

Nadia Zlateva, How business prepares now for the quantum computing future, NCC BG and NCC UK: Collaboration and Twinning Activities, 18-20 July 2022, Sofia, Bulgaria





Even though artificial intelligence (AI) and machine learning (ML) are taking center stage in the world of emerging technologies, there's another technology that is slowly making its presence known to society – quantum computing (QC).

New quantum machines such as **Google**'s Bristlecone chip and **IBM**'s Q initiative are already appearing in headlines.

IBM has also provided public access to an online quantum computer for research and experimentation purposes.

IBM's Q quantum computer



The basic mathematical framework for quantum mechanics was originally developed in the early part of the 20th century by Niels Bohr, Werner Heisenberg, Erwin Schrödinger and Paul Dirac.

Now, 100 years later, the **EY "2022 Quantum Readiness Survey"** investigates how UK organisations are beginning to explore a fundamentally different type of computer.

It is time for business leaders to begin planning for this new era of QC. Although a commercially viable, fault-tolerant and fully error-corrected quantum computer is yet to be built, the power of quantum computers is increasing rapidly.



In addition, public and private investment is growing quickly

According to a McKinsey report, announced investments into quantum technology companies in 2021 amounted to \$1.7 billion, which represents approximately 20 times the amount raised by the sector five years prior in 2016 and more than a two-fold increase on 2020. That number is forecast to skyrocket to \$15 billion by 2028.

New technology start-ups are being created every year and higher-education institutions have begun to answer the call for more quantum talent. Already, organisations have access, via the cloud, to quantum computers that allow them to start to develop solutions for challenges that will never be fully solved using classical computers — in areas, such as optimisation, search and materials discovery.

Start-up activity and investments in quantum computing have skyrocketed since 2015.

Volume¹ of raised funding, \$ millions



¹Based on public investment data recorded in PitchBook; actual investment is likely higher.

²Public announcements of major deals; actual investment is likely higher.

³Start-ups from 2019 and later are likely still in stealth mode or are not yet recognized as quantum-computing companies by relevant platforms and experts. Source: PitchBook; McKinsey analysis



If current trends persist, QC is likely to cause disruption sooner than many people think.

For some organisations, this will create enormous opportunities. For others, considerable risks.

Whether a business thrives or fails in the coming years will depend, on its overall readiness.

The fast-developing ecosystem, increasing investment, and accelerating research breakthroughs in QC signal it's time for executives to consider the technology's business implications.



As for the naysayers who say quantum tech won't be ready for live deployment any time soon, the industry also suffers from a hype problem - capabilities being exaggerated and even some accusations flying around of alleged falsification, as with the example of quantum startup **lonQ** that was recently accused by *Scorpion Capital* of misleading investors about the effectiveness of its quantum hardware.

"There are impressive advantages that pre-quantum or quantum-inspired technologies provide. Some companies are exaggerating the time scales. If quantum computing gets overhyped, we are likely to face the first quantum winter." Joseph Reger, *Fujitsu CTO*



Fujitsu is itself developing quantum systems, and announced earlier this year that it was working to integrate QC with traditional HPC technology. The company also unveiled a high performance quantum simulator based on its PRIMEHPC FX 700 systems that it said will serve as an important bridge towards the development of QC applications in future.



EY "2022 Quantum Readiness Survey" was completed in collaboration with the National Quantum Computing Centre, UK



From February to March 2022, a total of 1,516 UK-based executives were approached for their views on the opportunities and challenges associated with QC, and how if at all, their organisations are preparing for it.

To take part in the survey, executives had to demonstrate at least a moderate — but preferably a high — level of understanding of quantum computing. Of the **1,516** people approached, **501** met this requirement and completed the survey. All these respondents have senior roles in their organisations.

The respondents' organisations are distributed across 11 sectors, with financial services, health and life sciences, and automotive and transportation the most widely represented. The respondents work in medium-sized or large organisations, with annual revenues ranging from £350mn to over £14bn.

Quantum-generated disruption will occur within the next five years, believe surveyed UK executives



The data shows that, in the UK, nearly all (97%) of the 501 executives surveyed expect QC to disrupt their sectors to a high or moderate extent. Nearly half (48%) believe that QC will reach sufficient maturity to play a significant role in the activities of most companies in their respective sectors by 2025. Yet, no more than one-third (33%) of the organisations have already begun strategic planning to prepare for the technology's commercialisation. Furthermore, only 24% have set up pilot teams to explore its potential, or are currently working to do so.

