Joseph N. Pelton

Preparing for the Next Cyber Revolution

How Our World Will Be Radically Transformed – Again!

Springer

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Acknowledgments

This is a book that took a number of years to develop and evolve into its current form. Many people helped me to think about how the future is unfolding in today's world in such a chaotic and sometimes economic and politically unpredictable way. This book is not about small themes and issues. Indeed it is about fundamental issues such as: Can "democratic" values and systems survive the Internet? Can today's forms of capitalism and employment survive "super automation"? These issues demand a great thought and consideration by politicians, economists, technologists, and indeed everyone in society that values a stable, peaceful, and prosperous world that can escape the scourges of war and suppression of democratic values.

Colleagues and friends such as Professor Ram Jakhu of Canada, Dr. Scott Madry of North Carolina, and Dr. Peter Martinez of South Africa, among others have helped to clarify my thinking on the difficult and challenging topics addressed in this book. My friend, frequent coauthor, and superb editor Peter Marshall helped with not only the research, final editing, and structure of this book but also helped to dissect the critical thinking. Others have helped to inspire key thoughts in this book through their seminal writings. In this respect, I would particularly like to thank environmentalist Timothy Morton whose concept of "hyper objects" is a significant idea. It helps to explain why coping with climate change, technological innovation, and super automation is such a difficult problem to cope with in modern society. With sincerest thanks to all.

Arlington, VA, USA Joseph N. Pelton

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About the Author

Joseph N. Pelton Ph.D., is the former Dean and Chairman of the Board of Trustees of the International Space University. He also is the founder of the Arthur C. Clarke Foundation and the founding president of the Society of Satellite Professionals International – now known as the Space and Satellite Professionals International (SSPI). Dr. Pelton currently serves on the Executive Board of the International Association for the Advancement of Space Safety. He is the Director Emeritus of the Space and Advanced Communications Research Institute (SACRI) at George Washington University where he also served as director of the accelerated Master's program in telecommunications and computers from 1998 to 2004. Previously he headed the Interdisciplinary Telecommunications Program at the University of Colorado Boulder. Dr. Pelton has also served as president of the International Space Safety Foundation and president of the Global Legal Information Network (GLIN). Earlier in his career, he held a number of executive and management positions at COMSAT and INTELSAT, the global satellite organization where he was Director of Strategic Policy.

Dr. Pelton has been a speaker on national media in the United States (PBS NewsHour, Public Radio's All Things Considered, ABC, and CBS) and internationally on BBC, CBC, and France 3. He has spoken before Congress, the United Nations, and delivered talks in over 40 countries around the world. His honors include the Sir Arthur Clarke, International Achievement Award of the British Interplanetary Society, the Arthur

C. Clarke Foundation Award, the ICA Educator's Award, the ISCe Excellence in Education Award, and being elected to the International Academy of Astronautics. Most recently, in 2017, he won the Da Vinci Award of the International Association for the Advancement of Space Safety and the Guardian Award of the Lifeboat Foundation.

Dr. Pelton is a member of the SSPI Hall of Fame, Fellow of the IAASS, and Associate Fellow of the AIAA. Pelton is a widely published author with some 50 books written, co-authored or co-edited. His *Global Talk* won the Eugene Emme Literature Award of the International Astronautics Association and was nominated for a Pulitzer Prize. His most recent books include *The New Gold Rush: The Riches of Space Beckon!*, *Global Space Governance: An International Study*, and the second edition of *The Handbook of Satellite Applications.*

As director of Project SHARE, while Director of Strategic Policy for INTELSAT, he played a key role in the launching of the Chinese National TV University that now is the world's largest tele-education program. He received his degrees from the University of Tulsa, New York University, and Georgetown University, where he received his doctorate.

Chapter 1
What Is the Cyber Revolution?

Within a few decades, machine intelligence will surpass human intelligence, leading to The Singularity – technological change so rapid and profound it represents a rupture in the fabric of human history.

Ray Kurzweil, The Law of Accelerating Returns (http://www.kurzweilai.net)

I really think there are two fundamental paths [for humans]: One path is we stay on Earth forever, and some eventual extinction event wipes us out…. The alternative is, become a spacefaring and multi-planetary species.

Elon Musk (Nick Stockton, "Elon Musk Announces His Plan to Colonize Mars and Save Humanity" Science, Sept. 27, 2016 https://www.wired.com/2016/09/elon-musk-colonize-mars/)

An Epochal Shift in Human History?

