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Societal Futures to Inform Space and Aero Planning: A Technological Projection: *"We Change Our Technology and Our Technology Changes Us" [Kevin Ashton, ref. 1]*

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Table of Contents

Introduction

It is axiomatic that technology is the basis of society [ref. 2]. Over past decades and continuing, humans have invented, developed, and deployed a vast and increasing array of revolutionary and disruptive technologies. It has been suggested [ref. 3] that we are Homo Technicus, with the current state of affairs likened to the "Wild West". These technologies are altering human society and increasingly the humans themselves and are binned under the broad categories of Information Technology (IT), Bio, Nano, Quantum, and Energetics, with the internet being the poster child for the greatest recent impact thus far on human society [ref. 4]. These technology revolutions began in the 1950s with development of solid state electronics, followed by the biologic revolutions in the 1960s with DNA and genomics. The nano revolution began in the 1990s with self-forming nano tubes, and quantum technology, and energetics into the 2000s. These technologies all have potentially significant favorable and adverse impacts. The world has already experienced this with fossil fuels, which powered the Industrial Age, but caused increasing adverse climatic change.

Artificial intelligence (AI) is an emerging technology that has the potential to revolutionize human society, but with adverse impacts on human employment. This time is different with regard to machines taking jobs. Humanity has never before created additional intelligent species [ref. 5] with intelligence apparently different from human. The projected capabilities of Artificial General Intelligence [AGI] include machines providing lower costs and much greater capability across the jobs spectrum than humans, especially now that AI can ideate/create. AGI has very worrisome potential impacts, including the potential to render humans redundant (some suggest humans could become pets or are even eradicated).

The studies, projections, and "futures" discussions of ongoing and nascent tech developments are often focused on individual technologies and their nearer vice longer term impacts. There are, however, studies of technology timelines going into the future [e.g., ref. 6] to the end of the human era and the rise of a new super intelligence [e.g., refs 7 – 29]. Nearer term, as AI develops into AGI at human level and beyond [ref. 30] termed the Singularity, there are serious issues with ensuring that AGI is friendly to humans. From ref. 23, reasons not to fear the singularity include the possibility of immortality, freedom, utopia, abundance, sustainability, space travel, preserving history, embracing change, and more. Reasons to fear the singularity include human extinction, giga war, economic collapse, environmental collapse, fear of change, and more. Overall, future projections have proven to be optimistic in the nearer term and conservative in the longer term. The conclusion per ref. 23 is that if humans survive the singularity, then they would have to change fundamentally.

There are three nearer term societal issues that are most worrisome. These include solar storms that could destroy much of the IT upon which society is now wholly dependent upon, climate change, and the AGI/technical singularity issues. Of these three, the first two have solution spaces. However, AGI issues are not yet fully formulated, with extant projections for such across the range from no problem, we will accommodate, to the demise of humans and many variations in between. This is very much forward work as AGI develops. There are many other issues that beset society; some natural but most human engendered, and the later adjudged as more serious nearer term threats than natural vulnerabilities. Overall, humans have up to now been too successful as a species, are working themselves out of a job and out of a planet. Extant projections indicate a 19% probability of human extinction before 2100, due to anthropogenic technological causes, both purposefully deployed and by accident [ref. 31].

In general, tech developments have outpaced the capability of society to adequately study and regulate them for the good of society. Also, the amygdala part of our brain tends to make us conservative and nearer term. There is a need for more consideration and study/evaluation regarding combinatorial longer term impacts of technologies. Cigarettes and fossil fuels are obvious examples where longer-term consideration would have been extremely efficacious. There are many others. The current situation of tech development hyperdrive has increased the societal consideration of technology impacts latency period from some decade or so to a situation where we are "winging it". This lag in societal consideration potentially has massive societal downsides in several cases [ref. 32]. The early and quintessential treatise on the emerging societal changes from the now developing techs was the turn of the millennium article by Bill Joy titled "Why the Future Does Not Need Us" [ref. 33]. Joy writes, "Our most powerful 21st century technologies – robotics, genetic engineering and nanotech – are threatening to make humans an endangered species". A wakeup call that spawned many books and much commentary but little definitive evaluative and regulatory action.

