JUNE 2018

A NEW AGE OF TECHNOLOGY:

ROBOTICS, SMART MATERIALS, ARTIFICIAL INTELLIGENCE (AI), AND MACHINE LEARNING (ML)

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WHITE PAPERS

WEALTHMANAGEMENT

Technological innovations have been the prime movers of economic development for more than two and a half centuries. Among the most influential are general-purpose technologies, which go as far back as the internal combustion engine, the steam engine, and indoor plumbing and electricity.

Each of these inventions has spawned better and better ideas over time. For instance, without the advent of the internal combustion engine, we would not have many basic travel necessities — cars, trucks, planes — nor any of the shopping areas we depend on: shopping centers, big-box retailers, or factory warehouses, to name a few.

So how do we use these innovations? Companies such as Airbnb, Amazon, and Google have found ways to leverage innovative technologies to create profitable new business models. Consequently, the four main technological areas these companies are using – robotics, smart materials (SM), machine learning (ML), and artificial intelligence (AI) – are changing how we live. Our world is changing, and it's changing fast. Robots are starting to become part of daily life for everyone. Driverless cars are here. Collision avoidance systems are here. Siri and Alexa are here.

The question is: Are you properly invested for the next 10 years of technology waves? Contact your financial advisor to discuss the most appropriate way to integrate these growing industries into your investment portfolio.

ROBOTICS

In the 19th century, industrial processes were widely adopted into the home through indoor plumbing and electricity. In the 20th century, technology was no longer laboratory-bound as homes adopted more advanced technologies, such as kitchen appliances, TV sets, and vacuum cleaners. Now, in the 21st century,

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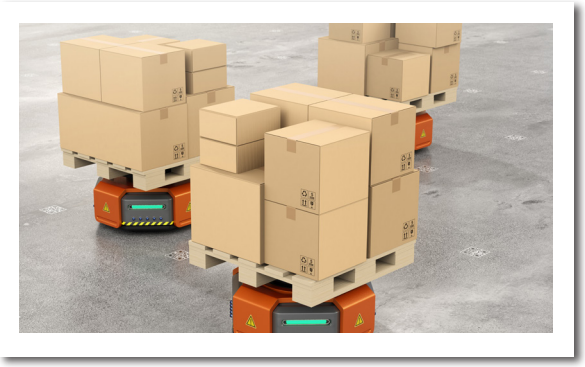
ROBOTICS CONTINUED

a new technological paradigm shift is on the horizon – the robotics revolution. So how will this revolution impact our homes, our jobs, our lives?

The definition of "robot" is a machine with the capacity to perform a complex sequence of tasks automatically – in particular, a computer-programmed series of tasks. This applies to many different types of robots, even those prevalent in sci-fi TV shows and films. However, a robot needn't have arms, legs, a voice, or even movement to fulfill the role of a robot. The 21st-century robot has a much broader definition – think HAL the computer in the movie 2001: A Space Odyssey. So how will these new age robots appear in our lives, and how will we interact with them?

Robots are breaking down the barriers among artificial intelligence, biology, embodiment, smart materials, and robotics itself, and this fusion of fields will have radical effects on all aspects of our society. We will see robots that can repair and monitor our natural environment, detect and eradicate cancer, and become companions for us as we enter our golden years.



A recent article in The New York Times profiled an Amazon employee that began his career by stacking large plastic bins weighing as much as 25 pounds each in the company's vast southern New Jersey warehouse. This repetitive activity was not only unstimulating, but also exhausting after a normal 10-hour shift. Now, this same employee monitors and troubleshoots multiple robots simultaneously, including observing a gigantic yellow automatic arm that performs the exact same task he used to do by hand.

This is a great example of how Amazon is leading the way in automation, replacing manpower with robot power. In 2014, the company began to manufacture automatons for its warehouses with machines built by Kiva Systems, which Amazon had acquired for $775 million two years prior, renaming it Amazon Robotics. Now, more than 100,000 robots are at work at Amazon outlets worldwide, with many more to come.

SMART MATERIALS

A smart material is a substance that demonstrates a noticeable effect in one realm when triggered to do so through another. These realms encompass areas such as chemical, electrical, mechanical, optical, and thermal. For example, a smart material can empower a robot to track a chemical by altering electrical properties within the robot when it is exposed to that chemical. Smart materials can expand the capacity of robotics – particularly artificial organisms – to perform many tasks that previously only humans could do.

