still the heart of several signal processing applications and Graphcore is currently leading the world in competition with the US giant NVIDIA in advanced AI processor technology. Graphene, a Manchester University invention, now being developed for the chip industry in Cambridge; Rockley's ground-breaking work in Photonics; and Compound Semiconductors, an emerging new chip areas critically important for power, energy saving and communications applications, are all areas where the UK could not only to contribute to, but also become, world leaders in tomorrow's regional or global semiconductor supply chains.

20. As mentioned before though, this will not happen unless the UK develops a semiconductor industry strategy supported by broad and effective government policies to turn this scientific know how and world-class expertise into manufacturing prowess. One key element here is local access to a silicon foundry to support the development of the prototype parts and processes.

21. Newport Wafer Fab in South Wales used to successfully service this activity but this avenue is now denied since the Chinese-owned Nexperia acquired the factory last year, forcing Rockley to find an alternative source in the US and leaving the UK's compound semiconductor cluster without an alternative option, seriously undermining this crucially important activity.

22. As demonstrated by ARM, Imagination Technologies, and GSS, there is no reason the UK cannot be competitive within the global context of the semiconductor industry in the areas it chooses to specialise in.

3. Are there opportunities for strengthening different parts of the current UK semiconductor industry? What are the potential weaknesses and strengths of the UK semiconductor industry to meet future requirements of electronic device manufacturing?

23. The biggest weakness in the current UK semiconductor supply chain is the lack of market pull. It has a relatively small local end-product base to sell into support its R&D costs. Policies need to focus on encouraging firms to increase their UK manufacturing, especially in the new market areas (AI, Robotics, High-Performance Computing) and automotive, building on the UK's UK's leadership in fom;a ona Formula One, the hotbed for all advanced automotive systems development and to encourage vertical co-operative clusters to bring new ideas to market fruition.

24. Despite having left the EU, the UK also needs to make sure it is still able benefit from, and contribute to, the various EU Horizon and Chips Act programmes so avoid costly duplication and unaffordable high budgets, now funded only by UK government and industry rather than these costs being shared across many parties and countries.

25. This would also ensure that the UK chip industry was robust enough to both entice new graduates into a high-tech industry career and to retain those who have recently graduated.

4. In which industries does the UK not have an end-to-end semiconductor supply chain? Are there any opportunities for these supply chain gaps to be filled within the UK?

26. As mentioned previously, no country in the world has a complete end-to-end semiconductor supply chain and such an objective would be unrealistic to attain, even in China with its deep industry support pockets and ambitious self-sufficiency goals. Even if it were somehow attained, it would be an economic and financially unsustainable own goal. As mentioned earlier given the complexities and practical obstacles (the UK doesn't even have all the natural resources needed) involved, any practical solution needs to be on a trusted partnership not on a self-sufficiency basis.

5. How can the Government strengthen semiconductor research and innovation? Are there any current areas of weakness in the present Government strategy to semiconductor innovation? Is there effective communication between the various stakeholders within the UK's semiconductor ecosystem?

27. As mentioned earlier the UK government's past and present programmes have always been both generous and effective in supporting advance research and, whilst academicians and research groups will inevitably always ask for more, there is no need for any additional support programmes over and above what is already in place.

28. What has been disappointing though is the UK government's return on these investments when measured in terms of increased global market share or contribution to UK GDP. One is minded to point out ITRI's mission statement "All research must have market potential and be of benefit to Taiwan's industry."

29. What the government ought to consider is adding an element of accountability to its support policies whereby applications are obliged to quantify the research's intended end market

value potential and customers as well as a competitive analysis and justification. It might also consider adding in a level of accountability by offering support by way of loans rather than grants repayable once the research has generated commercial viability in much the same way as the Airbus Industry support model works.

30. Another idea is to insist all publicly funded research programmes have equal parallel funding from an industrial partner, preferably someone who will be an end customer of the research.

6. Does the UK have the required skills, talent and diversity to be able to boost its current semiconductor industry and to respond to future disruption?

31. All regions in the world complain of a skills and talent shortage but the UK is probably in a worse position than most. Part of the problem stems from the fact there is a lack of industry jobs available, other than in research and design, and part of the problem is universities still seem to consider non-academic or pure research vocations as second-class career options.