The societal situation with respect to the developing technologies is akin to the introduction to Dickens' "Tale of Two Cities;" "It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of light, it was the season of darkness, it was the spring of hope, it was the winter of despair". Thus far, citations expecting the worst going forward appear to outnumber those that indicate it will be getting better or bearable. Much of the commentary pertaining to the situation going forward is concerned with wet electrochemistry-based humans. As discussed herein, there is a spectrum of other possible futures involving the ongoing human evolution of humans and associated altered humans.

Then there is the tech "dual use" military application landscape, national security applications/issues, which the current commentary does not address. This discussion assumes the "Technological Completion Conjecture" of Bostrom" [ref. 9], that states "If scientific and technological development efforts do not effectively cease, then all important basic capabilities that could be obtained through some possible technology will be obtained". In other words, if one area tries to halt a technology it proceeds in another area, unless there are obvious major downsides and/or worldwide regulations enforced. Whatever can be done technically will be done if it is in some sense "useful" and worth the investment. The poster child for this is "franken food" (genetically modified food products), abhored in some parts of the world to greatly utilized and developed in other parts.

In the Hunter-gatherer Age, nature provided. In the Agricultural Age, we controlled nature. In the Industrial Age, we mechanized nature, and in the IT Age we automated nature. Now, in the Virtual Age, we are robotizing/intelligizing nature. However, we are increasingly relying on complex systems whose risks we do not or cannot calculate [ref. 34 and 127].

This discussion is an attempt to consider the developing future societal context to inform space and aero forward planning, including the ongoing evolution of the humans by the humans. It does this by summarizing some of the multitude of revolutionary technologies now under development. This includes nascent, extremely society changing ones, and the major societal threats/issues based upon tech combinatorials [refs 35 – 37]. The various laydowns shown herein for revolutionary/emerging technologies include powerful new solution spaces for cyber issues, climate and energy, food and water, Martian colonization, do-it-yourself (DIY), and physics, which, along with biological and AI developments, have the potential to significantly change econometrics and create a plethora of serious-to-existential society issues. This is then utilized to make responsibly imaginable projections of the consequent impacts upon society going forward from a technological perspective.

Revolutionary Concomitant Technology Developments

AI/AGI - Circa 2012, machines became capable of executing neural nets in a useful manner, informed by big data in a process termed deep learning [ref. 38]. This particular approach to AI has grown rapidly across an expanding spectrum of applications and issues with respect to capabilities, research scope, intensity, market size and importance to society. An example of an important to critical application of AI is the ever-increasing shift to decisions by algorithm/AI. In specific arenas, the neural net AI approach has already attained or exceeded human capability and recently, on college boards and intelligence tests, AI was at the level or higher of a normal human. The observations of "Black Box" behavior/ideation/production of unique solution spaces by AI via processes opaque to humans [ref. 39], suggests that human intelligence is not unique. The critical application issue with respect to this AI approach is data curation. Uploading data from the web is in progress.

Applications of AI are burgeoning and developing from focus on specific tasks to ever larger contexts, including autonomous vehicles and systems. AI has improved process efficiency, reduced human errors and labor, and extracted insights from big data. Current applications include customer relationship management software, recruiting services, workforce productivity, resource planning tools, financials, optimization, and autonomy [ref. 40]. The Generative Adversarial Networks [GANS] approach is a very capable ideation engine. AI is proving faster, less costly, and is more capable than humans. It is therefore increasingly replacing humans in the workplace [refs. 41, 42] and we are creating additional intelligent species. There are projections of AI developing super human capabilities [refs. 43 - 46] for an increasing number of applications including autonomous robotics, direct brain-machine interactions/communications, a global mind, data analytics, and machine invention. For capability, safety, and cost reasons, AI is critical to the affordable expansion of humankind out into the cosmos, the economic development of deep space, and development of Advanced Air Mobility [AAM] and Personal Air Vehicles [PAVs]. The projections of the putative impacts of AI upon society are major to massive, in both favorable and many not so favorable ways.

