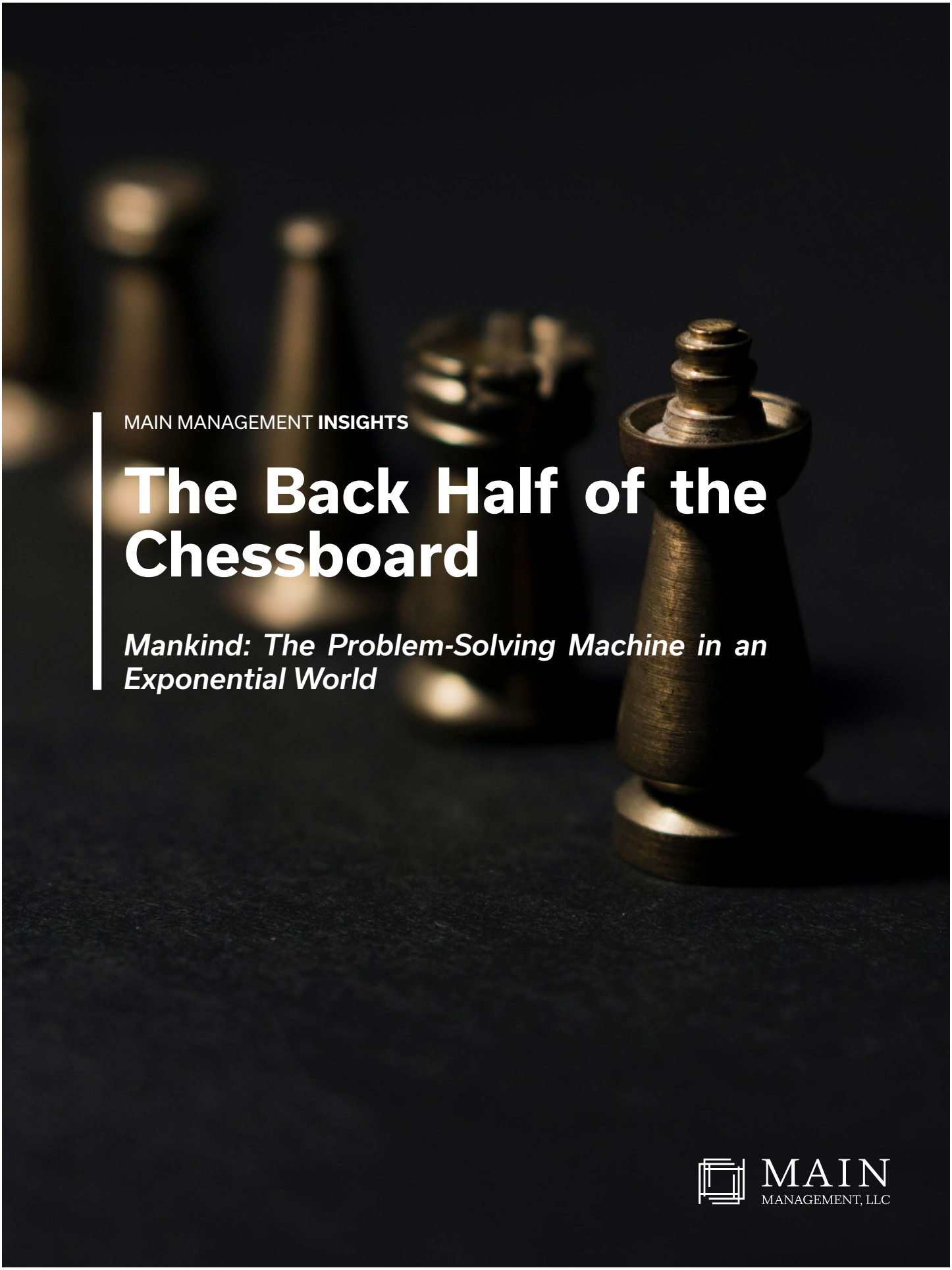


MAIN MANAGEMENT **INSIGHTS**

The Back Half of the Chessboard

Mankind: The Problem-Solving Machine in an Exponential World

MAIN
MANAGEMENT, LLC

The Back Half of the Chessboard

Mankind: The Problem-Solving Machine in an Exponential World

I. Our Quality of Life Has Improved

Despite great early progress, in 1651 the life of Mankind was described as "solitary, poor, nasty, brutish, short" in *Leviathan* by Thomas Hobbes. It is unlikely anyone wants to go back to those "good old days." Despite what you read, life today is much improved from the past. Since just 1800, the world's population is 6x larger, life expectancy has doubled, and real incomes are up 9-fold. Within our lifetime – while global population doubled – global income has tripled in real terms, life expectancy has increased by one third, we eat 1/3 more calories per day, and we are less likely to die from war, murder, childbirth, accidents, tornadoes, flooding, Whooping Cough, TB, Malaria, Smallpox, or Polio. Furthermore, we are less likely to contract cancer, heart disease, or stroke, and are much more likely to be literate. Just over 100 years ago, life expectancy was only 47 years, 50% of the population lived on farms, 20% of Americans couldn't read or write, only 6% of Americans graduated from high school, only 10% of doctors were college educated, 95% of all births took place at home, the candle was the main source of reading light, there were only 8,000 cars on 144 miles of paved roads, only 8% of people had a phone, there was no toothpaste or deodorant, and average wages were only $0.22 per hour. It would likely be impossible for them to imagine our lives today.