The world as we know it is changing. This is no small change but fundamental change. These are sea-changes that will alter the course of human history. There are now truly massive drivers of change afoot. These basic shifts are much larger than most people comprehend. Certainly, we are not prepared for the "Cyber Revolution" or transformations that 'Space 2.0' can bring about. These capabilities can open the door to what we call "the Fourth Wave Economy." In this Fourth Wave Economy work will be redefined. The Internet will challenge democracy. NewSpace systems can not only create a new space economy but also totally new capabilities that might allow us to create new space structures that could allow us to better cope with climate change or even terraform Mars so that its newly created atmosphere can sustain vegetation and life.

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Earning a living will take on new meaning in this Fourth Wave, an economy that will be circular rather than disposable. New technologies and new social and political practices can at least enable us to have a chance to meet the challenges of our times. Oddly enough the drive to cope with the effects of climate change will not only be our biggest problem but will also represent an opportunity. Coping with atmospheric change on Earth and perhaps on Mars – could also be one of the largest drivers of economic growth. Change that once took millennia to occur will now come to our planet in decades.

Ray Kurzweil has heralded the coming breakthroughs in artificial intelligence a true mega-driver of change. He has dubbed the movement to create human-like AI the "Singularity." Alvin Toffler would likely have called it the force behind the "Next Wave." In the author's book *Megacrunch*, I suggested that change would be driven by several forces that include "super automation," population growth, climate change, and other accelerators of economic, social and political change. These accelerators of change will be almost oxymorons. On one hand these breakthroughs, like super automation, will create huge problems of human employment, compensation, and the need to put the brakes on human population growth. Yet these same breakthroughs may prove vital to coping with climate change, coping with the so-called 'Sixth Extinction' and other challenges of the 'Fourth Wave' Economy. Thus technological breakthroughs will be both the 'yin' and the 'yang' of our future during the rest of the twenty-first century.[1]

Regardless of what we call this next epochal change in human history we can look forward to fundamental and even radical change in every aspect of our lives. This is not something looming in the distant future, but something that will unfold with stunning rapidity within the next few decades. The new Fourth Wave economy will probably take full effect within the next half century. Disruptions to democratic values and processes, climate change challenges and disruptions related to super automation, and over population are indeed occurring now. It will not be as sudden as the transformation of humanity as presented by Arthur C. Clarke in his novel *Childhood's End*, when all youth in the world in a matter of days merge into a giant mind meld where they begam functioning together as a giant global brain. Yet this is the going to be the biggest shift in what people do with their collective lives that ever before in human history. Changes will include how we earn a living, how rapidly we procreate, and where and how we live. If we are lucky we will even stave off the Athropocene disruption of our biosphere that is spaceship Earth. The question is will humans be smart enough to face the demands of future and do so within a very short period of time? In terms this vital condensed period of the Cyber-Revolution time we have to pull off a lot major changes at an accelerated pace.

It has been 4 million years since the arrival of the Southern Ape Man on Planet Earth. If we look at this period of 4 million years as what might be called a Cosmic

[1] In truth, it turns out that 'technological fixes' to human social issues are quite hard to accomplish and when implemented lack staying power. Automobiles were touted to the London City Council around 1900 as a fix to massive heaps of horse manure and city pollution. More recently, the noted economist John Kenneth Galbraith in the 1950s wrote a book that was much celebrated at the time. It predicted a bright future fueled by technology. This book *The Affluent Society* that held out so much hope for the future is today considered an exercise in looking to the future through rose-colored glasses. (John Kenneth Galbraith, *The Affluent Society*, (1958) https://www.goodreads.com/book/show/41589.The_Affluent_Society)

Super Month, then every second of this cosmic time represent 2 years. On this cosmic scale the invention of agriculture comes 1.5 h before midnight of the 30th day of the month. The Renaissance comes 4 min to midnight, and the Industrial Revolution is just 2 min shy of midnight. We have less than a minute of Super Month Time to avoid the sixth extinction, control human population growth, cope with climate change and transform our political, economic and social systems in a way that represents a pathway to survival.

In short, we seem ill-prepared for all the changes that will affect all our lives. This sea-change in how and why we do almost everything will truly be revolutionary and change the entire race of *Homo sapiens* in many diverse ways. We will become a true space-faring species armed with powerful new technologies undreamed of only a few years ago. Smart robots will not only take over labors in agriculture, mining, and manufacturing but also in a rising spectrum of service occupations – in areas that we today consider to be the domain of humans, such as accounting, health services, pharmacology, engineering and more.