Autonomous systems could, now or going forward (compared to human operation) [ref. 47]:

- Know far more
- Be less expensive
- Exclude operational human error

- Have far less latency
- Provide new functionalities
- Have far longer duty cycles
- Provide size reduction(s)
- Be faster and more efficient
- Be far more durable, and "patient"
- Operate at conditions and perform functions where and in a manner that humans could not

AI is increasingly demonstrating intelligence as good as humans in many respects but not particularly humanlike. There are increasingly nearer term projections for the development of AGI, human level and beyond, with up to existential impacts upon humanity. The critical challenge for AI of data curation is being approached by uploading the web.

Autonomous Robotics [refs. 48 – 50] - The fundamental aspects and precepts of trusted autonomy are safety, security, reliability, and resilience for both "on design" and "off design." On design refers to the functionalities and states required to execute the design mission, and off design refers to conditions and operations at other than those included in the parameters and conditions for design operability. Autonomy, enabled by AI and IT, is increasingly applied to an ever-broader spectrum of conditions and functionalities in the potential presence of known unknowns and unknown unknowns. An obvious overarching example of a known unknown requirement to be considered for all autonomous systems going forward is the preservation of electronic operability—the bedrock requirement for autonomy.

Trusted full autonomy (systems fully operated by machines) requires the identification of and solutions spaces for "untoward events" (also referred to as "edge cases"), conditions/occurrences beyond the operational automation functionalities and design, along with associated system functionalities capable of accommodating such in a safe manner. Sufficient powering is often a key requirement for autonomous robotics, and along with ever more capable chemical batteries and energy beaming there are the Japanese efforts to scale Low Energy Nuclear Reactions [LENR], a weak force, months long battery at some 10,000 times chemical energy density. Also enabling for autonomous robotics is the progress with respect to miniaturization and detection capabilities of sensors. Given the ongoing tech advances in AI, energetics, and sensors, autonomous robotics are/will increasingly replace humans. AI can, going forward, design systems that autonomous robotics can maintain, repair, and operate.

Immersive Presence/Virtual Reality/Holographics/Tele-everything/Digital Reality [refs 51, 52] – Human interaction at a distance has evolved over time from smoke signals, flags, and mirrors to the telegraph, the telephone, early video and, more recently, to augmented reality, virtual reality, and holographic projections, all of which provide increasing degrees of immersive presence. Today, we have early forms of telecommuting, teleworking, teleshopping, tele-education, telemedicine, telepolitics, telemanufacturing, telecommerce, and teletravel. Taken together, they represent early development toward virtual worlds by satisfying all five human senses, with the potential for direct projection into the brain. The tele-everything milieu is headed toward real-time actualization. It is the enabling technology for the now developing Metaverse, as we head rapidly away from the Industrial Age, power through the IT Age, and rush into the Virtual Age of comprehensive digital reality. With the richness of information on the web and the global sensor grid, the developing quantum computing, optical communications, and direct brain-to-machine capabilities, the metaverse should increasingly replace physical travel and interactions, as the extant tele-everything technologies are already doing. Obvious examples include the major shifts to virtual work and the impacts of tele-shopping upon physical retail shopping. The technology with respect to immersive, virtual presence combined with AI is creating a situation where it is increasingly difficult to determine reality from non-reality. Recent AI progress has greatly increased this developing conundrum.

Printing Manufacture – Additive or printing manufacture is a very rapidly developing revolution in manufacture writ large. There is a plethora of additive and energetics approaches. The current downside is the thus far alterations in material properties due to degraded material microstructures. Utilizing Nano scale printing, research has shown that microstructures can be improved, not degraded with factors improvements in material properties. This is very much, as are most technologies cited herein, a developmental work in progress, with ever increasing successful applications. Printing manufacture and the information on the web is apparently creating a planet of DIY and inventors. Using hydrogen, carbon, and oxygen from water and plants, most plastics can be created/printed at home (e.g., DIY) to create much that is needed, vice central manufacturing and transport of goods. The many benefits of additive manufacturing include faster, less material, cheaper, reduced labor costs, products not otherwise possible to fabricate and reduced latency/improved responsiveness and flexibility. This is yet another instance of "machines taking the jobs". Printing has long been on the road to the development of the manufacturing vision in Drexler's "Engines of Creation", molecular/atomic fabrication, and assembling atom by atom, with wonderous, unique possibilities [ref. 53].