Americans who are considered 'poor' today have routine access to quality food, housing, health care, consumer products, entertainment, communications, and transportation, that even the Vanderbilts, Carnegies, or the Rockefellers could not have afforded. Based on long term trends, we are healthier, better fed, richer, freer, more peaceful, more literate, and even smarter. Angus Deaton, the 2015 Nobel Prize winner said, "life is better now than at almost any time in history," and, "more people are richer and fewer people live in dire poverty. Lives are longer and parents no longer routinely watch a quarter of their children die." However, much of the general public is oblivious to the poverty trends of the world. In 2016, the Dutch surveyed over 26,000 people in 24 countries, asking, "in the last 20 years, has poverty increased by 50%, increased by 25%, stayed the same, decreased by 25%, or decreased by 50%?" Only 1% of the respondents got the correct answer, which is that it decreased by 50% (*The Economist*).

People are historically skeptical about the future. These feelings can be seen especially in news headlines, where every major event is portrayed as the end of the world. Part of this reasoning may be biological. The Amygdala in the brain is our early warning indicator and creates the fight or flight response. Skepticism of the future may be caused by this part of the brain.

There have been many popular, yet faulty, predictions about the future. In 1798, Thomas Malthus predicted that the population would outpace agricultural production, leading to widespread famine. Evidently,

no such event occurred on a wide scale. Similarly, in 1971, Paul Ehrlich came up with *The Population Bomb* theory, stating that "population will inevitably and completely outstrip whatever small increases in food supplies we make." He claimed that "life expectancy would drop to 42 years by 1980 due to cancer epidemics" and "over the next 10 years, and by the 1980s, most of the world's most important resources would be depleted." The conclusion is that the pundits are usually wrong – because Mankind is a problem-solving machine.

II. How Mankind Has Progressed: Specialization and Innovation

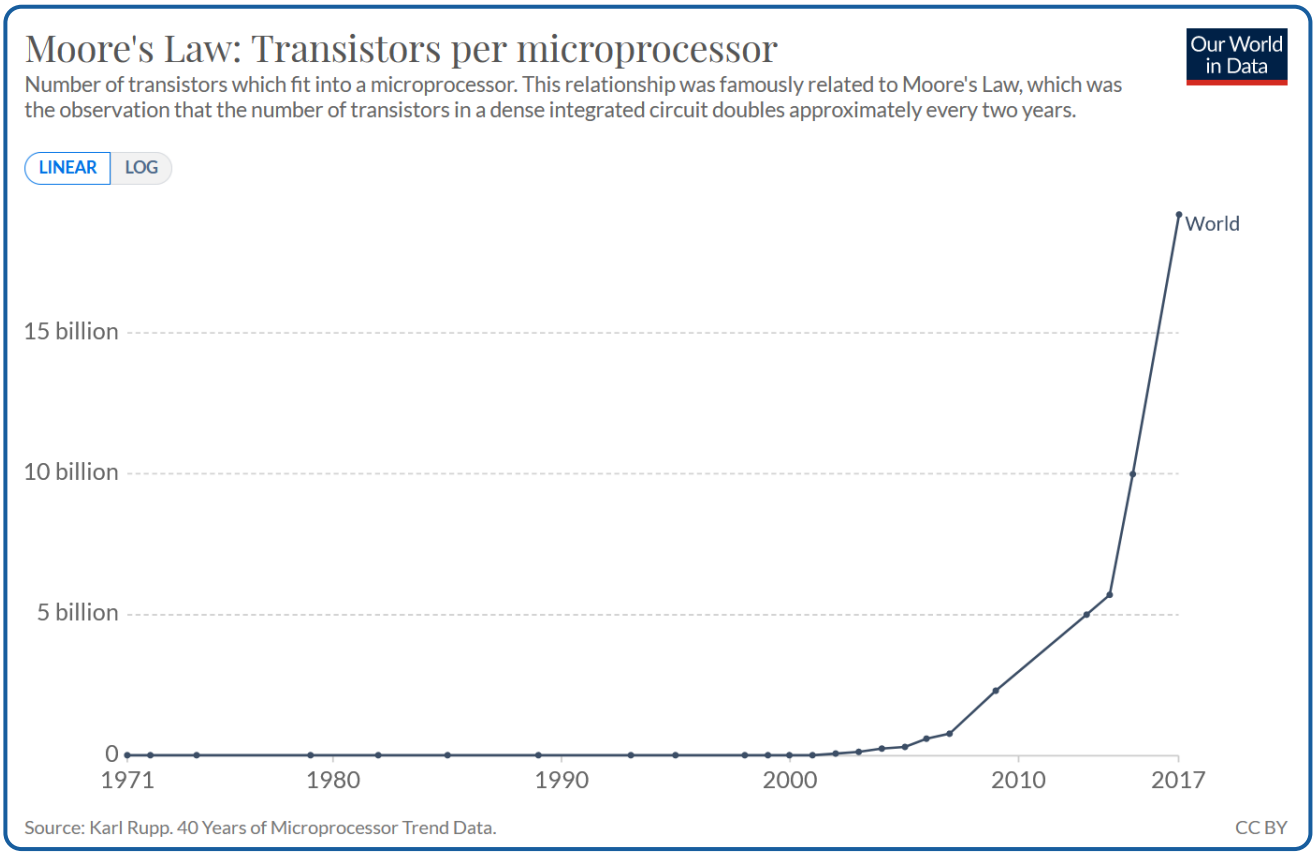
One often wonders where the world is headed during their lifetime and their children's lifetime. However, as Yogi Berra said, "it's tough to make predictions, especially about the future." To see how Mankind may progress in the future, it is important to first look back on how we've progressed so far. As Winston Churchill said, "the further back you look, the further ahead in the future you can see." Mankind has progressed so far by extending its reach. We have extended our reach by exchanging or trading things or ideas. First, humans discovered the division of labor. The division of labor led to specialization. Specialization encouraged innovation. Innovation saved time. Time saved has resulted in prosperity. As a result, a virtuous circle has been created. Examples of humans extending their reach are present throughout human history. Hunter-gatherer societies are an example of a division of labor, where tools like fire, knives, and the wheel are examples of innovations that saved time. In the past few hundred years, innovations such as the sewing machine or shipping containers changed the ways we communicate and interact. For example, the sewing machine (invented in 1846) was a drudgery reliever and time saver, created new demand and new jobs, brought better clothes into the financial reach of more people, created the 'ready-made' clothes industry with a wide range of new products, and more. The shipping container (invented in 1956) reduced the time to move goods around the world by 85%, reduced total shipping costs by 35%, and helped drop the shipping rate cost per pound to less than 1/500th of the cost in the early 1960s. Because knowledge is cumulative, Mankind has made huge strides – much more than people realize. The ultimate manifestation of these innovations has been increased life expectancy. It went from 18 years in Cro-Magnon, to 25 in Ancient Egypt, to 30 in 1400s Europe, to 37 in 1800s Europe/USA, to 48 in 1900s USA, to currently 76.3 for males and 81.2 for females.