Why are we so very unprepared for this massive change to our lives? The answer apparently comes from environmental philosopher Timothy Morton, who invented the term "hyper-object" in 2007. Morton explained this concept of a hyper-object and what it meant in a book by that name in 2013. It is a term he used to describe a concept so large and so "massively distributed in time and space relative to humans" that we really have a hard time grasping it or its implications for our past, present, and especially our future.[2]

The universe, second-generation star systems, climate change, exponential increase of the human race, cosmic hazards – and for some of our politicians, trigonometry – might be said to fall into the category. Tell most people that an asteroid will hit Earth and end the human race in another week, and they will react with alarm and hysteria. Tell them that population growth, climate change, cosmic hazards and other mega-trends will destroy the human race in another 1000 years and such warnings – despite being substantiated by reams of scientific fact – will have little positive effect. Such cautionary messages will be discarded without much further thought. This type of longer-term warning becomes easy to dismiss by members of the general public because it is too far in the future and too massive in scope to be truly comprehended – to whit a 'hyper object'.

Far-sighted individuals such as Elon Musk and Stephen Hawking have talked about what it might take to colonize Mars and why it is vital to do so. Musk is developing a super rocket known as the Big Falcon Vehicle (BFV) (or Big F….ing Vehicle) that would, in theory, be able to take a significant number of astronauts to Mars. Musk has explained his vision of settling Mars and why it will take a colony of a million people to make such a colony sustainable for the longer term. Other visionaries have even more ambitious schemes. Arthur Clarke has even envisioned how 'von Neumann' self-replicating machines might, in time, be able to transform a planet the size of a Jupiter into a star so that it could generate a new solar energy source for colonies further out from the Sun.

[2] Meara Sharma "Why We Can't Comprehend Climate Change", Washington Post, April 8, 2018, p. B-1, B-5.

People have not grasped that we are truly on the technological verge of being able to create new types of structures in space that could save us from massive solar storms, or allow an atmosphere to form on Mars, or create a heat pipe that could pump trapped heat out into the void of outer space. We have yet to realize our potential or understand the seriousness of the threat we face from dangerous hyper-objects that threaten our longer term existence. This book is thus both a cautionary tale and an exploration of the human potential. Our challenges are technological, social, cultural and political. In the age of the Internet, the political challenges may prove the largest.

CEO of Planetary Resources, Inc., Peter Diamandis, has teamed with such partners as James Cameron in his efforts to create an asteroid mining company that will bring new riches to a global economy and would in time bring actual industrial production systems to outposts in space. Even this author, in his book *The New Gold Rush: The Riches of Space Beckon,* has talked about a trillion-dollar space economy and the unlimited resources that extend beyond the limits of the world we that we live in. Too often our political leaders have a tough time 'thinking outside the box.' Of course, this is not thinking outside of the box but thinking outside of the orb. Our "box" or "orb" on which we live needs to be seen for what it actually is. Our world is a 6-sextillion-ton orbital spacecraft that is traveling through space at 100,000 km or about 66,000 miles an hour.

There is a future potential of a vast new multi-trillion-dollar space economy and the potential of a space industry that extends beyond the gravity well we dwell within on Planet Earth. But such a possible future is generally rejected as farfetched or simply irrelevant. This is because for 99% of all humans, such things are simply not real. Such flights of fancy, science fiction, or space enthusiast speculations can be ignored as not being relevant to most people's everyday lives. The average man or woman in the street thinks in terms of things that relate to occurrences that happen a day, a week, or perhaps a year from now.

Really big and massive things that are decades in the future tend to become 'hyper objects' and discarded as being too complicated and too remote in time to be considered a topic for average people. Almost all thoughts about the very long-term future and especially large-scope subjects that are complex and difficult to understand become what Tim Morton calls a hyper-object. Such 'science fiction' does not relate to the world we live in. For most of us, our world contains mortgage payments, sports events and news, TV and movies, marriage and divorce, the birth of kids, trips to the emergency rooms of hospitals or clinics with broken ankles and other 'real life' issues and problems.

But in truth there is today a space and cyberspace revolution afoot. This revolution, that is producing new technologies, new services and new capabilities, is reshaping the world we are living in and reconstituting our economies, redefining the nature of our jobs, and disrupting the way things are done.

This technology-driven revolution that is bringing the Fourth Wave of disruptive change to the global economy also brings us the opportunity to recognize and confront the key hyper-object challenges that humanity faces today. These challenges are, in order of importance: climate change, population growth (especially

in terms of megacity vulnerabilities, air and ocean pollution and resource consumption), cosmic hazards and super-automation, a global employment crisis, and jobs lost due the coming of the Cyber Revolution. There is, of course, always the joker in the deck, represented by weapons of mass destruction and potential world war involving chemical, biological and nuclear weapons.

