

A Signum Special Situations Report

# Artificial Intelligence

Strategic Investments  
2016 - 2021



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# Special Situations Report

## AN EXTRAORDINARY TRANSFORMATION is happening right now in business, society and the global economy.



A new form of industrial power is emerging that is driven by advances in the field of Artificial Intelligence...

It will disrupt companies in every industry...forcing them to adapt now or face being wiped out entirely.

**Artificial Intelligence (AI)** is an evolving constellation of technologies that enable computers to simulate human thinking – allowing them to learn, reason and take action all on their own steam.

It starts with machine learning – a type of AI that allows computers to learn and find patterns when exposed to new data....

This is the intelligence behind the **AlphaGo** algorithm that recently beat the world Go champion...

As you read these words, machine learning algorithms are feeding upon trillions of bits from our phones, homes, cars, websites, mines, hospitals, supermarkets and countless other locations.

And as AI continues to evolve, becoming increasingly ubiquitous, companies will invest billions to gain a foothold in a fast evolving system of intelligent machines.

There are very immediate implications for investors...

- **GROWTH OPPORTUNITIES** – AI is the next great instrument of industrial and economic change. In this report you'll discover how the spoils will go to companies who invested (and continue to invest) heavily in their AI capabilities.
- **TOXIC INVESTMENTS** – Up to 40% of companies currently quoted on mature stock exchanges will be wiped

out or acquired over the next five to ten years. You could be holding investments that are toxic to your portfolio. This report indicates those who could suffer.

- **NEW VALUATION TOOLS** – The tools we use for analysing companies are inadequate, we need new valuation methods and new metrics.
- **NEW RISKS** – The age of networked AI is not without inherent risks such as cyber attacks, flash crashes, black swans and compressed company lifecycles.

## What Every Investor Needs to Know ...

Just as it was crucial in the last decade for professional investors to understand what was happening in the financial system, the next decade will depend on our ability to understand the fast evolving and disruptive power of AI.

It is about understanding the forces, many of which are already unleashed, that are about to transform every aspect of society.

In fact, a new system has already been built up over the last decade that will see machine learning algorithms proliferate across society at an accelerating pace.

I've spent the last 45 years on the front line of tech developments, analysis and research. And I have never seen so many technologies come to fruition at the same time...from Big Data, to the Cloud, to machine learning and AI...

We are entering a remarkable period for business growth and investment as the AI convergence rapidly redraws the industrial and economic landscape.

The aim of this report is to help you take all necessary action.

# This is not a rehearsal...

AS YOU ARE ABOUT TO SEE, almost every sector and industry will be affected by AI: and your portfolio will almost certainly contain stocks that will require your personal review.

I have witnessed several false dawns in AI...

There was the famous Fifth Generation project by the Japanese government in the early 80s – an effort to produce a massively parallel computer that was supposed to signal a great new epoch in machine intelligence, but never materialised.

In the late eighties, there was a great deal of excitement about fuzzy logic and neural networks. That too failed to deliver on the hype.

The problem? Each of these systems needed constant intervention by humans – programming, inputting rules and tweaking.

The difference today is that we have created the perfect conditions for AI to take hold – a real-time environment for machines that allows them to constantly learn, communicate and access data from the physical world.

This is a highly complex field with many different threads and disciplines involved – my aim in this report is to simplify and give you the tools and resources you need to assess your current portfolio and take all necessary action.

We will identify the companies that will benefit most from these developments – a list of key trends and pioneering investments are included at the end.

This report also discusses the new tools and metrics that will prove most useful to assessing a company's relative technology prowess...

Ultimately, this report will give you some key actionable ideas and tips to protect your portfolio against the turbulence ahead.

# The AI Build-Out Phase

A KEY REASON for AI finally taking off is the success of **machine learning** – where computer **algorithms** are used to autonomously learn from vast streams of **data**.

This is the first instance of artificial intelligence that society will become comfortable with. Ultimately, it's about making ever more accurate predictions about what we buy, what we view and the patterns of our everyday behaviour.

Google uses machine learning to decide which pages to show you. Each time you use their search engine, Google's AI gets a little smarter...

Amazon uses algorithms to discover your tastes and monitor the price of competing products...

Although these smart algorithms seem like a recent development in fact, scientists had cracked the theories and maths of machine learning decades ago.

What was missing was the infrastructure to radically scale this intelligence across society – an infrastructure that Chinese and US tech titans (**Google, Alibaba, Facebook, Tencent, Amazon, Baidu**) have been furiously building for the last decade.

Three things were needed....

# A World of Sensors

MACHINE LEARNING NEEDS DATA to work just as we need food to function.

Thanks to the rapid adoption of smartphones and the proliferation of other devices in industry, vast networks have been established, connecting everything from cars and streetlights to elevators and fire alarms, and producing a flood of new data.

This is the Internet of Things (IoT) – a system of sensors that now outnumbers the human population of the planet.

By the end of last year, there were an estimated 9 billion ‘things’ connected to the Internet.

And some are predicting as many as 50 billion by 2020.

In the next few years, the number of connected machines will increase exponentially with the advent of the Industrial Internet of Things – a McKinsey report from last year predicted that the IoT <including the industrial internet> will become a \$11 trillion per year industry by 2025.

