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RISK & INNOVATION

# The Big 3 Coming Technological Game-Changers

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## OVERVIEW

Predicting the next game-changing invention is a difficult business.

Sometimes, the value of new technologies is not realized as they first emerge. Former IBM President Thomas Watson infamously predicted, "there is a world market for maybe five computers" back in 1943.

Other times, the potential of new developments can be vastly overstated. In 1955, Alex Lewyt of the Lewyt Vacuum Cleaner Company forecasted that nuclear-powered vacuum cleaners would be a reality within a decade — as optimistic a notion as the perennial predictions of flying cars and jet-packs.

But if you get it right – preparing for the change in advance, or investing in the new field early – the business opportunities are immense. Early adopters can reap the rewards of new markets, while considering potential disruptions from emerging technologies in advance can minimize the upheaval when they arrive.

There are three technologies being developed in laboratories around the world today that really could revolutionize the way the world works, sending shockwaves through the global economy – if some of their last major challenges can be overcome. Within the next decade, breakthroughs in nuclear fusion could bring unlimited energy, quantum computing could herald a new age of analysis and innovation, and the miracle material graphene has so many potential applications it's hard to keep track. Are you ready for the opportunities – and threats – that these technologies of the future could bring?

# IN DEPTH

### Quantum computing

First theorized in 1980 by Paul Benioff of the Argonne National Laboratory in Illinois, quantum computers work at a subatomic level, but their small processors aren't the only radical feature. Where a modern computer's binary approach only allows one calculation per bit, quantum computers can perform millions of simultaneous calculations per "quantum bit" (qubit), making them trillions of times faster and more powerful than our computers today.

Although there have been several experiments proving the basic concept of quantum computing over the last couple of decades, a more scalable, practical device has eluded researchers. But in April 2015, IBM announced a breakthrough: a new method of measuring and correcting quantum state errors that could make production of larger-scale quantum computers realistic. Estimates of how long it will take range from five years to several decades, but with Alibaba and Intel both announcing significant new investments in quantum computing research in late summer 2015, the race is on.

While the potential positive impact of faster computers on fields like big data analysis could revolutionize countless industries, the key challenge will be security. With the arrival of viable quantum computers, most existing algorithmic security systems will become obsolete overnight. Some banks are already investing in developing sophisticated post-quantum cryptographic systems in preparation for the new quantum age. With cybercrime and security breaches an increasing concern for many organizations, getting ahead of the curve on quantum security already makes sense.

### Nuclear fusion

Nuclear fusion is what powers the stars. The holy grail of energy production, it promises a source of clean, cheap and near-infinite power that is small and portable enough for companies to have their own office power station, or even to fit into airplanes and ships. Unlike nuclear fission, which powers current nuclear reactors, nuclear fusion is fuelled by abundant hydrogen (rather than rare radioactive elements), and its waste poses a minimal pollution threat.

The challenge has long been in containing and channeling fusion reactions into usable energy — until recently. In 2013, the U.S. National Ignition Facility announced that they'd achieved this for the first time, albeit only for a fraction of a second. The milestone was quickly accelerated when Lockheed Martin's Skunk Works lab announced earlier this year that a compact fusion reactor was only 10 years away. With plenty of other organizations experimenting, the race is on.

However, opinion is divided – with some of the fundamentals still unsolved and huge investment needed to overcome current challenges, some argue that despite the promise of cheap, infinite energy, rather than hold out for fusion, for businesses looking to reduce the impact of energy price volatility, solar panels and wind turbines remain a safer short-term bet.

**Graphene**

This allotrope of carbon is a wonder material — a single atom thick, 200 times stronger than steel by weight and nearly transparent. It is also the most efficient conductor of heat and electricity yet discovered.

Graphene's suggested potential uses are numerous: A lighter alternative to carbon fiber or steel; "atomic scaffolding" to give strength to other materials; an atomic-scale lubricant; hugely efficient electrical circuitry and storage; flexible computer screens; filtering water of impurities; wearable solar cells; even treating cancer.

First theorized in 1962, graphene was not successfully produced until 2004, resulting in a Nobel Prize in Physics for Andre Geim and Konstantin Novoselov of the University of Manchester. The challenge has been mass production – a problem several companies now claim to have solved. With the European Union investing €1 billion over 10 years in graphene research, the revolution could soon be upon us.

While graphene may have the most obvious potential to disrupt the manufacturing and electronics industries, it could also impact healthcare, cosmetics and more. It will also reduce costs for every business once it becomes more easily manufactured. For now, it remains one to watch, and possibly to investigate further — because whomever makes the first big breakthrough in bringing graphene-based products to market could end up monopolizing an entirely new industry.

# POINTS OF VIEW

"Quantum computing could be potentially transformative, enabling us to solve problems that are impossible or impractical to solve today... This could have enormous potential in materials or drug design, opening up a new realm of applications." – Arvind Krishna, Senior Vice President & Director, IBM Research

"If it is truly possible to bottle up a star, and to do so economically, the technology could solve the world's energy problems for the next 30 million years, and help save the planet from environmental catastrophe" – The New Yorker

"We don't want to claim that we're going to solve all of humanity's problems, but we are in for a very interesting next 10 years." – Andrea Ferrari, Graphene researcher, University of Cambridge

# FURTHER READING

When You Wish Upon a Star: Nuclear Fusion and the Promise of a Brighter Tomorrow – The Observer, January 25, 2015

The Golden Age of Quantum Computing is Upon Us (Once We Solve These Tiny Problems) – Fast Company, May 2015

The Drive to Realize the Graphene Opportunity – Materials Today, June 2014