Quantum Computing – Quantum computing (QC) [refs. 54 and 55] utilizing superposition, interference, entanglement, logic gates, and measurements can, conceptually, solve any problem that classical computing can. The estimated future market covers many uses [ref. 56], with applications at the trillion-dollar level. There have, over the years, been a wide range of speculations as to the potential speedup that quantum can provide over classical computing, including many large-to-revolutionary values. These drive much of the world-wide efforts in quantum computing, which is very much a work in progress. The major realization issue for QC is long coherence times for Qbits. Many different Qbit approaches are being studied [ref. 54], including superconducting, trapped ion, quantum dot, quantum wells, nuclear spin, electron spin, cavity trapping, fullerenes, linear and non-linear optics, diamond-based, bose-einstein doped optical fibers, and carbon nanospheres, etc. Projected revolutionary applications include encryption and decryption of classical encryption, search, optimization, system simulation including turbulence, chemistry, nanotechnology, AI, and biology including drug discovery.

Challenges in addition to long coherence time for Qbits include increases in numbers of qbits or gates. The current leading hardware contenders [ref. 55] are superconductors, ion traps, photonics, quantum dots, and cold atoms. References 56-65 provide a cross section of the state-of-the-art of quantum computing architectures, references 66-71 for materials for quantum computing, and references 72-76 on quantum computing algorithms. Per reference 77, the imposed fluctuation approach for increased coherence time is being applied. There is much development still needed for turning Qbits operations into a viable "computer", including network/communications related issues and much else [e.g., ref. 78].

Quantum Non Electro-Magnetic (E-M) Vector/Scaler Potential Communications - There are patents and efforts utilizing quantum technology as a communication approach in addition to quantum crypto functionality. This communication approach is based upon use of the vector and scalar quantum potentials with the E-M fields suppressed. The issues associated with E-M communications (our current communications mode) are many, including interception, alteration, cyber attacks, environmental interference, etc. This quantum communications approach, documented in six patents in the 1980s and the Puthoff patents in 1998 [ref. 79] and 2019 [ref. 80], is penetrating, non-shieldable, has a far field signal that drops off as one over distance or "R" vice one over R squared for E-M, is not detectable by E-M devices, has high bandwidth, and utilizes Josephson junctions. The fundamental enabling physics is the Aharonov-Bohm effect [refs. 81, 82]. The approach is under serious development and if successful, will be far more capable in space than even optical communications. Some have asserted that this will go through water. The technology has obvious and hugely important national security implications and would greatly alleviate the huge extant cyber vulnerabilities for a society zeroth order dependent upon electrons for nearly everything.

Direct Brain-Computer/Machine Interfaces/Communication – Brain-machine direct communications (brain-computer interface) can enable greater direct, higher bandwidth interaction than available from the human senses between humans and the machines. Methods to accomplish this range from invasive to increasingly now non-invasive. The several goals of this technology development include interacting with brain embedded IT chips, repairing – to – augmenting brains, improving the efficacy of human/machine interaction, vastly increasing human knowledgeability, enabling the physically handicapped to more fully interact with/participate in the physical world, and operation of prostheses. An end point of this technology is a capability evolving from science fiction to practice, uploading human brains into machines. This overall technology is an important facet of the now ongoing evolution of the humans by the humans toward cyborgism, along with increasing direct human machine partnering going forward. An enduring issue will be the apparent reduction in humans of wet electrochemistry in favor of/toward more durable and capable autonomous robotics composition. An intriging possibility enabled by this technology is education becoming an upload, and with the right brain chips, a massively greater education. This technology also carries with it various possibilities for mind reading and mind control-to-destruction [refs. 83 – 87].

The Internet of Things (IOT) – The vision for the IOT is the connectivity of everything: IT, devices, equippage, sensors/the global sensor grid, and the global mind/AI. Estimates include 21 billion devices or "things" connected via the web by 2025. Such connective capability is a key enabler for the increasingly connected, evolving autonomous, virtual, AI, and hyperefficient world. Enabled would be "smart everything", with superb coordination over time and distance, collection of data to feed AI and superb autonomy. There are obvious and serious concerns with such universal connectivity, especially with respect to security, safety, privacy, and overall operability. Cyber issues are paramount, and the developing quantum vector/scaler potential communications, which cannot be detected, jammed or co-opted would greatly alleviate many of the currently dominant cyber concerns. As with much of the evolving technologies, increasing issues include where, in all this, especially with the now rapidly evolving AI, are the humans, and concerns regarding the vulnerabilities of the enabling electrons/electronics.

