

The Technological Arms Race

Implications for investors

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We are often reminded of the sage advice from Sir John Templeton: "The four most dangerous words in investing are 'this time it's different'." As investors, we need to question whether we are entering a new technological and machine age over the next 10-25 years that could disrupt most businesses and possibly society as we know it. In this regard, the new technological and machine age may be more important than the industrial revolution. Quite possibly, this time it is different and whilst heeding Sir Templeton's advice, as prudent investors we cannot ignore the technological developments that are almost certain to provide substantial threats and opportunities to businesses.

There are numerous powerful lessons on the rapid disruption of businesses from technological innovation. In 1998, Kodak sold 85% of all photographic film, by 2012 it filed for bankruptcy. What is surprising about the Kodak story is that it invented the digital camera, yet was effectively destroyed by its own invention. Nokia became the world's largest mobile phone manufacturer in 1998 with a 40% market share. In 2013 Nokia sold its loss-making mobile phone business to Microsoft. Google was founded in 1998 and by 2015 had grown its share of the global advertising market to 14%, while newspapers' share of global advertising fell from 35% in 1999 to 12% in 2015.

Perhaps more importantly, large scale/global disruption from technological advancements appears to be occurring at a faster and faster pace. Consider Uber - founded in March 2009 and is now the world's largest 'taxi company'. Facebook was founded in February 2004 and now has in excess of 1.6 billion monthly active users, while Airbnb was founded in August 2008 and is now the world's largest accommodation company.

Exponential versus linear growth

It is difficult to comprehend that we could rapidly face a radically different world from the advancement of technology when our own experience suggests that fundamental change is occurring incrementally and at a gradual pace. A reason why we may be underestimating the impact of technological change is that most changes in our life (like ageing, learning, career progression, etc.) occur in a well-established linear trajectory whereas technological progression is exponential. This means that technology evolves at a multiplying rate rather than at steady intervals.

There are numerous examples of technologies progressing at an exponential rate. Three well cited examples are:

1. **Computational power** - Over the last six decades, computational power has increased over one trillion times per integrated circuit, roughly doubling once every two years. An iPhone 5 released in 2013 has twice the processing power of the 1985 Cray-2 supercomputer, which at the time was the world's most powerful computer.

2. **Genome sequencing** - When the project to sequence the human genome was started in 1990 it was thought it would take thousands of years to sequence the entire human genome (six billion bases). The full genome was sequenced 10 years later. In 2000, the cost to sequence an entire human genome was around US\$100 million and by 2015, the cost had fallen exponentially to US\$1,000.
3. **Data** - It has been estimated that the amount of digital data in the world is doubling every two years. Estimates suggest that more data has been created in the past two years than in the previous history of the human race.

In order to predict what will happen in the future through technological change, investors need to extrapolate and think exponentially. Ray Kurzweil, a natural language processing pioneer and entrepreneur, a renowned futurist and currently Director of Engineering at Google, wrote in a March 2001 paper titled "The Law of Accelerating Returns":

"An analysis of the history of technology shows that technological change is exponential, contrary to the common-sense intuitive linear view. So we won't experience 100 years of progress in the 21st century, it will be more like 20,000 years of progress (at today's rate)."

Are we nearing a tipping point in the development of artificial intelligence?

Artificial intelligence (AI) is the field of computer science involved with the development of computer systems capable of performing tasks normally requiring human intelligence. According to Nick Bostrom, an Oxford philosopher and leading artificial intelligence thinker, the progression of artificial intelligence can be thought of in three stages.

1. **Artificial Narrow Intelligence** is AI that specialises in one area, such as a computer beating the world chess champion or winning the quiz game, Jeopardy.
2. **Artificial General Intelligence (AGI)** is a computer system that is as smart as a human across any intellectual task (including complex reasoning, thinking abstractly and learning from experiences).
3. **Artificial Super Intelligence**, or Singularity, where computer intelligence surpasses human intelligence and then rapidly advances to be about a billion times more powerful than all human intelligence.