Today, the world continues to benefit from the virtuous circle noted earlier. The division of labor leads to knowledge exchange, which leads to specialization, which leads to trade, which leads to time saved and prosperity. The answer to being successful is not to be self-sufficient, like some have tried, but rather through the exchange of ideas and trade. Ultimately, there is no end to this virtuous circle. The more humans diversify as consumers and producers, and the more they exchange or trade, the better off they will be. Further, the more people are drawn into global division of labor, the more they specialize and exchange, the wealthier we will all be.

III. The New Age of Computation: The Power of Compounding and Exponential Growth

Mankind's first major technology breakthrough was the Industrial Revolution. James Watt's steam engine may have been the most transformational invention in the history of Mankind. It allowed Mankind to overcome the limitations of muscle power, both human and animal, and unleash massive amounts of energy at will. The steam engine led to factories, mass production, railways, and mass transportation. Mankind's second major technology breakthrough was the Information Revolution. It allowed computers and digital devices to do for mental power what the steam engine did for muscle power.

Chess was invented around 600 AD and the inventor presented his brainchild to the emperor. The Emperor was so impressed that he told the inventor to name his reward. The inventor's response was, "all I desire is



some rice to feed my family." He specifically requested: "place one grain of rice on the first square of the chess board on day one, two on the second day, four on the third, and so on for 64 squares." The Emperor said, "make it so!"

Things were uneventful through the first half of the board. However, at square 32, the inventor would receive approximately 4 billion grains of rice – the size of a large field of rice. In the back half of the chessboard the emperor realized his error and beheaded the inventor. Assuming 10 grains of rice per square inch of land, at square 64, there would be 18 million-trillion grains of rice. The necessary land to grow that amount of rice would amount to 2 times the surface area of the entire globe.

While our generation has experienced a world that has grown in linear terms, future generations will benefit from growth in areas that are **exponential**. To explain the impact of "exponential," 30 steps linearly is 30 (1, 2, 3, 4, 5, etc.), whereas 30 steps exponentially comes out to one trillion (1, 2, 4, 8, 16, 32, etc.). For perspective on how large 1 trillion is, 1 million seconds equals 12 days ago, 1 billion seconds equals 30 years ago, 1 trillion seconds = 32,000 years ago. Further 1 trillion one-dollar bills stacked is 67,866 miles high. Therefore, to pay off our current $20 trillion national debt, it would take 5 stacks of one-dollar bills reaching from the earth to the moon.

A math quiz will underscore how this compounding works. Question #1: would you rather receive $1 million now, or a penny doubled every day for 30 days? The right answer to question #1 is the penny doubled for 30 days; the result is $10,737,418.24. Question #2: A more illustrative question to understand the power of compounding: if day 30 equals 100% of the total (or $10.74 million), what percentage of the total are you at day 20? The correct answer is 0.1%.