Global Brain/Mind – Increasing connectivity, a massive and ever expanding web content and the inclusion of the ever improving AI into the web software, have enabled web operations to become increasingly a de facto global mind. The development of the AI capability to search/summarize/evaluate/process vice simple basic search, is greatly accelerating such a global mind capability. The enabling keys are the increasingly massive amounts of data writ large on the web and the IT/computational capabilities to rapidly process/evaluate it. The latter will be greatly improved as we transition to quantum computing. First order AI capability is proportional to the amount and variety of the data, and as we develop the IOT and a global sensor grid, along with adding data/information to the web, the result augers to be a superb global brain/mind which human brains, augmented and natural, then tap into and interact with. "With ever more efficient technologies for communicating and processing information, the boundary between brain and external aids for thinking will practically disappear, so that computers and communication interfaces will feel as if they are an integral part of our personality. In the longer term, the effacing of borders between brain and computer will likely lead to an effacing of the border between individual, computer-supported brains, leading to the emergence of a collective mind or "global brain," an integrated thinking, conscious being with an overall world view and sense of purpose" [ref. 88]. The development of direct brain to machine communications greatly increases bandwidth, increasing massively effective utilization of the ubiquitous knowledgeability and solution spaces on the web.

Global Sensor Grid – Deploying the combination of IT, the miniaturization of nearly everything, quantum technology, IOT/the internet and sensor technology, we have long been putting sensors on increasingly nearly everything.

We have placed sensors underwater, in the water(s), on land, sea, air and space, on people, in homes and factories, on equippage, safety/security sensor nets, and sensors on:

- Smart buildings & roads, other smart infrastructures
- "Overheads"/satellites
- Cell-phone sensors
- Mini-cameras
- Smart appliances, clothes, other smart "products" (e.g., shoes)
- Military sensor nets
- Radio frequency identification (RFID)/nano tags
- Near Space (75K-350K ft altitude sensors)
- Transportation devices
- Biological sensors including in situ/in vivo/on toilets
- Scientific sensor nets
- Populace observations & contributions communicated via internet
- Smart dust

These sensors are multiplying rapidly, many are harvesting their energy vice using onboard or supplied energy, are becoming ever less expensive, smaller, and more capable including greater bandwidth and a wider spectrum of physical quantities measured. These sensors are being increasingly networked and connected into a global sensor grid(s), with trillions of sensors projected. Along with fulfilling their original functionalities, the sensors as a whole constitute the ongoing and historical statistics, stasis, "health", etc., that, along with the web per se, contents constitute the knowledgeability of AI and AGI going forward. This will be a major component that enables AI/AGI to ideate, execute functionalities, find solution spaces to nearly all issues and problems along with optimization of ongoing processes and tasks.

Human Cyborgism – Humans have long enhanced their capabilities and senses via a variety of ways and means, clubs, spears, bow and arrow, gunpowder, the lever, glasses, and on and on. Humans, as a result of IT and BIO, are now enhancing capabilities via onboard, embedded devices. These include Coclear implants for hearing, artificial hearts for living, artificial retinas for seeing, artificial limbs, artificial organs, and now brain chips and direct brain to machine communications. Humans are now enhancing at a prodigeous rate and brain chips/implants and direct brain communications enable "partnering" and merging with machines going forward. However, to the extent that humans retain wet electrobiochemistry components humans will lag the developing machine capabilities. The alternative is the ultimate merging with machines, brain uploading, the end point extreme of the ongoing evolution of the humans by the humans.

Augmentating human capabilities began as a way to render humans with disabilities capable of fuller and perhaps more independent/productive lives. More recently human enhancement with capabilities beyond usual human capability is developing rapidly. Cyborgism, especially brain chips and mind-to-machine communications, are a zeroth order approach to direct physical partnering with AI/the machines and provides very high bandwidth connectivity to the global brain and IOT. The end state for increasing cyborgism is brain uploading, as humans slough off ever more wet electrochemistry with its high upkeep and limited operability [refs. 89 – 91]. Historical humans, even bio-enhanced historical humans will be challenged to compete with the various flavors of cyborgs, as well as the emerging autonomous robotics.

