

EVENT TITLE: Quantum Computing: Staying Ahead of the Technology Curve (What Board Directors Need to Understand)

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PROGRAM SUMMARY

Quantum computing is emerging as one of the most consequential technological developments of the coming decade, with the potential to reshape industries, challenge existing cybersecurity frameworks, and create new competitive advantages. During this NACD New England virtual program, experts provided directors with an overview of how quantum computing works, where the technology is advancing most rapidly, and what boards should begin considering now from a governance and strategic oversight perspective. While practical quantum advantage has not yet been fully realized, progress is accelerating quickly, underscoring the importance for boards and management teams to begin building awareness of both the risks and opportunities this technology may present.

Understanding the Fundamentals of Quantum Computing

Quantum computing represents a fundamentally different approach to information processing than traditional computing. Classical computers rely on binary bits that represent either a zero or a one. Quantum computers instead use quantum bits, or qubits, which can exist in multiple states simultaneously through a phenomenon known as superposition. In addition, qubits can become entangled, meaning their states are correlated with one another and can process information collectively.

These properties allow quantum computers to evaluate many possible solutions to complex problems simultaneously. As a result, quantum systems may eventually solve certain classes of problems exponentially faster than classical computers.

Although the theoretical principles behind quantum computing were first proposed decades ago, technological advances have only recently enabled the construction of scalable systems. Early prototypes have progressed from small experimental devices to processors capable of operating with hundreds or thousands of qubits. While practical quantum advantage has not yet been fully realized, experts suggested that the pace of progress has accelerated significantly in recent years.

The Growing Quantum Ecosystem

Investment across the technology sector reflects growing confidence in the potential of quantum computing. Major technology companies such as IBM and Google are investing heavily in research and infrastructure, while venture capital and strategic investors are supporting a rapidly expanding ecosystem of specialized quantum startups.

Governments around the world are also making substantial investments in quantum technologies. National initiatives focus on advancing research, strengthening supply chains, and developing specialized workforces capable of supporting this emerging field. These investments reflect both the economic potential and the strategic importance of quantum computing.

For corporate leaders, the scale of global investment signals that quantum technology is moving beyond theoretical research toward practical commercialization.

Emerging Business Applications

While most commercial applications remain in development, several promising use cases are already being explored.

One major opportunity lies in drug discovery and life sciences research. Quantum computers can simulate molecular interactions with far greater accuracy than classical systems, potentially enabling researchers to model complex proteins and enzymes more efficiently. This capability could significantly accelerate the development of new drugs and medical treatments.

Another important area is financial modeling and portfolio optimization. Financial institutions routinely analyze vast numbers of variables when pricing derivatives or managing investment portfolios. Quantum systems may eventually allow these complex models to be evaluated more quickly and accurately.

A third emerging application involves supply chain and logistics optimization. Transportation networks, manufacturing schedules, and distribution systems often involve extremely complex variables. Quantum computing could help organizations identify more efficient routes, schedules, and resource allocations.

Across industries, quantum technology offers the potential to address problems involving large-scale optimization, simulation, and advanced data analysis.

The Convergence of Quantum Computing and Artificial Intelligence

A particularly important development is the growing intersection between quantum computing and artificial intelligence.

Today's AI systems operate entirely on classical computing infrastructure, but quantum computing may eventually expand the capabilities of machine learning models. Artificial intelligence is already helping researchers design and optimize quantum hardware, improve error correction systems, and develop new quantum algorithms.

In turn, quantum computers may eventually provide AI systems with access to new forms of data and computational power, particularly in areas involving molecular simulation and complex optimization problems. As these technologies mature, hybrid computing systems that combine classical, AI, and quantum capabilities may become increasingly important.

Governance Implications and Strategic Risks

For boards of directors, one of the most immediate considerations involves cybersecurity. Many current encryption systems rely on mathematical problems that are extremely difficult for classical computers to solve. Quantum

computers may eventually be able to solve some of these problems far more efficiently.

If that occurs, certain widely used encryption standards could become vulnerable. While such a transition is unlikely to happen suddenly, organizations will need time to adapt their cybersecurity infrastructure to emerging post-quantum cryptographic standards currently being developed by institutions such as the National Institute of Standards and Technology.

Directors should therefore begin evaluating their company's exposure to cryptographic risk and ensure management is assessing preparedness for emerging post-quantum security standards. At the same time, quantum computing presents opportunities for companies that can use the technology to improve analytics, optimize operations, or develop new products.

Board questions to consider include: Has management assessed the organization's exposure to quantum-related cybersecurity risks? What steps are being taken to monitor emerging quantum technologies and evaluate potential business applications?

Preparing Organizations for the Quantum Era

Although most companies are not yet deploying quantum computing solutions directly, experts emphasized that organizations should begin building quantum literacy among leadership teams and boards.

Initial steps may include educating technology leaders on the fundamentals of quantum computing, assessing where advanced computing capabilities are critical to the business, and monitoring developments across the rapidly evolving quantum ecosystem.

Some organizations are also beginning to experiment with early quantum platforms available through cloud providers. These pilot programs allow companies to gain familiarity with the technology and evaluate potential applications before large-scale adoption becomes necessary.

Developing awareness today will help organizations respond more effectively as the technology continues to mature.

As quantum computing continues to advance from research to practical application, boards that begin building awareness today will be better positioned to oversee emerging risks, evaluate strategic opportunities, and guide management through the next wave of technological disruption.

Experts also noted that the pace of development in quantum computing has accelerated significantly in recent years. Capabilities once expected to take a decade or more may arrive much sooner, reinforcing the importance of early awareness and ongoing monitoring by boards and management.

KEY TAKEAWAYS:

Build Quantum Literacy Now

Boards and executive leadership teams should begin developing a foundational understanding of quantum computing and its potential implications for their industries.

Evaluate Cybersecurity Exposure

Quantum computing may eventually challenge existing encryption standards. Directors should ensure management is assessing the organization's readiness for post-quantum cryptographic requirements.

Monitor Strategic Opportunities

Quantum computing may unlock new capabilities in areas such as drug discovery, financial modeling, logistics optimization, and advanced analytics.

Start Planning Before Disruption Occurs

Although practical quantum advantage has not yet been achieved, progress is accelerating. Organizations that begin evaluating risks and opportunities today will be better positioned as the technology matures.

Prepare for Accelerating Technological Change

Quantum computing is advancing faster than many experts previously expected, with meaningful capabilities potentially emerging within the next several years. Boards should monitor developments closely and ensure management is periodically reassessing both risks and strategic opportunities as the technology evolves.

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