The progress of computers and information processing

What $5,800 could buy in 1964 and now.

has been astounding, and it should continue. Computer's speed (calculations/ second/$1000) has doubled every 3 years between 1910 and 1950, 2 years between 1950 and 1966, and currently, it doubles every 12-18 months! Moore's law predicts we will double the number of processors and their speed every two years – thereby quadrupling the calculations per second. Today computers are 100 million times more powerful for the same unit cost vs. 50 years ago. If cars were similar, they would cost less than 1/100 of a cent and travel at the speed of light.

The double exponential growth of price plus performance for computing has held steady for 125 years. It is all about better, faster, smaller, cheaper. The result of technological advancement is lower costs per transistor. The cost per transistor is 50% lower per year which leads to 100% better value. It used to cost $1 per transistor; now there are 10 billion transistors for less than $1.

The size of computers has decreased tremendously. The industry is moving from 14 to 10 nano sized transistors now and is working on 7 nano chips. For reference, a nanometer is 1 billionth of a meter, a red blood cell is 7500 nanometers, a human hair is 100,000 nanometers, and the industry made 250 billion-billion transistors in 2014, or 8 billion transistors/second, or 25 times the number of stars in the Milky Way.

The power of computers has also grown exponentially. In 1985, the Cray-2 Supercomputer was 1.9 gigaflop (1.9 billion floating point operations/ second) and cost $35 million in 2011 dollars. In 2011, the original iPad (now 9 years old) has the same 1.9 gigaflop speed as the Cray-2, plus a speaker, microphone, headphone jack, 2 cameras, HD video, wireless telephone, GPS, and digital compass. It also cost only $1000 and is smaller and lighter than a magazine. If you compare a modern iPhone to computers 50 years ago, the iPhone is 1 million times less expensive and 1000 times more powerful, meaning it is 1 billion times more powerful in terms of computation and communication per dollar.

Other examples of technological progression include air conditioners in 1956 versus now. In 1956 the 2500 BTU Air Conditioner from Sears cost $299.95. Today, an 8000 BTU Air Conditioner costs only $249 despite CPI being up 9-fold. Today's cost would be 91% less than an inflation adjusted price ($249 vs. $2,766). Additionally, at current wage rates, it would only take 11.6 hours to buy versus 164 hours in 1956 ($21.43/ hour vs. $1.83 in 1956, or 93% less).

On a Best Buy flyer in 1994, some of the notebook computers they offered cost $4,489 and $5,699 in today's dollars. Today, Best Buy offers 51 computer laptops for less than $300 with infinitely better performance. Therefore, technology has brought equivalent prices down 95% and made computers available to everyone – not just the 1%.

Some of today's industries, areas, and activities which are moving at the speed of Moore's Law include computer processing, big data, data storage/ bandwidth, networks, sensors, 3D/4D printing, gene sequencing, nanotechnology, biomedical engineering,

robotics, brain scanning and artificial intelligence (AI). The key question is if Moore's Law can continue. The answer is yes for several reasons. First, the existence of the cloud means no more physical setup is needed as processing power is lashed together through the cloud. Additionally, chips have been designed to optimize needs, better algorithms will also speed results, and new materials like graphene and carbon nanotubes will help to replace silicon. Further, quantum computing is a game-changer. Therefore, with anything based on information processing, we are entering the Back Half of the Chessboard.

IV. Our Future Given a Continuation of Moore's Law and Technology

1. Computing Power

Since this trend should continue to escalate over the next 25 years, the computer that used to take up an entire building, which now fits into your pocket, could eventually be small enough to fit inside a blood cell. One of the largest future areas of impact is the computer versus the brain. Human brain speeds are 10 million billion calculations per second (CPS) or 10^16 power. A low end $1000 computer calculates at 10^11 power or 100 billion CPS. Given Moore's Law, the computer could match the human brain by around 2025. Fast forward another 25 years, a computer could be capable of performing 100 million, billion, billion (10^26) CPS and match the cumulative brainpower of the entire human race (singularity.com).

In 1997, IBM's DEEP BLUE beat World Chess Champion Garry Kasparov. DEEP BLUE could analyze 200 million board positions representing different moves or countermove sequences every second. In 2011, a more powerful Watson beat the two best Jeopardy players of all time, combined. Watson's knowledge came from "reading" 200 million pages of natural language documents including all of Wikipedia and every available encyclopedia. Watson processed 4 trillion characters in just 3 seconds to give its answers. In 2017, Google's "AlphaGo" beat the world's best player 3-0 using neural networks which mimic the human brain. Clearly, artificial intelligence is here.

2. Clean and Abundant Energy

So far, energy has progressed from wood to coal to oil to natural gas to nuclear to solar. This is the 9th time this century that the US has had the largest decline in emissions in the world. This is the 3rd consecutive year that emissions in the US have declined. Further, carbon emissions from energy use from the US are the lowest since 1992 and the level of US CO2 emissions are back to the early 1990s. Solar power is a huge potential game-changer, and we will get there. The solar energy that hits our atmosphere is estimated at 174 peta-watts (1.74 x 10^17) annually. Humans consume about 16 terawatts of energy annually. 16 terawatts of the sun's energy hits the earth every 88 minutes. Therefore, over 5000 times more solar energy falls on the earth's surface than we use in a year. The solar power industry has already grown considerably.