For instance, let's say a patient needs a robotic device that can be implanted, but will absorb into the body once it is no longer needed. While not possible now, one day doctors may be able to use biodegradable, biocompatible, and selectively dissolvable polymers to accomplish this feat. Smart materials largely cover the same set of physical properties (stiffness, elasticity, viscosity) as biological tissues, so state-of-the-art, soft robotic technologies have the potential to deliver capabilities like those of the natural tissues. Once smart material applications demonstrate successful performance of a given task, they will inevitably propagate through the health care industry. They may even be advanced enough to assist the elderly,

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SMART MATERIALS CONTINUED

disabled or physically frail by providing them with mobility-restorative clothing – perhaps even enabling a wheelchair-user to walk again.

The capacity of soft robotics to interact and integrate with biological tissues leads to the possibility of implantable devices that can renew damaged and diseased biological structures and organs. This type of soft robotics is now in development and will likely reach clinical trial stage within the next two decades. We can only imagine the next direction future robotics may take. Immersive virtual reality. Replacement bodies. Full disruption of life and society. It appears the sky's the limit.

ARTIFICIAL INTELLIGENCE (AI)

The term 'artificial intelligence' (AI) was developed in 1955 by Dartmouth College mathematics professor John McCarthy. In 1956 he coordinated a conference on this subject, creating public fascination with all the possibilities for AI in the future. Since then, AI's main progress has been made in the broad realms of perception and cognition – particularly related to speech, as Alexa, Google Assistant, and Siri demonstrate. A 2016 Stanford study discovered that "smartphone speech recognition can write text messages three times faster than human typing." This means that a smartphone's speech recognition through AI surpasses the overall speed of phone typing and texting by 200%. While AI, too, has its own version of human error, the error rate of speech recognition has gone down from 18.5% to 4.9% since its initial inception.

AI's image recognition capacity has risen as well. Facebook and other social media sites can now identify your friends' faces in photos you post and allow you to tag them more quickly. A smartphone app called Merlin can identify almost any bird from a photo. It is also used widely at corporate headquarters as an electronic replacement for plastic or laminated ID cards.

Even vision mechanisms in self-driving cars have increased in pedestrian recognition accuracy – instead of

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ARTIFICIAL INTELLIGENCE (AI) CONTINUED

an error rate of one in 30, now it's one in 30 million. The ImageNet mass image database, too, declined in image recognition error rate – from more than 30% about eight years ago to approximately 4% about two years ago.

Another branch of AI is natural language processing (NLP), which aims to advance interaction between computers and natural human languages. Alexa, Siri, and Google Assistant are leading the way in natural language processing. Just ask Google the height of the Eiffel Tower, and Google's AI system will automatically interpret the landmark as an object with a characteristic property of height, using data from your voice, and give you its height in meters.

MACHINE LEARNING (ML)

A prevalent subcategory of AI is machine learning (ML), a machine's capacity for perpetual performance improvement without requiring humans to detail how something works or to coach the machine along. The broad presence of ML in our lives enables us to construct technologies that learn how to do their own tasks without instruction, preparation, or preprogramming from humans. This seemingly infinite capacity to learn and master tasks can apply to many situations, such as fraud detection and disease diagnosis.

ML has also greatly improved cognition and problem-solving. Machines have already trumped chess and poker champions, even faster than originally expected. Many top firms have benefited from ML's capacity, and we're benefitting, too! Examples include...

- Google's DeepMind team has harnessed ML to increase cooling capacity at their data centers by more than 15%, after human expertise had significantly upgraded those cooling systems.
- Cybersecurity firm Deep Instinct is using ML to ferret out malware.
- PayPal employs ML to avert money-laundering.
- Amazon utilizes ML for inventory optimization and product recommendation improvement.
- Infinite Analytics designed an ML system to accurately predict the ad a visitor would click on. This refined online ad presentation for a consumer-packaged goods corporation, which tripled ROI on advertising for the company. This system also made the process of customers' search and discovery more efficient for an online store in Brazil, skyrocketing its yearly revenue by $125 million.

As ML is further developed, its possibilities are endless. For example, it could predict the likelihood of flooding for a house built on a floodplain based on previous meteorological patterns. On a more personal level, ML could even suggest a film you might enjoy watching on Netflix based on its database familiarity with your personal tastes!

WHAT CAN AI DO TODAY?

AI's zenith is yet to be reached. The more it nears its apex, the more cutting edge transformations it will create in every industry, from entertainment and healthcare to finance and insurance. Innovative startups will leap frog over standing companies who cling to antiquated production methods. AI is already sequencing individual genomes in health care. Eventually, this will enable doctors to determine the probability of contracting a certain disease, and to tailor their treatment to an individual's genetic composition.

