Discussion-2 New technologies may lead to a series of unintended consequences

<u>Discussion Topic:</u>

New technologies may lead to a series of unintended consequences. However, fear of those consequences may slow changes that can be beneficial. However, fear may slow beneficial change. Jasanoff asserted we should combine the "can do" of science and engineering with the "should do" of ethical and political analysis (Winston & Edelbach, 2014). Take a specific example of technology and explain how these two have been or might be combined.

<u>My Post:</u>

Hello Class,

In the era of AI, quantum computing can be as transformative a technology as AI itself. Google introduced the Willow quantum processor in December 2024 and Microsoft's Majorana 1 topological chip in February 2025. Both chips are Quantum Processing Units (QPUs); however, their approaches to quantum computing differ significantly. Whatever quantum computing technology comes to dominate in the near future, the combination the AI and quantum computing technologies will bring about an era reminiscent of science fiction movies that will have a profound transformative impact on humanity. This sparks today, a mix of extreme excitement and deep concerns. Although quantum computing combined with AI offers the potential for unprecedented positive technological advancements, it can also lead to very serious negative consequences. This is a reminder of the tension that can exist between the "can do" of science and engineering and the "should do" of ethical and political analysis (Winston & Edelbach, 2014). This post provides an overview of quantum computing, examines Google's Willow and Microsoft's Majorana 1 Quantum Processing Units (QPUs), discusses the benefits and risks of quantum computing, especially when combined with artificial intelligence (AI), and explores the ethical questions "can do" versus "should do" regarding these technologies.

Overview of Quantum Computing

Quantum computing uses the quantum mechanics superposition and entanglement principles to perform computations. Unlike classic computing which uses bits (1s and 0s) to encode information, quantum computing uses qubits (0s, 1s, and superposition). Bits represent two possible states of a system ‘1’ and ‘0’ (Microsoft, n.d.a). On the other hand, qubits represent the possible quantum states of a system, and a quantum system can be in three different states one of them is superposition which allows a quantum system to exist in multiple states simultaneously. In other words, a qubit can be in a superposition of 0 and 1, allowing multiple computations in parallel by processing all possible states of the qubits at once. This will allow, theoretically, to compute answers to problems that would be impossible to solve using even the most powerful supercomputers that humanity could ever build (Domain of Science, 2024). However, quantum chips are very vulnerable to noise which generates errors in qubits. Before the Willow and Majorana 1 QPU chips noise was the obstacle to achieving reliable quantum computation. Both chips address the noise problem, each using their own approach. While Goole Willow's approach focuses on error correction, using a combination of software and hardware, to mitigate the noise and decoherence, Microsoft's Majorana 1's approach uses quantum topology to resist noise and decoherence at the chip level by using a novel topoconductor material. Google labels the Willow chip as an experimental device, while Microsoft describes the Majorana 1 as a prototype with the potential to scale to a million qubits on a single chip, claiming that the first fully functional quantum computer would be a reality within a few years. The table below compares the features of the chip and their error rates.

Table 1

Willow Features vs Majorana 1

Feature	Google's Willow	Microsoft's Majorana 1	Error Rates
Qubit Type	Superconducting qubits	Topological qubits	Willow: Reduced by half with each increase in physical qubits Majorana 1: Reduced by a factor of ten compared to traditional superconducting qubits
Number of Qubits	105	8, can scale to 1 million	Not directly comparable due to different qubit technologies
Scalability	Error reduction with scaling	Designed to scale to a million qubits	Majorana 1 offers a 10,000x reduction in physical footprint compared to competing systems
Error Correction	Error suppression through scaling and surface codes	Inherent error protection through topological qubits and measurement-based approach	Both aim for fault-tolerant quantum computing, but with different strategies
Strengths	High qubit count, high quantum score in benchmark tests	Qubit stability, potential for massive scalability, simplified error correction	
Current Status	Experimental device	Early prototype	

Note: The table compares the different features and error rates of the Willow QPU from Google and Majorana 1 QPU from Microsoft. From several sources (Nayak, 2025; Domain of Science, 2024; Trueman, 2025; Microsoft, 2025b)

As shown in Table 1, both chips are state-of-the-art; however, Microsoft's Majorana 1 appears to have an advantage due to its topological design, which provides more stability, scalability, and error resistance and has the potential to be implemented within a fully functional quantum computer within a few years rather than a decade.