Photovoltaic installation has grown 50% per year for over 10 years. Costs per watt have dropped 60%/year over past 5 years, and each doubling of production drops pricing another 20%+. The issue is not scarcity, but accessibility. The missing element – storage capability – will be solved.

3. Water

The third future area of impact is access to clean water through water solutions using technology. Currently, the problem is that ~ 800 million people on earth do not have clean water, 50% of all disease comes from water pathogens, and bad water is responsible for 2+ million deaths/year. You could empty half of all the beds in all the hospitals in the world with access to clean water. One solution is Dean Kamen's slingshot, where anything that is wet can be turned into clean, potable, distilled water. The second solution is Michael Pritchard's Lifesaver bottles. Typical bacteria are 200 nanometers and viruses are around 25 nanometers in size. The Lifesaver bottle filter has a membrane with pores that are only 15 nanometers wide, meaning no bacteria or viruses can get through – only clean water. The lifesaver bottle produces 6,000 liters of water and bigger versions produce water at 1/2 cent per day.

4. Food

In the context of better and more reliable food, the vertical farm is an idea that dates to the Gardens of Babylon and Francis Bacon talked about it in 1627. The US Military built large scale hydroponic facilities to feed soldiers in WWII. Traditional farming currently uses 70% of the water on the planet, whereas hydroponic farming uses 70% less water. In 1983, aeroponics was discovered. It uses 70% less water than hydroponics. For example, a 30-story building in NYC could feed 50,000 people per year. The attraction of vertical farming is that it uses 180% less land, has year-round crops, has no lost crops due to weather, uses 90% less water, uses no pesticides, and has minimal transportation costs. These advances will leverage the "Green Revolution" started by Norman Borlaug, who introduced disease-resistant wheat that helped greatly improve food security. Today, the world uses 65% less


Wikimedia Commons

land to produce the same amount of food as 50 years ago, meaning far more food has been created from less land. The Netherlands are a farming example to the world; the country's rallying cry is "twice as much food using half as many resources." Their achievements include Holland's greenhouse complexes covering 175 acres, water usage has declined by 90%, pesticides have been virtually eliminated, and antibiotics have been cut by 60%.

5. Knowledge

Currently, there are more cellphones on the planet than toilets. If those phones have internet connections, users have access to more knowledge than President Clinton did when he was in office. "Project Loon" by Google is trying to bring the internet to all 7 billion people on Earth. The "hole in the wall" in India proves that great things can happen. Blended learning - free online education like Khan Academy, edX, Udacity and MOOCs will ultimately transform teaching. There is a chance for improvement in all the billions of minds not yet connected. With all those people finally having a voice, there are potential contributions that no one can predict.

6. Connections

The Internet of Things is the idea of trillions of devices being connected online, such as cars, thermometers, or light switches, all of which will have their own IP addresses accessible through the internet. Individuals will be able to find keys or stolen property, your internet provider or the net will alert you when you need to reorder household products, and individuals will connect their physical being to the internet. Further, companies will be able to perfectly match product demand to raw material orders and streamline supply chains. GE predicts a $15-30 trillion market for the Internet of Things.

7. Health

In the future, medicine will be personalized and enhanced by blending information, science, and technology. Better information leads to better diagnosis and treatment, which leads to a healthier population. Enhancements through tech include 3D-printing, stem cells, virtual reality, and technology inserted into our cells, bodies, and brains. "Dr. Watson" can use its capabilities to better diagnose patients' problems than the best oncologists by referencing all the medical knowledge ever published. Dr. Watson can digest 200mm pages of medical information every 3 seconds. Further, Dr. Watson's medical advice will be ubiquitous as it will stored in the cloud. Since medical information is doubling every 5 years, patients will get better, faster, more accurate, and affordable diagnosis from Watson. Eventually, we may be able to create a "Lab on a Chip."


National Cancer Institute

After spending $150MM, Craig Venter mapped the Human genome in 2000. The cost of sequencing has come down 50% every 4 months since then. Today the genome can be sequenced for only $1000. Sequencing the genome means medicine and human biology become information technology and is subject to the benefits of Moore's Law. With that knowledge, patients can know specifically what will work for them or not. We will continue to merge technology with our bodies. For example, 3D printers can print medical sensors the size of a grain of sand that can be imbedded to help predict heart attacks, fight cancer, and help brains function. Further 3D printing examples in medicine include organs – liver, kidney, thorax, ear; medical – pills, prosthetics; and implants - knee, hip, teeth, skull, hand, and legs. 3D printing also impacts food – chocolate, candy, crackers, pasta; apparel – custom athletic shoes, dresses, eyewear, bikinis, jewelry, cars; aircrafts – 1000 airbus parts are printed in 3D now, GE jet engine parts; architects can "print" a house in 24 hours, better models of homes or buildings; music – Stradivarius, flute; and miscellaneous – custom lamps, artwork.