In finance, AI financial advisors will be able to discern the companies that best parallel a customer's values and risk profile by analyzing that customer's social media posts and will proceed to automatically tailor the customer's portfolio according to their observations of market trends. Wealthfront already conducts AI-automated financial analyses and services for clients with assets of many different values, and soon it will be the norm in the financial world.

PUTTING THESE TECHNOLOGIES TO PRACTICAL USE

Smart devices embedded with these technologies have broadened the scope of services insurers can offer their clients. For instance, AIG has teamed with a car rental firm to develop an AI pilot for 'smooth driving' to determine how safe an AI pilot can be. In their test, sensors in the client's vehicle fleet culled data in real time to determine each AI driver's 'smooth driving score' so the smoothest driver could be adapted as a model for safe driving on the road.

This initiative also reduced the number of insurance claims by incentivizing renters to drive more safely, thus expanding technology's potential for insurance companies. The more sensor data the insurance industry can access, the more the industry will be able to automate its processes. And the more the insurance industry can rely on AI, the more it can transform, advance, and adapt.

WORKING THE POTENTIAL OF MACHINE LEARNING

The mobile dating app Tinder has suggested that AI can even revolutionize dating. In a recent Forbes profile, Tinder executives discussed a scenario in which the app could predict, with limited input from a user, the people that user would most likely be interested in. As a faster, more direct alternative to the tedium of swiping, matching, and having the same online conversation repeatedly, theoretically, a user could converse with a Tinder bot which could determine how likely he or she is to find a potential partner attractive, identify common interests and recommend a place to meet.

CONCLUSION

AI, particularly machine learning, is our era's premier general purpose technology. Its far-reaching effects on all lines of business and the general global economy are already evident in its radical transformations of our lifestyles, its contribution to the growth of industries, its improvement of the efficiency of operations, and its sparking of unprecedented technological innovations. AI has also spawned many new products and processes through drastically upgraded vision systems, speech recognition capacities, automatic problem-solving beyond the human mind's capacity, and more.

Though we cannot forecast with absolute certainty which companies will stand out in the AI world, it is certain that those best able to adapt AI to their operations, infrastructures, and day-to-day business will prosper. Companies that can sniff out and seize the opportunities AI presents will best benefit from it, provided they are willing to experiment with new technologies and assimilate them into daily operations.

CONCLUSION CONTINUED ON P7

CONCLUSION CONTINUED

This is especially crucial given the dissolution of dividing work between humans and machines. For example, a human types a memo and a photocopier copies it. Companies that stay with this old mindset will be far less competitive in the market than those who adapt ML in their business and fuse its capabilities with those of their staff. This benefits not only the company, but also the world. According to recent studies, by 2035, AI could double economic growth in as many as 12 developed nations and increase labor output by up to 40%.

AI, ML, and robotics are all on the precipice of becoming transformative at a higher level than previous general purpose technologies ever were. Though thousands of firms worldwide are already capitalizing on the potential of these technologies, most of their biggest opportunities remain untouched. Their global impacts will balloon in the decades to follow as they are assimilated by nearly every industry under the sun. The impediment to the full flowering of these technologies in all sectors of society is in the business imagination it takes to fully implement and manage them in the workplace and beyond, as the strategic integrations of AI by Amazon, Google, Microsoft, and other high-tech and retail leaders can attest.

Such imagination is key, given that technological progress is rapidly spurring tectonic transformation in business. As with steam power, indoor plumbing, electricity, and other early technologies, access to AI alone does not distinguish the triumphant from the trampled. Innovators who can see beyond the conventional to imagine new methods – and who have the know-how to execute their visions – will make the difference in company success.

There are numerous reasons for businesses to adopt AI and ML systems. AI and ML systems have already equaled or exceeded human-level capacity to determine people's emotional state from their facial expressions or tones of voice. These systems can even detect the strategies of world class chess or poker champions well enough to beat them at their own game. This kind of people-reading isn't magic – it is just an example of the cognition and perception that AI/ML is rapidly developing. There is so much more to explore in the world of AI – the world itself just needs individuals who are intelligent, perceptive, and driven enough to bring society into the new age of robotics.

At the end of the day, every investor needs exposure to the next wave of technology, be it hardware, software, semiconductor, or something else. Companies that do not evolve their technology will become extinct. Twenty-five years ago, most of us never thought we'd see an electric car, wouldn't own a camera, afford a cell phone, talk with a person around the world for free on FaceTime, or have a robot drive our car, cook our meals, or fold our laundry. That day is here, investors, it's here. Take advantage of it.

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