The impact of this transition was perfectly summed up by Professor Brian Arthur in a pivotal study for McKinsey:

“With the coming of the Industrial Revolution – from the 1760s when Watt's steam engine appeared to the 1830s – the economy developed a muscular system in the form of machine power.

Now it is developing a neural system. These individual machines and sensors are like neurons. And the axons and synapses are the communication pathways and linkages that enable them to be in conversation with each other and to take appropriate action.”

The emergence of this new machine-to-machine economy that is 'vast, autonomous, invisible' is now on track to grow to the same size as the overground physical economy by 2030.

## Super Computing Power

UNTIL NOW, the US and Chinese Tech Titans lacked the necessary computer power.

It took the power of 50 supercomputers to enable AlphaGo to play 1.3 million simulated games, and over 1,500 to perform in the competition setting.

Deep learning pioneer Geoffrey Hinton needed 16,000 computers at Google to run an algorithm that can recognise faces from 10 million random videos. Roughly 80% of the non-linear progress in machine learning is down to this availability of computer power.

China has several Tianhe-2 supercomputers – currently acknowledged to be the world’s most powerful supercomputers – at work on weapons development and genomic projects.

The gathering impact of the Cloud is also vital. This is where more of the world's computer power and intelligence will reside – available to all for hire on an as needed. It is and will be run by the dominant platform companies: Amazon, Microsoft, Google, Facebook, Alibaba, IBM and GE.

As Tech maverick Kevin Kelly points out:

“The AI on the horizon looks like Amazon Web Services – cheap, reliable, industrial-grade digital smartness running behind everything, and almost invisible except when it blinks off.

Like all utilities, AI will be supremely boring, even as it transforms the Internet, the global economy, and civilization.... This new utilitarian AI will also augment us individually as people (deepening our memory, speeding our recognition) and collectively as a species.”

## Human Brains

YOU NEED SMART PEOPLE TO MAKE SMART MACHINES and the tech titans have been in a frenzy to secure the services of scientists who develop autonomous machines.

Google paid \$400m to secure the AI talent at DeepMind.



Andy Ng / Chief Scientist / Baidu

Recently, Andy Ng, a disciple of Hinton and Facebook's own Yann LeCun, helped launch the Google Brain project but was poached by Baidu to lead a team of 200 deep learning researchers, all focused on developing algorithms capable of unsupervised learning.

In fact, there is still a very small pool of scientists with the training to make the big advances in machine learning.

## The Machine Learning Gold Rush

WITH THE ESSENTIAL infrastructure now in place, a vast, automatic and mutating global network of machines can go to work.

Free from the need for much external (ie: human) intervention, it will soon transact a huge proportion of the world's business as it becomes ever more responsive to our behaviour.

The AI effect will be felt across every sector – an economy where billions of machine learning algorithms are available, each designed to solve a specific problem, many of them improving as they interact and learn from each other.

## Healthcare

TAKE AN INDUSTRY LIKE HEALTHCARE, where digital health technology, sensors and data science will soon dominate. As complex algorithms process more data, we will see a feedback loop of advances in medicine that will disrupt current medical practice.

Hundreds of thousands, even millions of data on our blood, heart pressure, cells and DNA will be used to diagnose a medical condition or to continuously monitor a therapy or prescription as the phenomenon of the 'quantified, self-monitoring self' grows.

Companies like **Sentrian** are leading the drive towards remote monitoring.

As the price of wearable healthcare devices has fallen, patients can now carry biosensors – on their smartphones or on an adhesive behind the ear – with the kind of sophisticated technology that used to only be available in intensive care.

**Sentrian** has a number of wearable devices that collect data such as heart rate, blood pressure, oxygen, and feeds them to a cloud-based engine where machine-learning algorithms detect subtle patterns in chronic conditions such as heart disease, diabetes and pulmonary diseases.

**IBM's** Watson, cognitive super-computer, with a natural language Q&A process and medical expert systems has been helping oncologists in particular with diagnoses, treatment determination and therapy monitoring, and crucially is continuing to learn with each exchange.

Our smartphones and sensor-laden wearables will generate continuous insights about lifestyles, activities and habits to brief the likes of Watson, but will also feed info into global datasets.

**According to a report by Juniper Research, the global market of wearable smart devices will grow to \$19 billion by 2018.**

Another transformative force at work in medicine is genomics.

Thanks to the collapse in the price of DNA sequencing and genetic profiling, it is becoming feasible to collect vast streams of genetic information on conditions such as breast cancer and Huntington's Disease, and to take any appropriate measures.

**Illumina** is the clear leader in DNA sequencing technology, while China's **Shenzhen-BGI** <unlisted> is the world's leading sequencer and is accumulating huge datasets on the genetics of disease and other matters such as intelligence, leading to worries about a spectre of eugenics in the West if not in China itself or in Korea or Japan.

# Automotive

TODAY'S TYPICAL CAR IS A NETWORKED SUPERCOMPUTER on wheels processing streaming data from a host of onboard and external sensors.

With the advent of self-driving cars, we will see vast networks of communicating machines feeding data about travel patterns, congestion and intelligent driving habits.

Last summer for example, **Delphi Automotive** turned an Audi into a 'robo car' which successfully motored from coast to coast in the US.