Benefits of Quantum Computing and Impact on AI

Once fully functional quantum computers become a reality, they will transform various fields and elevate AI capacities to levels impossible to imagine, unveiling possibilities beyond what we can currently comprehend. For example, quantum computers can simulate with ease molecular behavior and biochemical reactions which when combined with AI could massively speed up the research and development of life-saving new drugs and medical treatments. For a similar reason, it could immensely accelerate the discovery of new materials such as advanced composites, superconductors, etc. revolutionizing industries like energy, manufacturing, and environmental science. They could have a considerable impact on AI research and training by accelerating training runs and optimization, enhancing model complexity and creativity, and improving the robustness and generalization of the AI model (Fowler, 2024). As well as improving data processing for AI training, enhancing encryption and security within AI applications, and combining quantum computing with neural network architectures (Kiessling, 2024; Quantinuum, 2025)

Quantum Computing Risks and Ethical Isssues

However, quantum computing also raises several risks and ethical issues such as data security and cybersecurity which are already an issue due to the "harvest now, decrypt later" attack, where malicious actors collect encrypted data today with the intention of decrypting it later when quantum computers become available (Bown, n.d.). Additionally, quantum computing could exacerbate inequities between rich and poor countries by limiting access to advanced computing power (Boger, n.d.). Moreover, it could bring into existence AI systems so powerful that they could outsmart humans, potentially leading to a complete loss of control and even posing an existential risk to humanity.

"Can Do" and "Should Do"

Both Google's Willow chip and Microsoft's Majorana 1 chip promise to bring immense benefits to humanity and they exemplify the "can do" spirit of scientific research, technological innovation, and engineering, sitting at the boundary of humanity's understanding, knowledge, and technological capabilities. However, the ethical "Should do" question arises: should humanity develop such technology that, if combined with AI, could bring catastrophic consequences like loss of control and existential risk? This ethical question cannot be answered without considering its geopolitical counterpart: "Should we develop such technology and combine it with AI, knowing that if we do not, someone else will anyway? In the technological AI/Quantum Computing race in which the US and China are locked, the countries perceive the "Should do" statement not as a question with a choice but as a must driven by national security and global dominance.

-Alex

References:

Boger, Y (n.d.). *Ethics and quantum computing.* Scientific Computing World. https://www.scientific-computing.com/article/ethics-quantum-computing

Brown, L. (n.d.). *Understanding quantum risk: The threats posed by quantum computing*. GRC Viewpoint. https://www.grcviewpoint.com/understanding-quantum-risk-the-threats-posed-by-quantum-computing/

Chamber, A. (2025, February 20). *Microsoft unveils Majorana 1, its first quantum processor chip.* Technology Record. https://www.technologyrecord.com/article/microsoft-unveils-majorana-1-its-first-quantum-processor-chip

Domain of Science (2024, May 13). *Microsoft's Topological quantum computer explained* [video]. YouTube. https://www.youtube.com/watch?v=ihZXl33t8So&t=17s

Fowler, G. (2024, May 14). *How quantum computing will impact generative AI.* Medium. https://gafowler.medium.com/how-quantum-computing-will-impact-generative-ai-779ba190cf18

Kiessling, C. (2024, December 20). *Quantum computing and AI – A superpower in the making?* Roland

Berger. https://www.rolandberger.com/en/Insights/Publications/Quantum-computing-and-AI-A-superpower-in-the-making.html

Microsoft (n.d.a). Superposition. *Explore quantum.* https://quantum.microsoft.com/en-us/insights/education/concepts/superposition

Microsoft (2025b, February 19). *Microsoft's Majorana 1 chip carves new path for quantum computing.* Microsoft. https://news.microsoft.com/source/features/innovation/microsofts-majorana-1-chip-carves-new-path-for-quantum-computing/

Nayak, C. (2025, February 19). *Microsoft unveils Majorana 1, the world's first quantum processor powered by topological qubits.* Microsoft. https://azure.microsoft.com/en-us/blog/quantum/2025/02/19/microsoft-unveils-majorana-1-the-worlds-first-quantum-processor-powered-by-topological-qubits/

Neven, H. (2024 December 9). *Meet Willow, our state-of-the-art quantum chip.* Google Blog.https://blog.google/technology/research/google-willow-quantum-chip/

Quantinuum (2025, January 22). *Quantum computers will make AI better*. Quantinuum. https://www.quantinuum.com/blog/quantum-computers-will-make-ai-better

Spinq (2024, December 18). *Meet Willow, Google's latest breakthrough in quantum chip.* Spinq.

Trueman, C, (2025, February 15). *Google CEO: Practical quantum computers likely still a decade away.* DCD. https://www.datacenterdynamics.com/en/news/google-ceo-practical-quantum-computers-likely-still-a-decade-away/

Winston, M., & Edelbach, R. (2014). *Society, ethics, & technology (5th ed.).* Wadsworth Cengage Learning.