There is evidence that technology may be nearing a tipping point – technology is now advancing at such a rate that a breakthrough in AGI may be rapidly approaching.

We believe the world's major technology companies are collectively assembling the equivalent of the "Manhattan Project"

that led to the development of the atomic bomb in World War II. Companies such as Alphabet (Google), Facebook, Microsoft, IBM, Alibaba, Baidu, Amazon and Apple are investing unprecedented amounts of money in artificial intelligence research and development, expansion of computational power, collation of the world's data and knowledge, and assembling the world's leading intellectual capital.

Over the past few years there have been dramatic advances in machine learning, voice and image recognition, machine understanding of language (machines can now read and understand documents) and the early development of quantum computers. Each of these areas appear important in the development of AGI and it seems reasonable to expect accelerating advances in the years ahead.

Predictions

In making any predictions, and at the risk of appearing naïve in hindsight, we remind ourselves of the famous quote from one of the most prominent names in American Baseball, the late Yogi Berra: "It's tough to make predictions, especially about the future." With this 'health warning' it appears possible/likely over the next 10-20 years the following could occur:

- **Development of intelligent virtual personal assistants** that know who you are, understand natural language, anticipate what you want, read and understand your email, answer questions and organise your life. Early versions already exist, including Google Assistant, Apple's Siri, Facebook's M, Amazon's Alexa and Microsoft's Cortana.
 - **Development of augmented and virtual reality** which could ultimately become integrated communication interfaces, where a video or holographic representation of people you are communicating with are projected into your world. Initial applications of augmented virtual reality are focussed on entertainment, such as Pokémon Go. Over the longer term, virtual reality could replace any real world experience such as shopping or overseas travel.
 - **Digitisation of goods** via the mass commercialisation of 3D printing. With exponential reduction in cost and improvement in performance, 3D printing could ultimately result in most hard (and possibly soft) goods becoming virtual goods digitalised into a source code that could be downloaded and printed locally.
 - **Digitalisation/Automation of white collar tasks.** It is likely that advancements in artificial intelligence (machine learning, voice and language understanding, image recognition) could one day replace many white collar professionals.
 - **Development of advanced fully autonomous specialised robots** which could replace most highly specialised manual labour such as surgeons.
 - **Commercialisation of driverless cars and expansion of car sharing.** Development of driverless car technology is well progressed and could dramatically change how cars are used. Google's self-driving car fleet has driven more than 1.5 million miles with only one minor accident, demonstrably safer than humans.
- **Breakthrough advances in medical technology and longevity.** It appears likely with continued advancements in genome sequencing, epigenetics, gene editing and genomics, image recognition, machine learning, big data and nanotechnology/implantable devices that there will be major breakthroughs in medical science.
 - **Development of humanoid intelligent robots** (i.e. robots that look and sound and react exactly like humans) that could replace functions that require a human interface, such as a receptionist, a store assistant, a waiter or bartender.

Investment implications

It is likely that advancements in technology will disrupt many industries and economies over the next 10-20 years. As investors, we need to assess many issues that could arise from rapidly advancing technology, including:

- Are some industries safe or immune, and what will be the pace of disruption?
- Could personal digital assistants begin to erode the value of brands and advertising as a means of product discovery?
- Could 3D printing, driverless cars, machine learning and automation lead to massive labour displacement, in both manufacturing and transportation jobs, and persistent structural deflation?
- Can we rely on a rise in the middle class in emerging markets if manufacturing jobs are massively displaced?
- What assumptions should we make about longevity and the impact of aging?
- How do you value businesses in a rapidly disruptive world?

The implications of technological advancement for investors are many and there is still more to be understood. In our view, disruptive and profound changes to businesses, industries and economies from exponential advances in technology appear to be ever closer to our door step. As investors, we need to carefully weigh up nearer-term investment opportunities against the likelihood of exponential progress and be prepared and positioned for fundamental and disruptive change over the longer term. The risk is that we will fail as investors if we fail to see the future. This time it may well be different.

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