Nine days after leaving San Francisco, the tech packed car rolled into New York after driving 3,400 miles, doing 99% of the driving, only yielding to the flesh and blood intelligence behind the wheel when it was time to leave the highway or negotiate a city street.

This has caused a fundamental power shift: from the legacy car makers to their key component suppliers – the auto component suppliers are not just supplying the 'input' end but also the 'backend' cloud services and smart online hubs that monitor and control many automated car systems.

As cars move towards full self-drive by 2022, the industry will be totally disrupted again by robot car pioneers **Google**, **Apple** and the Chinese internet giants.

# Agriculture

THE ERA OF PRECISION AGRICULTURE has dawned with networked self-drive tractors, automated combines, meter-by-meter real-time profiling of fields and micro-climates by satellites and surveillance drones to determine appropriate water, fertiliser and insecticide inputs daily or more frequently as appropriate.

For example, **Monsanto** is fast becoming an algorithmic precision agriculture operation. They acquired a company called the Weather Corporation, which literally analyses

microclimates meter by meter – a significant reason why Bayer is making a \$62 billion pass at Monsanto.

In fact, as the industrial internet grows, driven by autonomous machine-to-machine interactivity, the bulk of the world's business will be turned over to algorithms: from asset management to big machine maintenance, supply chain logistics, robot controls and 'smart home' orchestration.

For the past two years, the most advanced **Cybersecurity** systems have even been using machine learning to mimic the human immune system, first learning about the system itself, then spotting intruders by their actions.

Companies will know their customers like never before. Google's algorithms already largely determine what information you find, Amazon's what products you buy.

**Increasingly, humans will choose to trust platforms and services determined by math and code rather than ones mediated by humans.**

The Blockchain, a distributed ledger that can't be tampered with, will become a widespread means of exchanging digital assets without having to trust one another or another third party in the exchange process.

We will be surrounded by codes that make copies of themselves, and by algorithms that spawn more algorithms. As science historian George Dyson predicted...

"Some will code for music, some will code for operating systems, some will code for sprawling, metazoan search engines, some code for proteins, some code for DNA belonging to individuals who serve as custodian creators of more code".

There are three immediate implications for professional investors...

# 1. Growth Opportunities & Toxic Investments

WE ARE NOW entering a highly disruptive time for investors and business leaders.

According to recent research by the McKinsey Global Institute, a new digital divide is opening up. Leading sectors such as technology, media and financial services have increased their digital intensity four fold since 1997, with the greatest gains coming in the past decade.

Whereas laggard sectors such as government, healthcare, construction are being left behind.

With the exponential growth of the online world, a new breed of capitalists has emerged – exploiting the force of network effects, just as Microsoft did with such singular success with Windows in the pre-internet era.

These exercises in serial monopoly are the brain children and obsessions of their controlling fathers – Zuckerberg, Page, Brin and Bezos.

Each of these visionary entrepreneurs see themselves as mission control to the future: questioning everything on the fundamental assumption that the world doesn't work well and needs them and the technologies they develop to work better.

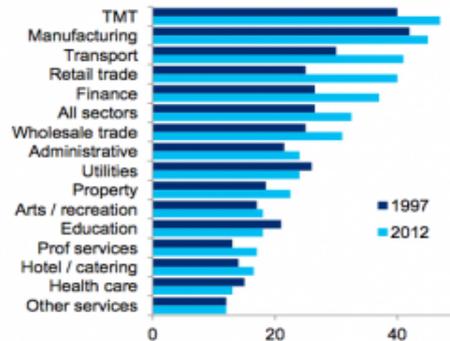
They've built wide and deep moats around their companies: neutralising the threat of invaders by acquiring them and/or scooping the pool of scarce computer scientists, data scientists and machine learning experts.

The chart below from a study by Citi's Matt King, tells a story of a seismic shift in power towards the top four firms in every industry – many of them thriving as they exploit data, analytics, machine learning and artificial intelligence – establishing a "winner takes all" philosophy where profits and value are largely created by a cluster of serial monopolies....

## Implication for profits

### The winners take all

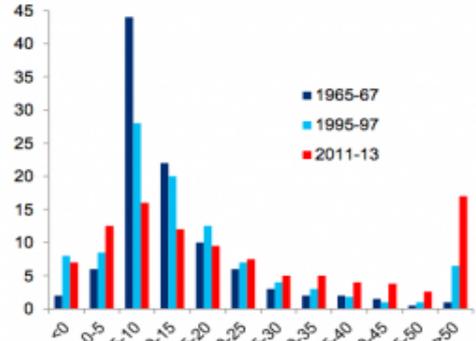
Top four firms' share of total revenue in each sector, US, %



Source: The Economist.

### Hard to be just moderately profitable

US companies' return on capital (ex goodwill), % of total companies



Source: McKinsey Corporate Performance Analytics, The Economist, BEA, Federal Reserve..

Source: Citi Research

As the build out continues, we'll see tremendous value created as devices and sensors are installed – **the IDC estimates that the Internet of Things market will grow to more than \$1.7 trillion by 2020.**

And the companies that gain control with hardware such as Amazon's Alexa and Apple TV – can establish huge profitable platforms.

This battle of the platform titans will dominate the next decade as **Amazon, Facebook, Google, Apple, Microsoft** and in China **Tencent, Alibaba** and **Baidu** fight each other to become the 'only one' – the only portal or mobile app anyone needs to go to for anything they want or need online...social networking, search, e-com, streaming entertainment, banking, business engagement.

