Welcome to the Quantum Age…

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I hope to achieve two objectives with this article. First, make the case that quantum computing will eliminate uncertainty. Secondly, describe what we, as risk management practitioners, must do to remain relevant in the Quantum Age.

First of all, lets tackle the idea that quantum computing will eliminate uncertainty.

Quantum computing will likely be mankind's most disruptive technological innovation, ever. Quantum computing, coupled with AI, will profoundly impact every aspect of human life. Quantum computing ushers in the most dramatic changes to the risk management profession since Giolama Cardano wrote *The Book on Games of Chance* in 1520.

Google recently debuted their new quantum computing chip, Willow. Willow performs computations within a nanosecond that would take today's most sophisticated supercomputer more than 10 septillion years to compute.[1] This massive computing power will effectively eliminate future uncertainty and will dramatically change the risk management profession forever. As I read this article about Willow, I found it extremely difficult to comprehend the scale of Google's claim. I spent the better part of a week studying, analyzing, and plugging numbers into algorithms just to be able to understand the sheer magnitude of these numbers.

I have been involved in modelling and simulation for many years, so I have a good understanding of complex models, model variables, simulation runs, etc. So, I decided to use a global climate model (GCM) to help further my understanding. GCMs are highly complex models with hundreds to thousands of variables such as temperature, humidity, water vapor droplet size, soil temperature, water temperature, water salinity, and thousands more variables. Essentially, to construct a GCM, the earth is divided into 1 kilometer (km) grid squares. The earth model is composed of 500 million horizontal grid squares and 50 billion vertical grid squares.[2] Once the model is constructed and variables set, simulations are run to determine what weather can be expected in each 1 km grid

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[1] Vallance, Chris. 2024. "Google Unveils 'Mind-Boggling' Quantum Computing Chip." *BBC News*, December 9, 2024.
[2] Schultz, Philip A., and David M. Lawrence. 2024. "High-Resolution Land Surface Parameters for Kilometer-Scale Earth System Modeling." *Earth System Science Data* 16: 2007–2024. https://essd.copernicus.org/articles/16/2007/2024/.

square at a particular point in time. That all sounds simple enough but let's now look at what that really means.

A GCM requires at least 3 quadrillion calculations per simulated day. It would take today's fastest supercomputer approximately 4 months to complete a one-year climate simulation.[3] A one century simulation would then take approximately 25 years to complete. This is where quantum computing gets very interesting. The fastest supercomputer today is El Capitan at the Lawrence Livermore National Lab.[4] El Capitan performs approximately 2.79 quintillion (279 followed by 15 zeros) instruction per second. In contrast, Google's Willow quantum computing chip performs approximately 1.0512 duodecillion, that's 10,512 followed by 38 zeros. That means that Willow can create a one century GCM simulation in 1 sextillionth of a second instead of El Capitan's 25 years.

Let me briefly illustrate what that has to do with eliminating uncertainty. Using Willow, we can do the following:

- Select a 1 km grid anywhere on earth,
- Pick any point in the future,
- Envision a 1 in 100 million weather event,
- Run a Monte Carlo simulation that would give us a 99.99% chance of correctly predicting the 1 in 100 million weather event occurring in the exact 1 km grid.

With Willow, we can do this 4.28 billion times per second.

Quantum computing gives us the ability to create extremely complex models with thousands of variables and have a 99.99% chance of being correct about virtually <u>any</u> future event. This effectively eliminates just about all uncertainty for any event or scenario that human beings can imagine.

Now, on to the second objective of this article, what we, as risk management practitioners, must do to remain relevant.

The first question risk practitioners are likely asking themselves is, "If we eliminate uncertainty, what does that mean for us?" The short answer is that we must pivot and think differently about our profession. Quantum computing will fundamentally reshape the risk management profession, requiring risk practitioners to pivot and re-skill if we wish to

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[3] Neumann, Peter, Peter D. Düben, Pantelis Adamidis, Sergey Aloyan, Peter Bauer, Matthias Brück, and Nils P. Wedi. 2018. "Assessing the Scales in Numerical Weather and Climate Predictions: Will Exascale Be the Rescue?" *Geoscientific Model Development* 11 (4): 1665–1681. https://gmd.copernicus.org/articles/11/1665/2018/.

[4] Axios. 2024. "El Capitan Becomes the World's Fastest Supercomputer." *Axios AI Plus*, November. https://www.axios.com/newsletters/axios-ai-plus-1d219430-cebf-11ef-94d9-fb20818cb525.

remain relevant in this new era dominated by quantum computing and AI (aka The Quantum Age). Collectively, AI and quantum computers will completely take over traditional risk management tasks such as risk identification, risk response planning, risk prioritization, risk reporting and likely other aspects of traditional risk management. The elimination of uncertainty requires risk practitioners to prioritize strategic planning, organizational resilience, and key risk indicators (KRI) over nearly all other traditional risk management practices. The risk practitioner's key role in the future will be to become experts in the organization's strategy and understand how emerging risks will impact that strategy. We must become highly proficient at creating models so that we can recommend to Leadership the best way for the organization to pivot and avoid emerging risk or capitalize on emerging opportunities. We must become experts in planned resilience and adaptive resilience. Lastly, we must become KRI gurus so we can develop reliable early warning systems that inform us about which of the thousands of risks and opportunities are most likely to occur and what the risk velocity is for each.

In conclusion, I would like to offer some food for thought. First, we can argue that Google's claim about Willow's performance is exaggerated or atypical of most applications. But, the fact remains that even if Willow's performance is half or a quarter of Google's claims, we will still be able to develop highly complex models with thousands of variables and get to 99.99% likelihood of occurrence in hours or days versus centuries with today's fastest supercomputer. Secondly, combining AI with the massive computing power of quantum computing will profoundly change every aspect of our lives. Finally, regardless of the effects of AI, quantum computing, climate change, geopolitical upheaval, and other major disruptors, adaptive resilience will be an excellent personal and organizational trait that will help both individuals and organizations thrive in the great unknown, referred to as the Quantum Age.