However, these advancements are not all new. The first human transplants/ replacements include hips in 1940, kidneys in 1954, livers in 1963, lungs in 1963, intestines in 1964, hearts in 1967, and knees in 1987. Ultimately, we will be able to create intelligent nanobots in our bloodstream which will keep our bodies healthy at the cellular or molecular level by turning cells on/off. While this might sound futuristic, blood cell-sized devices that can cure type 1 diabetes in animals or detect/ destroy cancer cells in the bloodstream

exist today. Ultimately, we will be able to reprogram outdated software in our bodies which will lead to longer, healthier lives.

Conclusion

The exponential pace of the "Back Half of the Chessboard" will result in transformational changes the world over. Life is getting better at an accelerating rate, and technology is the tool to "extend our reach". We are headed towards 4 billion more connected people. Abundant energy will lead to clean water, leading to better health and food, leading to longer, more satisfying lives. Additionally, more available and better knowledge will hopefully lead to more great ideas and a more peaceful world. We are excited by the prospect. Main Management's new **Thematic Innovation Rotation Strategy** hopes to capture these accelerations in the way innovations are changing our world. A growth-oriented global equity strategy, the Thematic chooses from innovations such as genomics, fintech, e-commerce, cyber security, clean energy, cloud computing, robotics and AI, gaming and esports, pet care, and autonomous tech. With over 300 underlying holdings, the Thematic strategy aims to provide diversification in the innovation space, and exposure to where we think the puck is going.

Appendix

Summary

As Mama Cass Elliott said, "It's Getting Better All the Time." We have witnessed the greatest improvement in living standards ever. Life expectancy has increased twice as much in the past 100 years compared to the previous 200,000 years. The risk of dying today from war or natural disasters is smaller than any time in history. Someone born today is more likely to reach retirement age than our forbearers were to live past their 5th birthday.

Food

There have been 106 episodes of major famines over the past 140 years (one every 16 months) in which

Click here to watch a video and learn more about Main Management's Thematic Innovation Rotation Strategy.

over 100,000 people died. From 1900 to 1909, 27 million people died from famine. From the 1920's to the 1960's, 15 million people died from famine. In the 1990's, 1.4 million died from famine. In the 21st century, 600,000 have died from famine (only 2% vs. the totals of 100 years ago). In France, there were 26 national famines in the 11th century, 2 in the 12th century, 4 in the 14th century, 7 in the 15th century, 13 in the 16th century, 11 in the 17th century, 16 in the 18th century, in addition to hundreds of local famines (Ferdinand Braudel, The Structures Of Everyday Life: Civilization And Capitalism 15-18th Century).

Since 1990, chronically undernourished people have declined from 23% to 13% (down 43%) in the world's low/middle income population. Further, the hungry of the world declined by over 200 million people while the world population rose by 1.9 billion people. Childhood growth stunting has declined 25% since 2000. Additionally, the Green Revolution has saved land. From 1961 to 2009, farmland is up only 12% while food production is up 300%.

China has had great advances in food production. Under Mao, private land was taken and 40 million perished due to lack of food. As a result, life expectancy declined 20 years. However, in the village of Xiaoguang, a radical change happened. 18 families signed a secret pact where communal land was parceled out to each family. Families could then keep or sell what they produced beyond the government share. Grain

production jumped 6-fold from the year before and families enjoyed three meals/day versus one earlier. In 1982, China endorsed their reforms leading to current day surpluses of food versus famines just 20 years earlier.

One major cause of the trend away from world hunger was fertilizer. In 1909, Fritz Haber at BASF found a way to produce ammonia from hydrogen and atmospheric nitrogen. Carl Bosch advanced the research as he learned to synthesize it on an industrial scale, making it cheap and abundant. "40% of the world's population would not exist without the Haber/Bosch synthesis of ammonia" (Vaclav Smil). The synthesis of ammonia and the proliferation of fertilizer may have been one of the most important changes ever impacting the world's population rising from 1.6 billion in 1900 to 7.5 billion today. Without fertilizer and fields, the land productivity would be equal to what it was in 1961. Additional farmland the size of the US, China, and Canada combined would be needed to produce the same amount of food. In addition, fertilizer has also saved an estimated 12 million square miles of global forests.

Another major cause was the modernization/ mechanization of the food supply. It used to take 25 men to harvest a ton of grain 150 years ago. Today, one person in a combine harvester can harvest 1 ton of grain in 6 minutes. It used to take 30 minutes to milk a cow for 10 liters of milk. Today, it takes less than 1 minute with modern equipment. Changes in fertility have helped too. With greater wealth, the US family size was reduced from 7 children in 1800 to 3.8 children in 1900 to 1.8 children today.

Norman Borlaug started the "green revolution" by creating a better, high yield wheat crop. It was not sensitive to daylight hours, was a short dwarf stack that wouldn't fall, and took less energy to grow. It was first introduced in Mexico, resulting in a 6-fold increase in production versus 20 years earlier. It also resulted in a 70% improvement in India/Pakistan in 1st year it was introduced (now 7-fold better production). The high yield concept was also introduced to rice in Asia and helped eradicate rural poverty.