These titans have spent years building up huge user bases, rich and evolving proprietary databases and algorithmic capabilities to get inside their users habits, preferences, wants and needs.

For now they are unlikely to be dislodged by any outsider or upstart. They can only dislodge each other. Facebook, for example, is out to 'get' Google.

In fact, there is a widespread acceptance that the data, network-centric methods of the Tech Titans will need to be adopted by everyone else.

There is a self-fulfilling feedback loop – the more data they collect, the smarter the algorithms get, the money is reinvested in AI, the more the company benefits from its digital intensity....

Within the next five years every established industry sector/company will end up in one of the following 4 situations...

## DESTROYED

REMEMBER KODAK?

At the height of its power, the photography giant employed more than 140,000 people and was worth \$28 billion. Today Kodak is bankrupt and the new face of digital photography has become Instagram – a company that was ubiquitous, powered from the Cloud and employing just 13 people when it was sold to Facebook for a billion dollars in 2012.

If you have one of these toxic stocks in your portfolio take emergency action (dump and switch to the disruptor). I am currently reviewing deeply vulnerable companies in several industries, more on those later.

## DISRUPTED

INDUSTRIES AND COMPANIES will be infiltrated, reconfigured and repurposed.

Uber is shaking up the taxi industry, AirBnB is redefining the hotel and tourism sector and Netflix killed the video rental business and now threatens TV.

Amazon was set up as a bookstore to collect data on the reading habits of the middle class. It used algorithms to learn our tastes, habits and undercut every other book seller, then it learned to sell everything else, becoming a global superstore, a hardware

manufacturer (**Alexa, Kindle**), a utility (**Amazon Web Services**), a video distributor and a production studio (**Amazon Prime**).

Many companies were wiped out in the process.

The same pattern will be repeated in every industry. Take the \$350 billion global semiconductor industry, which is shrinking almost as fast as the geometries of the transistors it fabricates.

Since 2013, a third of the Philadelphia SOX index has vanished through bankruptcies and largely defensive M&A, and a further 20%-30% are expected to go by 2018.

Rather than making chips and letting applications follow as happened for fifty years, the industry now needs to start with the applications — from smart phones, robots, cars, and data centres on the Cloud — and work downwards to figure out exactly what chips the Tech Titans need, embedding ever more “bang per watt”, sensors and security in their devices.

**Facebook** is already testing its own chip designs based on the workings of the neocortex and deep learning under the leadership of Yann LeCun, its superstar head of AI.

**Apple** is the stand-out among the ‘captive, fables’ chip operation. Its ARM-based A Series application management chips, the core of iPhones, far outperform rival offerings from such ‘merchant market’ heavyweights as **Intel, Qualcomm** and **Nvidia**.

This is indicative of how much disruption we will see as companies adapt to an AI-directed society. Moore’s Law has mapped the steady exponential progress of technology for decades, but as we abandon traditional hardware and cede control to intelligent machines, huge legacy companies will be exposed.

## ENHANCED

SWITCH-ON CEOS adapt or buy into new benign joint-ventures/partnerships with existing tech titans...

Take the example of industrial behemoth **GE**. A few years ago, GE got a big fright.

IBM and other IT service companies with big data and predictive analytic skills in their armouries were proving a lot better than GE at signalling when a gas turbine might fail or a jet engine component might malfunction.

This was an 'existential' threat to GE's huge industrial service and maintenance business, which manages contracts of over \$300 billion spawned by its \$60 billion a year industrial equipment business.

GE's chief honcho Jeff Immelt set about morphing GE into a 'software' driven company and is investing well over \$1 billion to do so – a mammoth task that is beginning to pay off...

By last year the company had scaled up to 40 billion sensors in its machines and equipment ranging from locomotives and wind turbines to jet engines feeding 'constant data to complex mathematical algorithms to streamline their operations and predict, prevent and where necessary repair maintenance problems'.

## UNTOUCHED

COMPANIES THAT REMAIN immune to AI developments... for now

A small group of companies will remain relatively immune to technology... not least sin stocks and those companies that have built moats of their own.

But all businesses, whatever they make, can benefit from lower costs, supply chain efficiencies, faster R&D, more targeted marketing communications. And all these things can be improved by experimenting with Big Data, Analytics and smart Machine Learning Algorithms...

In fact, a company's relative technology prowess – increasingly the extent to which it is an algorithmic company – will largely determine whether it can create, keep and grow customers profitably, and that'll

take the development and deployment of a whole new set of analytical tools.

## 2. New Analytical Tools

EVERY SUCCESSFUL investment professional needs to be hypersensitive to the potential impact of these tech forces on their portfolios.

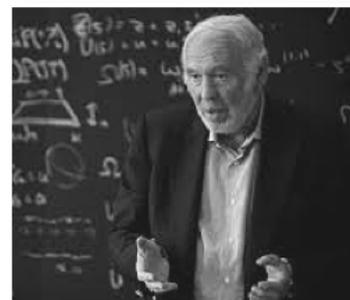
Leverage distorted our ability to value companies in the financial boom. And so it will be important to take a deep interest in how access to cheap, online intelligence will skew valuation – especially when born digital companies such as Uber can disrupt entire industries, armed with just a smart algorithm and a direct line to the Cloud.