Inexpensive Green Energy [ref. 92] – There are three major technologies under development which will simultaneously essentially "solve" climate, reduce the cost of energy, enable the redesign of many systems, enable greater functionalities, enable us to become "energy rich" and more society friendly via reduced noise, provide far greater range/longevity of operation, reduced pollution and fewer ecosystem adverse impacts. These approaches are the renewables/storage combinations, halophytes/salt plants, and the Japanese Low Energy Nuclear Reactions (LENR).

Renewables/Storage – There are a large number of green renewable energy sources including on, offshore, and high altitude wind, solar photovoltaic (PV), solar thermal, geothermal, ocean current, waves/tides and temperatures, Osmotic power, hydro, and biomass. Energy storage approaches include batteries, pressure including pumped hydro, heat, flywheels, and chemical changes. Transportation batteries are volume and weight limited, while grid batteries are not. The renewables, enabled by the Sun and the heat of the Earth have absolutely massive capacity, and technology developments have driven their costs below fossil carbon energy and are still dropping rapidly. The costs and capabilities of storage are also greatly improving. Some 90 plus percent of new generation is renewables and over 30% of generation is now renewables. The outlook is for increasing "distributed generation/storage," "rooftop PV", generation at point of use due to scalability, obviating eventually the many vulnerabilities of the grid from solar and other storms, and reducing the grid losses and costs.

Halophytes – These are salt plants that grow on deserts, wastelands (some 44% of the land on Earth) using saline and seawater (some 97% of the water on Earth). There are thousands of varieties, mimicing fresh water plants with respect to utilization, including food plants. These plants can sequester some 18% of their CO_2 uptake in deep desert roots, pulling CO_2 directly from the atmosphere. It is possible using halophytes and ground and ocean/sea saline/salt water to essentially "green the planet" soon, profitably and "solve" land, water (get back the some 70% of the fresh water now used for food), food, energy (biomass), and climate issues. The biomass provides chemical feedstock to obviate petroleum use for such.

Japanese LENR – The Japanese have apparently determined how to scale LENR, low energy nuclear reactions, creating weak nuclear force reactions, not cold Fusion, at some 10,000 times chemical energy density. This has no radiation, is a long lasting heat battery, and there are many ways to ever more efficiently convert the heat to electricity. The associated costs are low and size/weight is small. The scaling cited by a Japanese firm is in the range which would essentially and inexpensively "solve climate" and reduce energy costs, increase operational range.

Designer Biologics – The bio revolution, genomics, synthetic biology (synbio), etc. is enabling longer lives, reduced disease, and going forward, designer life forms including improved food plants, synthetic foods, and designer, bio-enhanced humans. In addition, approaches are developing for manufacture including bio processing and to design products that include/are enabled by bio functionalism. The IT/AI/computational revolution has turned bio from being largely an empirical, laboratory technology to predictive development and operation. Synthetic biology could provide food, materials, electronics, biocement, biopolymers, bioadhesives, life support, biofuels, biomining, pharma, and biophotovoltaics. Biologics is green and conducive to a circular economy [refs. 93 – 95]. As discussed with respect to societal issues, risks, the capabilities to do biohacking proffer opportunities for bioterrorism of many varieties. As usual with all powerful frontier technologies with great power comes great responsibility to protect society.

Theory of Everything in Physics – Quantum for the small and relativity for the large, developed in the last century, were extremely successful except for a long and interesting list of major "unsolved problems in physics" [ref. 96]. These unsolved problems include such as the 120 orders of magnitude over prediction by quantum for the cosmological constant, inability to find dark matter and dark energy, some 95% of the matter/energy universe, cogent explanations for the measured speed of quantum entanglement, in excess of 10,000 times light speed, and many others. There is an obvious need for a "theory of everything" (TOE) that at appropriate conditions devolves to quantum and relativity but explicates the many unsolved problems in physics. For decades, work progressed on the String theories as candidate TOEs. The quantum entanglement issue suggests that a TOE would be "non-local", of which the nascent non-commutative structure of quantum space time at the Planck Scale is one such [ref. 97]. If in fact the TOE, should it be developed, indicates nonlocality that would alter the current outlook for interstellar travel.