Another process that helped food advancements was pasteurization. Pasteur proved micro-organisms exist and could impact milk and wine and cause spoilage. Pasteurization kills the bacteria and allows for safe storage. Another was penicillin. Invented in 1928 by Alex Fleming, it launched against Tuberculosis, Diphtheria, Measles, and Polio (Polio has been reduced 99%). The third was the eradication of Malaria in 100 countries.

Disease

There have been three major plagues. The first was the "Justinian Plague" (541 AD), which killed 25 million. The second was the "Black Plague" or "Bubonic Plague" (1334 AD), which originated in Mongolia and killed 60% of Europeans, or approximately 1/3 of world's population at the time. The third was the "Modern Plague" (1860s), which originated in China and killed over 10 million people.

There have also been many smaller-scale outbreaks. From 1440-1640 there were 40 localized plagues in France (1 every 5 years). Tuberculosis spread in Europe in the 17th century and was a major killer in 19th century contributing to 25% of all deaths. Smallpox previously caused 400,000 deaths annually and Cholera caused tens of millions of deaths. Globalization helped spread these diseases with trade.

Overall, several factors helped eradicate diseases. Housing improved by moving from wood to brick, water was stored permanently, and new standards for cleanliness were introduced. To eradicate Smallpox, Lady Mary Montague used small doses of the disease to inoculate and induce immunity. With her approach, only 2% died. Additionally, Edward Jenner began inoculating with Cowpox. By 1800, most of Europe used his successful approach. This was the start of vaccinations and the beginning of the Germ Theory of Disease, a major medical breakthrough. Smallpox was defeated in 1980. To lower the maternal death rate, the introduction of hand washing helped mortality drop 90%. Death rates dropped from 458 deaths /100,000 births in England in 1935 to only 9 in 2015.

War

Wars have been a major cause of human death. Between 14,000 BC and 1770 AD, about 15% of humans died a violent death. The Mongolian invasions in the 13th century claimed 40 million lives which equated to one of every eight people of the 500 million on earth at the time. Human sacrifice was practiced amongst Egyptians, Greeks, Romans, Scandinavians, Chinese, and Japanese. The Aztecs were the most active killing 1.2 million between 1440-1524, or 40 per day. The Spanish inquisition, 1478 – 1834, killed 350,000 and tortured countless others for minor offenses. Witch hunts were real, and in France and Germany alone, 60,000 -100,000 were killed for witchcraft.

When Napoleon retreated from Moscow in 1812, 400,000-500,000 died from pneumonia, typhus, and dysentery – germs were as deadly as guns. World War I resulted in 17 million deaths and World War II resulted in 55 million. Additionally, the Algerian Independence War resulted in 500,000 deaths and the Korean war resulted in 1.2 million.

The Evolution of Light

In prehistoric times, our ancestors needed to chop wood for 10 hours over 6 days to produce 1,000 lumens of light – the equivalent of a light bulb that would work for 54 minutes. 60-hour work equivalents over time would produce the following: 1900 – 10 days of light, 1920 – 5 months of light, 1990 – 10 years of light, today – 52 years of light. The amount of labor that once produced 54 minutes of light would now produce 52 years, so the cost has fallen by a factor of 500,000 (source: Human Progress)

Innovations and Comparative Advantage

Companies and products that didn't exist just 20 years ago: 23andMe, AirBnB, Apple Store, Buzzfeed, Dropbox, Evernote, Facebook, Fitbit, Groupon, Grubhub, Hulu, Instagram, iPad, iPhone, iTunes Store, Kickstarter, Kindle, Lyft, Nest, Netflix, Open Table, Pentium, Pinterest, Playstation, Reddit, Snapchat, Sonos, Spotify, Square, Survey Monkey, Theranos, Twitter, Uber, Waze, Wii, Wikipedia, Xbox One, Yelp, YouTube.

"In 10 years … it's predicted that 40% of the Fortune 500 companies will no longer exist" (Babson Olin School of Business, Fast Company, April 2011, Pg. 121).

Self-sufficiency is not the path to prosperity. The more humans diversify as consumers and specialize as producers and the more they exchange, the better off they will be not only do we consume the work of others, we consume their inventions too. For example, the inventions of Leonardo Da Vinci, Galileo, James Watt, Ben Franklin, Thomas Edison, Charles Babbage, Wright Brothers, Thomas Edison, Alexander Graham Bell, And Tim Berners-Lee.

In 1900, $76 out of every $100 spent was on food, shelter, and clothing. Today that figure is $36. The cumulative accretion of knowledge by specialists that allows each of us to consume more and different things by each producing fewer and fewer things is the central story of humanity.

For example, Louis XIV, the Sun King, dined alone at Versailles in 1700 and chose his dinner from 40 dishes prepared by 498 people. He was rich because he consumed the work (time) of others. He was rich because others did the work for him. If you compare yourself to Louis XIV, your meal choices are greater and you're richer because you benefit from the work of far more people who are ready to serve you. Further, you are not just consuming others labor, but their inventions too. The point of all this cooperation is to make a smaller portion of labor produce a greater quantity of work.

The next step is comparative advantages. David Ricardo, an ex-London stockbroker in 1817, talked about "comparative advantage", which postulated that countries should trade with each other even when one country is distinctly better than the other at producing the traded goods.