Linear growth models no longer apply. And I believe that many analysts now rely on out-dated valuation models and business intelligence to make their decisions.

The unimaginable volume of data and rolling news feeds have made the traditional human-led backroom analysis as relevant as a 1950s typing pool.

A new kind of company analysis is needed.

Back in the 1980s, ex-CIA code cracker, world ranking mathematician and string theorist Jim Simons, built the first pure algorithmic **Math House** driven investment management company, Renaissance Technologies (Rentech).



Jim Simons  
Renaissance Technologies

Simons and his team of math heads and hard core quants kept throwing pattern-finding strategies at huge volumes of cleansed data from multiple markets and sources...

And they kept feeding them to optimise their algorithms and reveal trends, anomalies and to front run large transactions in the process of being completed in the market.

It was a huge success...

Rentech's founding Medallion Fund, averaged 71.8% annual return between 1994 and mid 2014. (Alas, it was closed to outside investors in 1993!)

Simons retired in 2009 and Medallion's fund performance is only known to the 'charmed circle' of 'insiders' under strict oaths of secrecy.

Rentech's success inspired outfits such as Winton and Cantab Capital to emulate Simons playbook of processing more and more data to become ever smarter at looking deep into both trends and human influences in the market.

Amazon is a company that has harvested these same methods – with a total focus on converting revenue into free cash flow to reinvest into fast improving its technology base and infrastructure and pricing the competition out of the market.

These methods that the Tech Titans are using – data, analytics, algorithms – will be emulated by every other industry. And they'll need to keep investing as companies compete in an AI system that is constantly mutating.

# Essential Investment Metrics

## 1. Digital Intensity

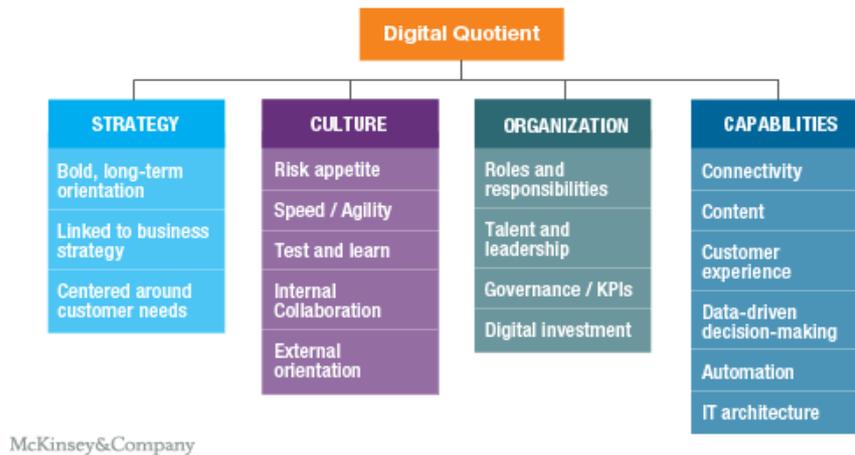
ACCORDING TO MCKINSEY, the new digital divide isn't about a reluctance to invest in equipment and systems; most sectors and companies now spend heavily on IT.

*"The gap is in the degree of digital usage. Digital engagement between companies and their suppliers and customers is five times larger in the leading sectors than in others".*

As you can see from the breakdown below, this engagement addresses strategy, culture, organisation and the data driven capabilities of the company. It is well worth using this McKinsey metric in your analysis -- it will certainly figure in my reports on AI investing in the coming months.

**Digital Quotient (DQ) evaluates four major outcomes**

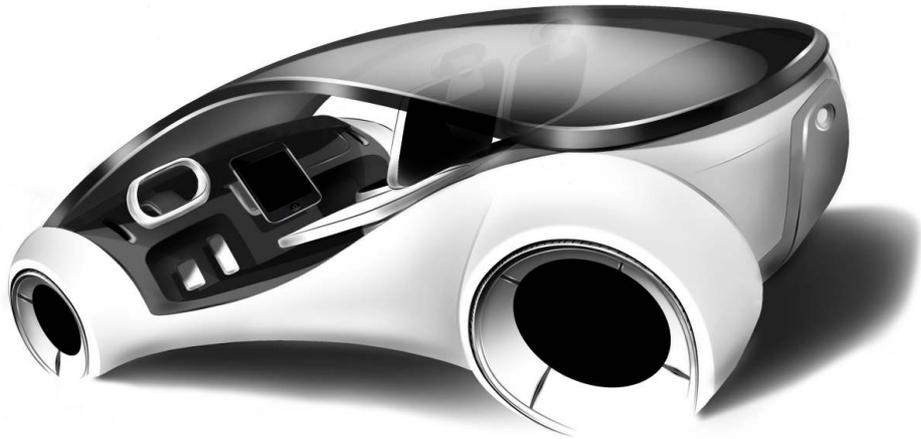
The maturity score determined by a DQ assessment directly correlates with digital and financial performance



## 2. R&D INTENSITY

COMPANIES NEED to continually reinvest and adapt to this ever evolving system. A company that directs a high proportion of its revenues into R&D, especially in machine learning and AI, will help the company adapt to faster product development cycles.