There have always been large-scale and disruptive threats to the world economy and social and cultural revolutions that humans will seemingly always have to face, but these hyper-object threats are larger and more profound than those faced in the past. This latest Cyber Revolution that is coming to your neighborhood soon will be even bigger in scope and impact than a world war. Perhaps only the Black Death had an impact on humanity that might be considered comparable in its disruptive force, but the plague impacted tens of millions of people, while the Cyber Revolution will impact maybe as many as 10 *billion* people.

What Has Changed to Create the Cyber Revolution That Is Now Unfolding?

What has changed? The answer is, almost everything. We just don't know it yet.

The global population is rising to dangerous levels that might reach 12 billion by 2100. Worldwide vulnerabilities have risen with urbanization that has now reached 53%. This mega-trend might reach 80% urbanization by 2050. Urban infrastructure is subject to the rising possibility of terrorist attack and natural disasters. One of these mega-threats that is under-reported is the rising potential of solar storms, called coronal mass ejections (CMEs). This type of solar storm will, in coming decades, pose a much greater threat due to current shifts in Earth's magnetic field. This natural magnetic shielding currently largely protects us from solar storms, but the shields are coming down.

Scientists now tell us we have entered the Anthropocene Age, where human industrialization and population has put us on a pathway to potential global transitions that threaten the viability of our planet as a safe place for human life. These potential changes are calamitous climate change, global warming, water shortages, ocean flooding of cities and the destruction of the vital infrastructure on which over a billion people depend and many trillions of dollars are invested. The threats are increasingly clear. The key follow-on question is, can our space and cyberspace technologies and systems provide us the capabilities to reverse climate change and global warming? Can desalinization plants and water purification systems provide us the water reserves we need? Can the rise of ocean levels, the intensity of hurricanes and typhoons be reduced?

Finally, there is the additional concern of super-automation that raises a new type of specter looming over global employment. AI, smart robots, and clever algorithms will upend global employment, but with forethought, can their impact on jobs, income and fruitful human occupation be minimized? Simple extrapolation of current trend lines related to super-automation technologies indicates that almost all

service jobs that exist today will be reduced. This is crucial, since 80% of the jobs of those that live in economically developed economies are in the service sector. Most employment projections are concealing or under-reporting the amount of job loss or job redefinition that will occur.

Bill Gates, who has even proposed putting a tax on smart robots, is one of the few who has envisioned the scope and scale of the Cyber Revolution. His company, Microsoft, is one of the major developers of AI systems and has one of the best overviews of how AI could impact global employment – and in a huge way. As such, he is also one of the few people who has put his finger on the size and future magnitude of this transition.[3]

The question is whether economists, technologists and political leaders anticipate the degree to which AI drives change. Will they and other leaders move quickly enough to find new and constructive answers to this massive change? Our unvarnished answer at this time is no. The leaders of the world economy are sitting on their hands and hoping that somehow it will all be okay. This is not an answer. This is, in fact, a giant cop out, and very soon we could be in deep trouble with very few answers and even fewer essential reforms. This book is a call for leadership to wake up and to start taking action.

Almost 30 years ago the author made predictions in his book *Future Talk* and *e-Sphere: The Rise of the World Wide Mind* about the rise of 'electronic immigrants' that could result in jobs being exported to other lower wage countries. As the cost and price of broadband communications and IT services plummeted, this is exactly what has happened.

Decades later, politicians bemoaned the fact that no one anticipated this problem with service jobs being shipped overseas. However, there were warnings. Super-automation and its impact on employment remains a huge problem that economists, technologists, and political leaders need to address while there is still time. Technology is creating this issue, but technology can also help to solve it. Yet we feel so helpless to solve these problems, because they are so huge, it seems best to simply ignore them.

Our business community and political leaders are not prepared for the threats that the coming Fourth Wave portends. Yes, big changes are coming, but what can the individual do about it?

No one seems well positioned to cope with climate change, overpopulation or super automation. And if the Cyber Revolution is going to create a Fourth Wave economy, where smart robots and AI algorithms take over a massive number of service jobs in the future, what could possibly be done about it?

As hinted earlier, the very technologies that constitute super-automation may also help us cope with these problems. Indeed, this might be a key part of the solution. It just might be possible that the best hope for the future would be to see how Fourth Wave systems could help address these problems.