Given that QC is emerging at different rates in different sectors, it is unsurprising that there is such a patchwork of maturity levels in the UK. The practitioners consulted predict different rates of commercial maturation, but none doubts its potential impact.



Executive views differ — in some cases significantly — as to when QC will play a significant role in their respective industries.

Consumer products and retail executives are most optimistic: nearly **70%** foresee a decisive degree of maturity by 2025.

A majority (56%) of telecoms, media and entertainment, and technology (TMT) executives expect the same in their sector within the same time.

However, most respondents in health and life sciences firms, in contrast, anticipate progress to take longer, with maturation being reached at some point between 2026 and 2035.

"Quantum will be a hugely disruptive technology, causing shifts in business models. The biggest risk for companies is failing to recognise when this shift is happening." Steve Brierley, Chief Executive Officer of **Riverlane**

Use-case exploration



Research into commercial applications that QC can enable is well under way.

Organisations are focussed on identifying those use cases most likely to generate value.

The most frequently cited categories overall involve the use of QC to enhance AI and ML (ranked first, for example, by financial services respondents), and in simulation and modelling tasks (involving, for example, better understanding of new materials or chemical reactions).



More UK organisations need to start laying the groundwork for their future use of QC.

In keeping with their overall optimism, most respondents say that their firm will be taking concrete steps within one and two years to prepare for the arrival of QC in their organisation. Within this timeframe:

- **72%** will have embarked on strategic planning relating to QC
- **68%** will have set up a pilot team to explore its potential for their businesses
- **71%** will have appointed executives to lead QC efforts

The gap between industry sectors is relatively small, despite some sectors (including TMT and financial services) often being much further ahead in related technology areas, such as HPC and AI. This could simply be due to the nascent state of the QC industry in general.

This ecosystem is growing fast



The biggest skills challenge with QC, say **55%**, will not be in finding people who can make the technology work, but in finding business leaders who know how to take advantage of it.





Leaders outside the QC industry can take five concrete steps to prepare for the maturation of QC:

- 1. Follow industry developments and actively screen QC use cases with an inhouse team of QC experts or by collaborating with industry entities and by joining a CQ consortium.
- 2. Understand the most significant risks and disruptions and opportunities in their industries.
- 3. Consider whether to partner with or invest in QC players—mostly software—to facilitate access to knowledge and talent.



4. Consider recruiting in-house QC talent. Even a small team of up to three experts may be enough to help an organization explore possible use cases and screen potential strategic investments in QC.

5. Prepare by building digital infrastructure that can meet the basic operating demands of QC; make relevant data available in digital databases and set up conventional computing workflows to be quantum ready once more powerful quantum hardware becomes available.

Businesses that expect to see disruption in their industry within the next three or five years need to act now



The **EY** survey reveals a disconnect between the pace at which some industry leaders expect quantum to start affecting business and their preparedness for those impacts.

For example, companies with quantum processors have increased the power of their hardware dramatically over the past several years, from just a handful of qubits to over a hundred in the case of IBM, which expects to deliver a 4,158-qubit system by 2025. Yet despite these advances, quantum computers remain a curiosity, with most operational systems deployed in research laboratories or made available via a cloud service for developers to experiment with.

"Quantum readiness is not so much a gap to be assessed as a road to be walked, with the next steps in the process being regularly revisited as the landscape evolves" Piers Clinton-Tarestad" EY's Quantum Computing Leader



While the **EY** report warns about companies potentially losing out to rivals on the benefits of QC, there are also dangers that organizations should be preparing for now, as **Intel** warned about during its Intel Vision conference in May'22.

One of these is that quantum computers could be used to break current cryptographic algorithms, meaning that the confidentiality of both personal and enterprise data could be at risk. This is not a far-off threat, but something that organizations need to consider right now.

"Adversaries could be harvesting encrypted data right now, so that they can decrypt it later when quantum computers are available. This could be sensitive data, such as your social security number or health records, which are required to be protected for a long period of time.", Sridhar Iyengar, VP of Intel Labs



• QC may just be emerging from science labs, but its transformative potential suggests that businesses have no time to lose in preparing for it.

In brief

- When it will become commercially viable is uncertain, but UK executives and experts expect QC to be disruptive in several sectors.
- Fewer than 1/3 of the UK organisations have embarked on strategic planning for quantum, highlighting the importance of becoming quantum ready.



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Thank you for your kind attention

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Here two atoms are shown to be entangled. The line connecting them is just for visual purposes. https://c.tenor.com/H-I0vC5AM5kAAAAC/entanglement-quantum-entanglement.gif