Apple, for example, has recently tripled the size of it's R&D spend in the effort develop it's next great product – the "Project Titan" electric vehicle.



With the declining pace of growth in iPhone sales, Apple is investing \$10bn in R&D this year alone -- a 30% increase on last year as it attempts to catch-up on developments in Artificial Intelligence by the other Tech Titans.

The stakes and competition between the Tech Titans will result in vast expenditure on R&D.

And that is true of any company who wants to adapt to an AI-directed society. To compete in this new environment, companies will need to invest very heavily in R&D.

This in turn will require an algorithmic research driven culture (a staff that complements computer scientists with neuro-computational experts, mathematicians and data scientists), and a fast evolving technology strategy.

### **3. USER BASE SIZE**

THE TECH TITANS have built up huge and rich user bases that allow them to test their algorithmic capabilities. And this is absolutely key to their ability to get inside their users habits, preferences, wants and needs.

The more data you have, the smarter your algorithms, the more your engineers can test and develop new algorithms that are increasingly tuned to the needs of your users.

These three metrics, and the culture that goes with them, feed into the **Technology Quotient** of a company – the Tech IQ. This is a shorthand for how well a company is adapting and adopting the cluster of AI technologies.

There is already a huge disparity between those invading and those with a low Tech IQ. I am currently preparing scores for a comprehensive list of blue chip stocks for investors – details to follow on that.

## 3. New Risks

THE IMPORTANT THING FOR INVESTORS now, is to be adaptive.

We need to rise above the noise of deals, hype, boom and bust and recognize who is actually leading this story.

That means digging into the personalities of the tech visionaries and recognising the key developments in making their strategy work...

It's how Google moved from search to digitizing society to speech and face recognition to neural networks and on to simulating the brain...

It's how Amazon plans to use Alexa/Echo to establish itself as a master console for all the devices in your home...

And how the other Tech Titans are looking to establish new platforms that a whole host of industries will have to adapt to.

It means recognising what companies have the intent and resources to adapt to this vision.

And who will be left behind...

## 1. Shortened Lifecycles

WE'RE FACING years of rapid, non-linear change. In short, life will speed up.

Today, the average age of a S&P 500 company is 12 years, having fallen from an average age of 40 years when the index was formed 40 years ago.

And we are about to see company lifecycles radically shorten again...

First, as a **Math House** company such as Rentech has shown, companies who feed vast streams of data to smart algorithms are much more responsive to change in an evolving economy.

Secondly, these companies can run entire businesses in **simulation** before risking a penny in the marketplace. Decisions can and should be made faster, organisational structures flattened, a culture of constant 'generate and test' fostered.

Third, there are increasing returns to scale. The more data, the smarter the algorithms, the more a company benefits, the more autonomous and intelligent the machines become.

Says physicist and computing pioneer Danny Hillis: "When you combine evolution with development, evolution can happen faster; the adaptive processes of development can fix the flaws in an imperfect evolutionary design. Things speed up."

There will be enormous **creative destruction**.

The AI boom will create systems of machines from different domains, all cooperating to support human activity...

Says Brian Arthur: "*Telecoms will allow digital elements to combine, sensing devices will perceive their environment and configure action...the result is a hitching together of domains from widely separated locations into temporary networks, connected collections of things in conversation, querying, triggering, executing. Aircraft*

*navigation is a good example – an onboard gyro communicating with GPS, navigational satellites, atomic clocks, autopilot, actuators to keep the flight in transit.”*

Sensors and machines will invade our homes, cars, smart cities – always operating in the background, guiding us.

We are likely to be living in smart cities that rest on a huge stack of sometimes fragile tech architecture.

Eventually, these smart systems will be self-assembling, self-healing, self-protecting.

In the financial boom, we saw vast new structures spring up to insure the system, to create systems of derivatives, to insure the systems of derivatives.

And humans will certainly react and create new systems as profits spike again...the economy mutating and rushing forward in ever shorter cycles of innovation.

Our role as technology evolves will be to combine technologies, to scale up, to direct combinatorial evolution. Uber used mobile and algorithms to create a business.

As each new layer of technology is added, we will see whole ecosystems spring up around them, feeding into the increasing complexity of order and decay.

In fact, we are using a bad metaphor when we talk about artificial intelligence.

Alan Turing preferred to call it "mechanical intelligence" – with large scale, algorithmic information processing that solves problems such as speech recognition, language translation, protein folding, stock market prediction...

And humans to drive how the system evolves...

## **2. Cybersecurity**

More and more serious disruption will come through cyber attacks by state agencies, terrorists, hackers and mischievous teenagers. We are at least five years away from fixing strong defences even at strategic hubs such as power stations.

### 3. Public Sentiment

There is no way of predicting how public tastes will swing away from technology and tech services. Who will be the next Kodak? Could there be a backlash over privacy, data collection, or the handing over of important decisions to machines?

### 4. Power & Politics

Governments will seek to intervene a great deal more in technology anyway. Many of these industries cross strategic interests, and we have seen from solar and wind power, that governments are willing to engage in extremely aggressive price wars in order to gain control of new industries.

### 5. Systemic Crises

Ultimately, we should be concerned about the risk of new **systemic crises**. We have been using computers to simulate complex systems for decades, and often in response to some new social menace.