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[3] Geoff Colvin and Ryan Derousseau, "Bill Gates Proposes a Robot Tax" Fortune, February 22, 2017. http://fortune.com/2017/02/22/bill-gates-proposes-a-robot-tax/

The key thesis of this book is that we just might be able to use hyper-object threats such as climate change, over population and super automation as a new economic opportunity. Oddly enough the problems that confront us might also hide within them the solution to these problems.

Why Are These Large-Scale Future Threats Suddenly So Urgent?

These problems have become urgent because we live in the 'Age of Future Compression.' New space and cyberspace technologies are exploding onto the scene with unprecedented speed. The future is coming at us faster and faster. What was once science fiction is quickly being replaced by science fact and beta-testing of systems based on space and cyberspace technological reality. We are no longer just having future-oriented thoughts about space travel or solar power satellites or smart robots that in coming years will likely become as capable as humans.

IBM's Watson is here and being applied to medical diagnosis, to smart city planning, and even to filling out tax returns. We have filings at the International Telecommunication Union for large-scale low Earth orbit constellations of small communications satellites and remote sensing. These innovations and much more are already here or are on the cusp of happening. Plans for new space ventures are blossoming not only in places like Silicon Valley but also in Toulouse, France, and Star City outside of Moscow, Russia. Further, remarkable new space ventures are underway in places like ISRO headquarters in India and the Chinese National Space Agency as well as with a number of start-up Chinese space companies such as CASIC that is developing the OneSpace launcher.[4]

At the 2018 Space 2.0 Conference in San Jose a group known as Orion Span announced their Aurora One 'luxury space hotel' that they suggested might be in space and operational by 2022. This modular system is projected to start with a crew of two and with six guests – if they can find paying customers that can afford $10 million for a 12-day stay in orbit.[5] And if this seems too much like vaporware, it should be noted that Bigelow Aerospace has both its Genesis 1 and Genesis 2 spacehabs already up and flying as beta tests for their space hotel. Robert Bigelow, who heads Budget Suites hotels on Earth, is hoping to play host in Earth orbit (Fig. 1.1).

However, 'Space 2.0' driven products and services are only a part of the evolving new economy that are symptomatic of the Fourth Wave economy that is driving innovation. It is actually the cyberspace industries that are truly driving our future

[4] Jeffrey Lin and P.W. Singer, "Watch Out SpaceX: China's Space Start Up Industry Takes Flight," *Popular Science,* April 22, 2016. https://www.popsci.com/watch-out-spacex-chinas-space-start-up-industry-takes-flight

[5] Maureen O'Hara, "First luxury hotel in space announced", https://edition.cnn.com/travel/article/aurora-station-luxury-space-hotel/index.html

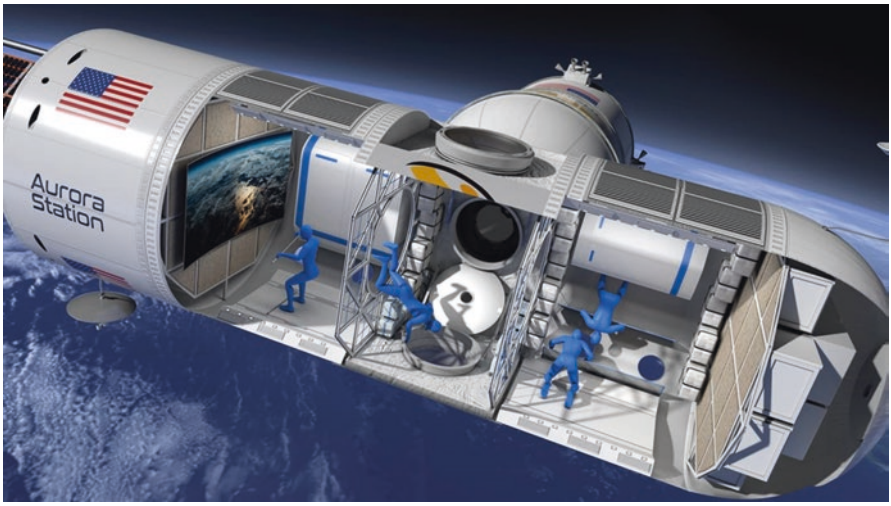

Fig. 1.1 The mock-up of the Aurora Station space hotel by Orion Span. (Graphic courtesy of Orion Span)

and the Fourth Wave forward. Just as Space 2.0 is coming out of Silicon Valley so are new AI algorithms and a myriad of new Internet-based disruptive technologies.