7. What are the potential national security concerns or vulnerabilities in our semiconductor industry? How should the UK collaborate with the United States and European Union? What are the ramifications on other industries and the wider economy within the UK?

32. Most of the UK's remaining semiconductor production fabs are building older technology products, such as Newport Wafer Fab (NWF), now owned by Nexperia, and this has given rise to several representatives from industry, academia, management consultants, the media and even some industry analysts commenting that these technologies are 'old hat' and cannot be considered a national security concern. This is very far from the truth.

33. First it ignores the fact that in re three parts to NWF's portfolio, the silicon power side (currently the largest sales volume) plus the photonics and compound semiconductor activities, both of which, as previously mentioned, are at the global cutting edge of technology.

34. Second, even the most advanced fighter aircraft, tanks, missiles, ships, communications devices, robotics, computers, automobiles, and so on all depend on 'old' technology as well. They are all operationally useless without the types of part made at 'old' fabs like NWF. This is exactly why these 'old' fabs still exist, are still in demand, and why Nexperia was so determined to buy the fab in the first place.

35. Allowing the fab to be sold to Nexperia, a fully owned Chinese-firm has created a serious economic and security risk to the UK with Rockley now forced to develop its technology and manufacturing capability in the US vs. the UK; the CS Cluster left without any access to an open foundry and NWF's power semiconductor technology and manufacturing IP and knowhow shortly to be transferred to Wingtech's (Nexperia's owner) new high volume power semiconductor plant in Shanghai China partially funded by the Chinese government.

36. The unintended consequences of allowing the acquisition to proceed are the loss of a key new emerging photonics technology to America; undermining the success of the UK's key compound semiconductor project (it now has nowhere to go to for its semiconductor production and providing direct and free support to China's ambitious semiconductor strategy.

37. not The current semiconductor shortage has shown that cars have been left unfinished for want of an 'old technology' power semiconductor device needed to activate the brakes, wind

down the windows or operate the seat or wing mirror adjustment, with huge economic consequences for both the car firm and UK GDP. Likewise, a missile or a 5G radio could be rendered unusable for want of a similar ‘old technology’ part in its bill of materials (BOM) and thus carry a real national economic and strategic risk.

38. Belgium (Imec), The Netherlands (ASML) and Germany sit at the heart of the EU's (and in the case of Imec and ASML) the global semiconductor industry, with the whole world completely dependent on the technologies developed in Imec and the lithography equipment developed and made by ASML.

39. ARM benefited enormously from its collaborative work with the EU research programmes which were instrumental in its IP becoming a common European standard. Were the UK’s semiconductor industry to cease co-operation with EU, it would be a spectacular own-goal and impossible for the UK to finance and resource the lost funding support even it was feasible, which it unequivocally is not.

40. The US semiconductor industry is notoriously poor at collaborative activities, even amongst their own, so it is unlikely the UK will find viable opportunities there.

41. As for encouraging US firms to build semiconductor fabs in the UK, whilst the UK was the location of choice for foreign chip firms in the 199os, primarily because of it language (the chip industry’s lingua franca) and also because the UK was seen as the gateway to the EU, no-new we have spoken with today in our work considers this an option. It is interesting to note that Intel, the world’s second largest chip firm after Samsung, has recently trawled the world openly seeking highest bidder incentives from various governments to build an advanced semiconductor fab in their country never even bother to stop off in the UK, choosing instead to build its European facility in Germany.

8. Is the Government currently providing the clarity and direction required to enable growth and security in the semiconductor industry? Are the right governmental organisations involved with ensuring effective development of our current semiconductor industry to thrive in the future?

42. The single biggest problem in providing clarity and direction is the fragmented nature of all the non-industry interested parties involved. Two distinct government department (BEIS and DCMS) both seem to have responsibility but it is unclear to industry exactly who is responsible for what (and thus who to talk to); academia seem to be more interested in fighting their own corner and protecting their own turf rather than cooperation with each other creatin duplication and inefficiency; and, in the same way, there are far too many trade bodies for an industry of such relatively small size, all stepping on each other’s toes. The industry would benefit from a more rational and simpler structure.