In the 1960s, Thomas Schelling simulated white flight and segregation. In the 80s, Joshua Epstein and Robert Axtell looked at inequality, in the 90s, Dirk Helbing was worried about traffic jams.

Today, it's pandemics and financial contagion. We live in a world of radically integrating systems that are becoming increasingly dependent on each other.

As Dirk Helbing says,

“We are creating **highways for disaster** spreading. We will see many extreme events, we will see problems such as the Flash Crash, or financial crisis. That is related to the fact that we have interconnected everything.”

We might even have to develop the kind of international computational systems that Helbing is working on – a Living Earth Simulator that gathers data from multiple agencies and looks for early signs of pandemic, earthquakes and financial contagion.

In some sense, we have created unstable systems.

“We can show that many of the global trends that we are seeing at the moment, like increasing connectivity, increase in the speed, increase in complexity, are very good in the beginning, but (and this is kind of surprising) there is a turning point and that turning point can turn into a tipping point that makes the systems shift in an unknown way.”

These systems are **non-controllable, non-predictable**.

We won't even understand the intelligence of the machines that are guiding us, says Danny Hillis. “Still civilised humans are the world's most successful symbionts”.

## TAKE ACTION:

# Resources & Recommendations

## 1. Use This AI-Ready Checklist

IN THIS REPORT I promised to offer you immediate and practical steps. Here is a checklist that can help you identify the dogs and diamonds on your portfolio...

Quiz the CEO on proprietary algorithms and datasets the company claims to possess.

Test the top management on whether they have looked into actual and potential Cloud-based services that might become relevant to them.

Ask them which of their competitors they fear and to what extent it's due to their tech edge.

Check how alert they are to left field, unlisted companies scaling in and around their market, as well as to giant Internet platform companies moving into 'adjacent markets.' Check the company's patents, recent hires and what category of personnel it's looking to hire. These can usually be found in the public domain.

Check with HR what categories of personnel they are hiring, and how they set about it – e.g. which university faculties do they visit. Do they, for example, know the difference between a data scientist and a data manager when interviewing. Check the partners, outside parties and outsourcers the company works with, especially universities.

Go with a fine tooth comb into the allocation of the R&D budget, as appropriate. Try to visit the lab and talk in a casual way or as an enthusiast to some of the researchers to get them to talk freely.

## 2. AI Profits

Here are the key AI shaped trends Signum Investment Intelligence follows:

## Cloud Computing

**THE CLOUD** is where more and more of the world's computer power and storage facilities will reside – available for hire on an as-needed basis. It is and will be run by the dominant platform companies: Amazon, Microsoft, Google, Facebook, Alibaba, IBM, GE.

The gathering impact of the Cloud will enable small spin-out teams from universities and Tech Titans to get started at minimal cost, scale up rapidly and attack legacy companies out of left field.

Uber and Airbnb are warm ups for the main event. It'll also undermine the classic approach of the server and storage suppliers and enterprise software companies such as IBM, HP, EMC, Oracle although IBM is rapidly building itself up as a Cloud based supplier of cognitive computing and expert systems.

## Machine Learning

**THE BULK OF THE WORLD'S BUSINESS** will be turned over to algorithms, whether for asset management, big machine maintenance, supply chain logistics, advanced driver assist, robot controls or 'smart home' orchestration, as the IoT and the industrial internet grow and form a Second Economy driven by autonomous machine-to-machine inter-activity, which by 2030 will match the global physical economy in size.

## Cyber Security

**CYBER SECURITY** will remain an ever-rising concern until the rigorous software development methods used by the NSA or NASA become widespread, and the next generation of technology has security built in. We live in the age of 'megabreach' by State agencies <US, Chinese, Russian, N.Korean>, corporate spies, protest groups, mischievous teenagers.

The last two years saw high profile attacks on JPMorgan Chase, Sony, US Office of Personnel Management T-Mobile US and TALKTALK Telecom. The consensus among the experts is that for large industrial systems and, e.g., the electric grid, it'll be five to ten

years before they will be able to withstand heightened incentives to attack them. If, for example, headlined state sponsored cyber attacks become more frequent and/or more damaging, growth in IoT and the Cloud could be affected.

## Digital Industrial

THE **INDUSTRIAL INTERNET OF THINGS** is if anything under hyped, extreme security issues notwithstanding.

A McKinsey report last year predicted that the IoT <including the industrial internet> will be a multi-trillion dollar business by 2025 and that excluding smart phones, PCs, tablets and wearables the number of 'connected' devices could reach two billion by 2020.

Gartner puts the total number of 'connected' devices at over 20 billion by 2020. The point is that anything with a digital signature, and that's anything from a smart watch to a car tyre can be and is being connected up to the IoT.

And it's not just small devices, a 'thing' within the IoT will increasingly be a mine, a construction site, a farm or a supply chain, and the 'smart home' will involve a lot more than a thermostat with Amazon, Apple, Samsung, and Google, among others, in market creation mode.

For many the ultimate 'thing' will be the autonomous car due by 2025 with some 80-95% self-drive cars well before then. There are already autonomous urban buses, tractors, excavators and vans on the market.

## Blockchain

THE **BLOCKCHAIN**, a distributed ledger that can't be tampered with, will become a widespread means of exchanging digital assets without having to trust one another or another third party in the exchange process. Silicon Valley doyen Marc Andreessen calls Blockchain the "most important invention since the Internet."

