**Emerging technologies assessment 1 leftover/backup text**

The recent developments in quantum computing have shown that such powerful machines could become a reality sooner than we might think, in this paper I have shown the inherent benefits of such a technology, its limitations, its applications and how it will affect us.

1. **Introduction**

Quantum computing was born from the need for immense computational power, as Moore's Law states, the number of transistors on a microprocessor continues to double every 18 months

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which up to this point has been proven true, Perez-Delgado, Carlos A and Kok, Pieter (2009, p.1) state *"These devices hold the promise of vastly increased computational power in simulating quantum systems, which in turn may lead to fundamentally new quantum technologies"* therefore we clearly have a need for computational speed and quantum computers can be seen as the next logical step in obtaining more computational power. This can be used for security reasons as modern computers today cannot efficiently perform integer factorisations,

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a quantum computer could solve this and in doing so be able to decrypt much of the current cryptographic systems in use today.

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As very little has changed in terms of quantum mechanics in the past decade however certain applications have been developed that make use of this theory such as cryptography in the encryption and decryption of messages, this view has been supported in the work of Rae (2011).

**SUPERPOSITION, QUBITS**

1. **Applications and Implications**

The most important features of quantum computers is the ability to perform tasks much faster than a classical computer, however specific algorithms need to be put in place that make use of quantum parallelism.

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When put into place a quantum computer could perform simulations much faster than a classical computer, these simulations could be used to design better quantum systems, it would allow for simulations with huge numbers of objects in them such as Britain's several forms of public transport, the simulations would detect flaws in the current systems and allow for adjustments and the designs for the most cost-effective way of overhauling the system. This would mean improved travel times, reliability and less expense on fuel, therefore this would save the transport companies money bringing down the cost for passengers needing to get where they need to such as their work, meaning they have more money to spend in shops on items they simply couldn't afford due to travel costs which helps boost the economy, all the while they have a transport service which is greatly improved, meaning they are less likely to be delayed or even unable to get to work for example which helps the business that they work for as more employees on time and working equals more productivity and therefore profit, which again helps boosts the economy. Therefore the simulations quantum computers could perform would allow for great improvements in everyday life, industry, it would be a point of great scientific discovery and potential.

A quantum computer could be the way that a true artificial intelligence (AI) is born as quantum theory suggests that every physical object is in one way or another, a quantum computer and therefore computers will be able to imitate conscious thought leading to an AI.

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Should a quantum computer be built with the potential of conscious thought, an AI will be born and could perform a multitude of tasks much faster than we could such as predicting the weather, this would make the predictions much more accurate, an AI could handle transport, an AI would be able to drive a vehicle with more care and attention than a human driver ever could, this would improve travel times and decrease vehicle related deaths thereby providing a more efficient transport service which would affect the economy as well by having goods reach their destinations much faster than before and have it immediately reported should something disrupt travel times such as theft, making transport services more efficient and reliable.

The social implications of quantum computers could be quite vast as should a quantum computer lead to the birth of an AI then a great deal will change in how we see our society, we may one day see every day technological objects that we have today become much more than that in the future, if an AI was placed in these objects they could become friends or trusted companions etc, they would be able to share our views, feelings just like a normal human being. Eventually these AI could be placed into mechanical bodies of their own in order for them to not only be perceived as more like a human and therefore be more easily accepted by society, but they could also play a physical role in society such as supplementing a human work force or even replacing it entirely.

There is a technology that is similar to this that is available today although far less advanced, the robot shop assistants or 'saya' as it is called will allow for many ways to assist shoppers such as where to find a certain product or even have a regular conversation with shoppers.

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Although this is useful it does not allow for the wide interactivity that another human can provide, this is something an AI especially one with a mechanical body of its own can replicate and therefore be more readily accepted by society, it also cannot perform any complex tasks such as physical labour something that an AI would be able to achieve.

This would allow for industries to prosper with the more efficient work force as well as giving people a greater quality of life if they are not needed to perform menial tasks such as stacking shelves or other forms of unskilled physical labour. It would challenge people to get a better education and with the rapid changes and advancements in technology there will be many jobs requiring much greater skilled labourers than in the past, this would push society to become smarter and in effect help the advancement of the human race. Therefore there are many benefits to the birth of an AI, however there are also dangers to a sentient machine as science fiction has shown if something were to go wrong it could be very bad for us as a species and so certain precautions must be taken, I believe though that the benefits outweigh the risks and therefore it is worth attempting to make an AI.

1. **Limitations**

The first quantum computer built, the D-Wave one, which uses the principles of quantum computing but is debated as to whether it is a 'true' quantum computer, was bought by Lockheed Martin a leading company for defence and aerospace. The technology at its current stage is still highly experimental and very expensive to produce, the D-Wave one in particular costs $10 million and is housed in a ten square metre shielded room, therefore quantum computers are still quite far from replacing supercomputers.

The hurdles that must be overcome for quantum computers to become a reality are vast and diverse, one such problem is the need for the right software, for example quantum algorithms that will allow the user to get the result they are looking for while taking advantage of the inherent quantum parallelism in quantum mechanics to achieve the immense processing power that today's supercomputers are unable to provide. One of the greatest advantages of quantum computing is being able to complete tasks in parallel to an exponentially large superposition

In terms of cryptography if a sufficiently powerful quantum computer could be programmed to make use of Shor's algorithm, a quantum algorithm designed to solve the problem of integer factorisation of large numbers, the quantum computer would then be able to break the RSA scheme the widely used public-key cryptography scheme and in effect be used to decrypt much of the security placed on the world wide web for example. This would also allow for greater protection of assets on the World Wide Web as it gives rise to post quantum cryptography as based on developments in quantum computers, research has begun in this field to secure resources on the World Wide Web for example, from quantum computers. This is supported by the work of Benenti, Giuliano (2007), Strini, Giuliano (2007).

However pioneering scientists and companies across the globe are pushing to make this a reality due to the benefits such a technology would bring and it is likely that when quantum computers become available a 'quantum revolution' will take place where quantum computers may well become a stepping stone to greater things such as quantum communication, quantum metrology and several forms of nanotechnology etc, much like the industrial revolution. This is supported by the work of Ladd, T D (2010) and Jelezko, F (2010) and Laflamme, R (2010) and Nakamura, Y (2010) and Monroe, C (2010) and O'Brien, J L (2010). Therefore this shows that there is a need for faster computers not only for the defence market but also for all of society as well.

1. **Similar Technologies**

Quantum Entanglement is a similar technology whereby if two or more distinct objects are linked or entangled, then no matter how far they are from each other, if one of the pair is affected in some way the other will be as well instantaneously. This can be used to transfer information instantaneously; this also potentially solves the problem of affecting quantum computers integrity simply by observing it. Therefore by using quantum entanglement to collate results without observing the quantum computer itself we can create a practical quantum computer.

Another similar technology is quantum teleportation, instead of using quantum mechanics to build extremely fast computers, some scientists hope to take the science fiction of teleportation and turn it into science fact. Although it will be many years before we can teleport a human, scientists have already begun to make progress in this area as in 2012 a macroscopic object was teleported to another.

1. **Conclusion**

In conclusion this paper has given a brief introduction to quantum computing, stating the possible benefits, limitations, similar technologies and the implications such a technology could have on the world.