An example of comparative advantage would be a

Wharton grad takes only 1 hour to make a lacrosse shaft and 2 hours to make a head (3 hours total) versus a Stanford grad that takes 4 hours to make a lacrosse shaft and 3 hours to make a lacrosse head (7 hours total). Should they trade with each other when the Wharton grad has a distinct advantage making both the shaft and the head? Would it be a waste of time for the Stanford grad to make either given the Wharton grad's advantage? Yes, they should trade with each other! If the Stanford grad specializes and makes 2 lacrosse heads (2x3 = 6 hours) and if the Wharton grad specializes and makes 2 shafts (2x1 = 2 hours), and they trade with each other - due to that specialization – the total time spent by both is now 8 hours instead of 10 hours earlier so each now enjoys an extra hour of free time.

Health

Throughout history, human existence and the nature of our society and lives has been determined/defined by our tools. Health will be enhanced at the intersection of medicine, science, technology and information.

Change always appears to unfold gradually, then seemingly all at once. For example, population/ demography trends and medical cures like sickle cell disease. The sickle cell disease was discovered in 1910, genetically defined in 1949, and cured by gene therapy in 2015. Now, it is an "overnight success".

What will we do with the progress seen with C Elegans (Worm)? Doubling for 10 years is equal to 1000X and Doubling for 30 years is equal to 1BillionX. Will we Backup our brains in the Cloud? Will there be Regulation?

Thanks to the pioneering studies by Kenyon there is now a strong reason to think that genetic or drug-induced extension of lifespan could delay the onset of diseases of old age. This concept has revolutionary implications. Kenyon discovered that mutations that reduced the activity of the DAF-2 gene doubled the lifespan of the worms which remained youthful and active much longer than their wild-type, normal counterparts. These observations suggested that DAF-2 mutations altered the rate of ageing demonstrating that a single specific gene could have a truly profound effect on ageing. Cynthia Kenyon wrote: "to me it seems possible that a fountain of youth, made of molecules and not simply dreams, will someday be a reality." The new work suggests that the accumulation of insoluble protein may not be the only cause of cognitive decline in frontotemporal lobar degeneration. Another mechanism could involve how the body deals with injured neurons in the brain. "These cancers may be using Progranulin as a sort of 'invisibility shield' to hide from the surveillance of the immune system," Kao said. "Thus, Progranulin could represent a druggable target in both neurodegeneration and some forms of cancer."

Optimism & Psychology

"Those who say it can't be done are usually interrupted by others doing it" – James Baldwin (1924-1987)

Optimism about future for youth reaches all-time low. Only 44% of Americans believe today's youth will have a better life than their parents. (Gallup – 2011). A primary reason people believe life is getting worse is that our information about the problems of the world has steadily improved. By contrast, during the 19th century, there was virtually no access to news on a timely basis. Over the past 200 years, there has been one constant: pessimistic forecasts about human prospects based on anecdotes about social ills which have been repudiated by the reality of material progress.

A positive loop for Mankind is division of labor, specialization, innovation, time saved, and prosperity (Source: Main Management). This has been accomplished through technology. In 1996, the ASCI Red was the world's fastest supercomputer with 1 teraflop (1 trillion floating point operations), cost $55mm, and took up 1600 feet of floor space (80% size of tennis court). In 2005, the Sony PlayStation 3 had 1 teraflop, cost $500, and was 1/10 of a square meter in size.

Moore's law can continue, for example, through IBM's "True North" powered by the Synapse chip. IBM's new

chip is the size of a postage stamp that functions like the human brain as it can smell, taste, feel, and hear. The chip contains: 4,000 cores; 1 million neurons; 256 million synapses; 5.4 billion transistors and operates at 46 billion synoptic operations per second and uses less power than a hearing aid. The ultimate goal is to create a computer "brain" that can power computer robots and smart devices. The chip processes various sensory data in parallel just like the brain by merging memory & computing. The working board is 16 chips working in concert representing 16 million neurons capable of processing instructions that would take "racks and racks" of conventional computers.

Governments are bad at picking winners, while losers are good at picking governments.

In 2016, 20,000 people in some of the richest countries were asked: "all things considered, do you think the world is getting better, or worse, or neither getting better nor worse?" The percentage of respondents who thought things were getting better in Sweden was 10%, the USA was 4%, Germany was 4%, and France was 3%.

For perspective, in the years since 9/11, Islamic terrorists have managed to kill about seven people per year within the United States. Each of those deaths are tragic, but some comparisons are warranted: lightning kills about 46 people a year; accident-causing deer another 150; and drownings in bathtubs around 300. That said, Americans continue to fear terrorism much more than drowning in a bathtub.

Psychological literature shows that people fear losses more than they look forward to gains; dwell on setbacks more than relishing successes; resent criticism more than being encouraged by praise. In other words, bad is stronger than good.

Regrettably, the hype, hysteria, and spectacularly wrong apoplectic projections will continue. Thankfully, they will continue to be proven wrong.

MAIN MANAGEMENT, LLC

www.mainmgt.com • 415-217-5800
601 California St Suite 200 San Francisco, CA 94108