## Robotics

**ROBOTIC AUTOMATION** is on the cusp of a prolonged surge as a slow growth, low profit global economy urgently needs to boost its flat productivity growth for political and social reasons.

For China it's a case of force majeure if it is to move to its next economic phase of upgrading its manufacturing industry and moving its products upmarket. Under the State Council's 'Make in China 2025' fiat China is going to have to activate large numbers of robots.

Despite its having accounted for nearly 30% of global robot shipments in 2014 and again last year, its robot density is still under 50 robots per 10,000 manufacturing workers, half the world average. To correct this China is expected to account for 40% of global robot shipments by 2020, mainly from Fanuc, Kawasaki and Yaskawa and ABB and Kuka.

All in all the global installed base of industrial robots is expected to grow by 10% a year for the next decade vs 2%-3% a year in the decade to 2013. Over the course of the decade networked robots that teach themselves and each other will become common.

**Social Robots** enabled by the availability of cheap sensors and the chip sets developed for smart phones and tablets will become commonplace in homes, recreation centres, health centres, and SME workshops over the next decade and very much so in the 'Shinto' cultures of Japan and S.Korea, with China getting into the act big time as well.

On the back of a capacious definition of what a robot is, Softbank's charming Pepper 'social robot' getting its 'smarts' from IBM's Watson in the Cloud is a case in point: so, too are Amazon's Echo/Alexa, also based in the Cloud and China's Rokid digital assistants.

Extending the category to remedial robots such as Cyberdyne's 'exoskeleton' to help the lame walk unaided and co-worker robots from Rethink Technology and Universal Robots <now part of Teradyne>, new breeds of robots are on the cusp of creating mass markets.

Understandably, Japan, the natural home of robotics, aims to lead the parade under Abe's project to triple the size of the Japanese robot industry to over \$20 billion a year by 2020 and to showcase a robot enabled society for the Olympics, Fukushima permitting.

## 3. Subscribe to Signum Intelligence

IF YOU'RE INTERESTED in the impact that disruptive technology will have on your investment decisions, the monthly **Signum Intelligence Briefings** will guide you through the industrial chaos as society transitions to Artificial Intelligence.

It is targeted to fund managers and individuals at major financial firms, family offices and pension funds.

### We'll alert you to the opportunities and risks

With Signum Intelligence, you will be able to recognise what companies in your portfolio are exposed to disruption from technology.

I believe that investment professionals will need to dive deep into assessing a company's Math House capabilities as well as its market share, financials and forward guidance, since the former will increasingly determine the relative health of the latter in more and more cases.

This applies to the vast majority of stocks in your portfolio. Almost everybody will have to use algorithms and big, increasingly 'streaming' data to create and nurture customers, create or redefine markets or gain market share.

The key is focus on a company's Tech IQ. This is a score that Signum uses to measures the degree that a company can adapt to the sudden transition. It helps you to identify the most toxic investments in your portfolio. And it will help steer you away from sectors are poised for a meltdown.

### The AI Transition Portfolio

We will publish a model portfolio that identifies the most interesting opportunities in technology.

This transition to an AI society will progress in a number of stages. And Signum will help you identify the most the most thrilling high-risk companies in each disruptive sector.

## Global Intelligence

It's also vital to recognize the governments are adapting to these plans, while developing their own strategies for specializing in advanced technologies.

China and the US need to smooth the progress of their national champions – investing to remove bottlenecks in bandwidth, satellites, energy, talent, technology metals. That heralds deep and immediate industrial change and opportunity.

We have a global network of intelligence contacts with regular off-the-record conversations with network of technologists, industry analysts, scientists, VCs and political contacts.

Still there are many competing AI technologies – including neural networks, genetic evolution algorithms and advanced probabilistic logic systems.

And the disruption won't end in the next five years.

The likes of Google, Amazon and Facebook have a high Tech IQ but nobody has an unassailable advantage when it comes to technology.

We need radical new ways to think about technology. I think it is important to alert you to the most epic developments from AI technology – the transition from narrow to general AI, the prospect of superintelligence, simulations of the brain – so that you are never surprised, but always entertained.

And inevitably it will involve asking very basic questions about humanity.

How much control should the machines have?

In what totally surprising ways will we leverage Artificial Intelligence?

How soon will it become part of our biology?

To find out more about this service, please feel free to contact me at [hello@michaelorme.co.uk](mailto:hello@michaelorme.co.uk).

Best Wishes,

Michael Orme  
Chief Tech Investment Analyst  
**Signum Intelligence**

### **About Michael Orme**

As a brain for hire, I've been in the midst of technology change for many years, analysing what it means and how it will impact business. Back in the 1980s, I ran the London operation of Regis McKenna, then Silicon Valley's premier marketing firm where I worked at the top level with Intel, Apple and Genentech among others. During the 1990s I was a strategy consultant to HP's global PC division and European channels operation. I was a writer in residence at the DTI-Foresight project in the mid-'noughties', and co-founded Cambridge Convergence which brought Cambridge University spin-out companies together with business angels and VCs, while writing in-depth briefings on robotics, AI, self-driving cars, and the Industrial Internet for institutional clients.