Ray Kurzweil, when he was made director of engineering for Google in 2012, said that AI algorithms will be "smarter" than humans as early as 2029. He has defended this seemingly over-ambitious prediction as being far from radical:

> *Today, I'm pretty much at the median of what AI experts think and the public is kind of with them…..The public has seen things like Siri* [Apple's voice recognition software that Kurzweil developed]*, where you talk to a computer and a 'computer' talks back to answer all your questions. They've seen the Google self-driving cars and almost daily new innovations. Predictions of new technologies about amazing new capabilities do not seem to be so radical any more.*[6]

Greg Wyler won the Arthur C. Clarke Innovators award in 2015 and he chatted about sustainable energy. He said that the cost of photovoltaic cells was decreasing very rapidly, and that this would allow the amount of solar energy systems to reach a level of doubling as rapidly as every year in the future. He indicated that these kinds of breakthroughs in sustainability and green energy would become commonplace when the Singularity was achieved.

What will be so different about the age of the Singularity? Large-scale employment, wealth, national power and warfare will likely be totally redefined. We might well see a single Russian multi-billionaire oligarch become not only one of the world's most powerful people but one of the world's most powerful "pseudo-nations." Let us repeat that, so that it can sink in completely. In the area

[6] Adam Withnall "World's leading futurologist predicts computers will soon be able to flirt, learn from experience and even make jokes", *The Independent,* February 23, 2014. https://www.independent.co.uk/life-style/gadgets-and-tech/news/robots-will-be-smarter-than-us-all-by-2029-warns-ai-expert-ray-kurzweil-9147506.html

of super automation and the Singularity, a person can buy artificially intelligent soldiers, subjects and military power. We did not want to believe that when we saw a possible future in the movie *Star Wars: Attack of the Clones.* Yet, such a future could occur. Perhaps in 20 years, one could invest a few billion dollars and buy a totally dedicated clone or AI-controlled robotic army that one person or computer program could totally command.

Such a robotic army of clones, controlled by only one person or a powerful cadre, could become overnight one of the top hundred military armies in the world – if not one of the top fifty. The old equations of power based on land area, human population, or agricultural production are suddenly evaporating into the shadows of the past.

At a Comsat conference in Washington, DC, in the early 1980s, Arthur C. Clarke said that the most important invention of the twentieth century was artificial intelligence. At the time the HAL computer from *2001: A Space Odyssey* sprang to mind. None of us at the time, however, had a clue as to what a specter of sufficiently powerful robotic machines of the future might bring. Today we are just beginning to think about AI-enabled robots and what they might be able to do. Ultimately, they can and probably will change every dimension of modern life. We are just beginning to understand what such a future reality will truly mean for jobs, warfare and power. Again, the key question is whether these powerful new technologies can be used to address the biggest challenges that face human society.

Everyone from Isaac Asimov to Elon Musk – and even several of the *Terminator* movies – has warned us about a future dominated by AI machines. In most cases people think of something like "Skynet" or VIKI from the *I, Robot* movie when they think of possible coming robotic threats. They envision a future world where the machines take over the world in order to rule people. They don't realize that the much more likely near-term outcome could be a time in which unprincipled people with money and power create cyber-powered networks and machines to create their own centers of power and control. The result might be the rise of rogue corporations or even rogue nations with unbridled cyber-based power. It is this cyber threat from AI-enabled robotic systems that could constitute a much more real and much nearer term threat. This is not to dispute that the longer-term threat could come as well.

Ultimately the biggest near-term threat might be not finding creative ways to use smart machines and AI algorithms to address the collective 'hyper-object' threats of climate change and overpopulation. The most difficult challenge of all might ultimately turn out to be super-automation – in terms of unemployment and social and economic displacement in society.

There is radical and fundamental change coming. This change, if we are not careful, could have a devastating impact on just about everything. The nature and very definition of work, education, health care, warfare and even human survival as a species are going to be swept up in the sea-change we are calling the Fourth Wave. But this change will be driven not by clone-equipped armies. It will not be driven by families buying a servant robot to clean their houses and cook their meals. Much of the fundamental shift in the world economy will be driven by the "NewSpace" economy and all of the amazing new technologies that are generating a cornucopia of new capabilities.

Entering the Fourth Wave Economy

Alvin Toffler in his groundbreaking book *The Third Wave* explained how humans evolved for millions of years as hunter/gatherer nomads until, about 10,000 years ago in 8000 B.C., they discovered the advantages of farming and agriculture. With the planting of seeds and the cultivation of crops they could create towns and cities. There could be specialization of skills, and new professions blossomed; people could be warriors, architects, craftsmen, etc. This was the first wave in the evolution of human civilization.

With the Renaissance there was a burst of new knowledge and the rise of scientific experimentation and engineering techniques. This enabled the birth of the Industrial Age. At this time 90% of the population of the world worked on the land as farmers, miners or related labors. Over a period of some 200–300 years the employment patterns around the world changed. More and more people worked in factories to produce products and machines. Those machines included tractors, harvesters, seeders and plows that allowed the industrialization of farming. Other machines enabled the mechanization of mining. Today, in industrialized countries, about 3% of the workforce is engaged in farming or mining. The Industrial Age, or the Second Wave, lasted from around 1700 up until the middle to latter part of the twentieth century.

In the 1950s the industrialized plants that made machines and products began to be automated. These plants could increasingly produce computers, processors and smart telecommunications and information technology products that could replace the industrial worker in more and more tasks. Fewer and fewer workers were needed on assembly lines that were not only automated, but the plants could operate 24 h a day with software that could direct everything.

The Third Wave, based on a service economy, increased unemployment of industrial workers. Workers on assembly lines hit their employment peak in the 1960s. There are many workers still in industry today, but more and more their jobs are in services such as sales, accounting and various forms of planning and management. Toffler's books, *Future Shock* and the *Third Wave,* and David Bell's books about the post-industrial society, were about how the service economy was driving employment and economic growth.[7]

The First Wave lasted 10,000 years, the Second Wave 300 years, and the Third Wave gave birth to the service economy, which has now lasted some 60 years, but its days seem numbered.

The Fourth Wave will be the age of NewSpace and AI and the new technologies that they will engender. These will include 3-D printing/additive manufacturing, sustainable and renewable energy systems, self-aware machines (SAMs) and intelligent robotic systems, plus a remarkable range of Internet-based applications that disrupt established industries and services. There will also be a host of other

[7] David Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (1973) Basic Books, New York.

developments that include 'smart' drones, reusable rocket launchers, on-orbit services and more. The Fourth Wave will be fueled by new industries and challenges that will be spawned by the trillion-dollar NewSpace industry and AI systems and will redefine what people do with their lives, as the meaning of work and productivity are reinvented.

The presidential election of Donald Trump in the United States, the passage of Brexit in the UK, the rise of Marine Le Pen's popularity in France and the shifts of political allegiances in Eastern Europe are not accidents. In a variety of ways these 'popular rebellions' are all fueled by those who see technological innovation and the impending arrival of the Fourth Wave as a bad thing rather than as a potentially good thing. They are concerned about the loss of jobs in industrial rust belts that are visual reminders of the downside of the shift of employment from the Second Wave to the Third Wave. Voters in the United States and Europe are worried about the prospect that new technologies and automation could decimate the service jobs of the Third Wave, on which so many workers depend. They are beginning to fear that the Fourth Wave economy might well erode all but high-tech jobs as super-automation advances.

Political leaders will – as they have so many times in the past – ask the stunningly uninformed question: "Well, why didn't someone warn us this was coming?" The answer is, of course, that they did, but it was preferable for them to ignore the "dying canaries" that warned us of technological unemployment, the downsides of super automation, the hazards of global overpopulation and super urbanization. Even the consequences of climate change are not fully understood by the electorate, though many sensed they were going to be a part of a diminished future.

Coal miners, assembly line workers and millions of others who are seeing their jobs disappearing are scared, angry and confused, and see no hope for the future. With trends associated with super automation, the future is clearly in a state of transition. No politicians are going to be able to bring back the lost jobs from the past. We are indeed entering a new economy that is driven by automation, artificial intelligence, big data, networking, the NewSpace systems and disruptive economic concepts that are centered on education and learning new skills.

However, these populist rabble-rousers are able to stir emotions, especially against immigrants, and exploit the angst that comes from the rapid economic transition now so prevalent in today's world. This means that the modern world is at a critical crossroads.

Several key trends are happening at the same time:

- New opportunities are opening up as a result of disruptive new technologies, such as labor-saving devices and self-aware AI, and a wide range of new industries that can speed the rate of innovation.
- Several key problems are confronting the world economy in tandem. These include: (i) rapid global population growth and even more rapid urbanization; (ii) climate change and growing global pollution; (iii) threats from terrorism (including cyber-terrorism), rogue nations with chemical, bacteriological and nuclear weapons and religious extremism; (iv) inadequate education and health

care systems; and (v) new economic and employment concerns that arise from super automation and the Singularity, which will compound job-related and economic issues associated with the Fourth Wave economy.
- Political leadership, regardless of their orientation, has been slow to recognize the complexity of the technological, environmental, economic and demographic issues that face modern society and the need for fundamental shifts to adjust to a Fourth Wave world. Instead of reform and basic adjustments to the above problems, there are emotional appeals to supporting populist agendas and in some cases extremist appeals to racism or anti-immigrant sentiment. This will only hinder the possibilities of rational response to current challenges that the Fourth Wave constitutes.

A Quick Tour of the Cyber Revolution

In the chapters that follow we will present the challenges of the Fourth Wave and possible strategies, using proactive planning (or futuring) to help us survive a time of great turmoil and transition – perhaps greater than humankind has faced to date.

We will explore hyper-object threats in more depth. This also entails examining in greater detail the key dimensions of the threats related to overpopulation and the growth of megacities, climate change and pollution-related problems, and how new capabilities can be applied to the challenges posed by the mega-trends that could threaten our future. We will first explore the nature of the major hyper-object challenges to be faced in the next few decades and then possible NewSpace and cyberspace responses that can help respond to these large-scale problems. This will examine how we might have to adapt our economic and technological practices and as well as our industrial production, supply, and market-based systems to meet the challenges.

As a first step we need to better understand the challenges posed by climate change, surging demographics, super-urbanization, natural disasters and especially cosmic hazards, including those that could become more deadly in threatening vital infrastructure as well as the coming era of super-automation and the Singularity. All of these forces will reshape our world in powerful ways. Once we grasp the full scope of the threat, we can begin to find ways to marshal Fourth Wave systems and technologies to address these so-called hyper-object challenges – politically, economically, environmentally, technically, socially and culturally.

We will explore how the expanding new space and cyberspace industries could help us address these various twenty-first century problems that we have characterized as the Cyber Revolution. These growth industries have many applications that go beyond coping with major challenges. The prime focus of this chapter, however, is to examine how these industry innovations can help to address the problems of overpopulation, overcrowded cities, and climate change and accommodate the changes that come from super-automation and the Fourth Wave economy.

Exploring the potential of smart cities and proactive planning is also covered, as a key response mechanism. This means we will explore techniques developed and tested in modern urban planning and the creation of smart cities, to see how this can help. We will begin to examine the need for and opportunities presented by greater cooperative economic and political actions in the smart city era. This is critical, since 80% of the world's population will live in an urban environment. Ironically the growth of the Internet and global social networking may form a valuable tool to support proactive planning, but these same capabilities also may also constitute a major barrier to the use of these techniques within modern democracies.

What type of education and health care systems are best suited to the needs of society in the decades ahead? As the many diverse demands of the Cyber Revolution become clearer and the challenges more demanding, we need to find way of coping with a world community under pressure to reform.

What is the meaning and the impact of the so-called personal communication revolution and nearly universal broadband networking in the age of the Cyber Revolution? There will be particular challenges related to living and thriving in the world of the Internet that will ultimately become the Internet of Everything. This world of broadband services and omni-present social networking will create its own unique set of challenges, which will include such issues as the lack of personal and societal privacy, the invasive nature of ubiquitous automation and the need to cope with constantly changing technological systems and software that requires mental agility to adjust to its latest iteration. In this world of universal Internet and constantly adapting software humans will strive to keep pace with ever faster and demanding smart machines that never rest. On top of it all will be the need to cope with information overload.

Finally, we will provide an overall analysis of the many twenty-first century challenges that will beset our spaceship planet in the Cyber Revolution. By the end of the century virtually every aspect of life as we know it today will have changed. It is essential that we change the ways we cope with climate change, the ways we seek to control urbanization and population growth, the ways that we plan our cities, the ways that we provide education and health care, the way that we share knowledge and use broadband communications and the way we live and earn an income. This will all change as we share our planet with smart robots and as the Singularity takes root and alters life on our planet. Some people feel that this change will be scary and disruptive, and the 'progress' that is coming is really not progress. The future, however, is a one-way gate. What humans may become will be revealed by the technological future, and we must be ready and adapt to change. We must find ways to marshal the force and intelligence of high tech industry to save our planet from overcrowding, climate change and super-automation. We must not only survive the Cyber Revolution but advance the human race to the next stage in its evolution. The twenty-first century represents a narrow and potentially perilous pathway to the future. Let us all hope we can succeed in creating a better future.