Inexpensive Space Access - The breakthroughs associated with serious space access cost reductions are due to SpaceX and their pioneering development of reusable rockets, along with reduced manufacturing and operational costs [ref. 98]. Projections for the SpaceX Starship are 100 metric tons for $2 million, to orbit, far below the usual thousands of dollars per kg. Even greater reductions may be in the offing from continued artificial intelligence (AI) developments and subsequent further replacement of expensive human labor by autonomous robotics, along with increased launch rates providing economies of scale. Also, efforts involving material printing at the nano scale to produce a much better material microstructure may enable reduced dry weight and payload weight, providing additional cost reductions. The SpaceX pioneered major low Earth orbit (LEO) access cost reductions will enable humans-to-mars both safe and affordable and the development of commercial deep space, beyond geostationary Earth orbit (GEO).

Data Analytics – The conventional approaches to design involved theory, experiment, and more recently, computation and numerical solution of differential equations. These approaches have now been joined by data analytics, decisions by algorithm, and AI. Using AI/machine learning and the information on the web, it is possible to optimize design of conventional and orthogonal functionalizations. Data analytics is increasingly applied to a wide spectrum of arenas in business and even personal life as well as design. Data analytics converts data to information and knowledge and then applies that knowledge. The discipline is broken down with respect to applications into descriptive, diagnostic, predictive, and prescriptive. The huge amount of data stored and available on the web has greatly fostered the development and successful utilization, increasingly via AI, of this 4^{th} approach to formation of solution space generation, enabling automated decision making.

Quantum Technology – There has been a recent and rapid development of quantum technology greatly aided by the nano technology revolution, termed the second quantum revolution. The first quantum revolution involved stable quantum states and resulted in nuclear power, semi-conductors, GPS, lasers, Bose-Einstein condensates, super-fluidity, super-conductivity, magnetic resonance imaging advanced communications, and advanced imaging devices. Quantum technology, the second quantum revolution addresses the control of quantum systems for quantum communications, metrology, computing, optics/imaging, sensing, navigation, materials, AI, biology, electronics, chemistry, information systems, cryptography, energetics, and medicine. The cornerstone of quantum technology is quantum entanglement, measured as occurring at some 10,000 times the speed of light. Entanglement is robustly proven experimentally, but lacks a clear understanding of the enabling physics, with several candidate mechanisms extant. Entanglement is a major basis to justify creative work to develop a "Theory of Everything". Another cornerstone is the research to establish the "stable Q-bit", delay of quantum decoherance. Quantum fluctuation energy is less than the Boltzman thermal energy and historically has required extremely low temperature for longevity. There are now several approaches that have extended the time to decoherance by many orders of magnitude, enabling quantum computing and all it will enable, and much else. Quantum technology is slated to greatly improve miniaturization, sensitivity, capability, and enable unique functionalities [refs. 99 and 100].

Materials - Materials technology developments impact society in major ways. The ages of prehistoric man are indicated by the materials successively utilized, stone, bronze, iron, etc. [ref. 101]. A common overal comment with respect to materials is "you have to make it out of something", and indeed we do. The materials technologies developed over the ages, now involving quantum level design, have massively expanded the capabilities of our technology overall [ref. 102]. Materials technology contributes greatly to increasing living standards, enhancing human experiences and solving societal issues and are critical to all aspects of society including energy, transportation, health, housing and industry, etc. [refs. 103 - 107]. The scope of materials science and technology is vast in terms of materials, their interactions, and scale. Materials science includes structure from the macroscale to the subatomic scale and a suite of materials processing approaches for nano, bio, electronic, optical, structural and magnetic materials including ceramics, glasses, composites, polymers, metals, semiconductors, and the creation of "designer materials" with specific properties [ref. 108]. Examples of the latter include aerogels, graphene, metamaterials, quantum dots, carbon nano tubes, multifunctional materials, and conductive polymers.

There is an amazingly long list of engineering materials properties of interest including those related to acoustics, optics, chemistry, electrics, magnetics, manufacturability, mechanical behavior, radiologics, and thermal, with each having a long list of specific properties and behaviors. Most materials applications require a favorable combinatorial set of properties, which/what dependent upon the specific requirements of the engineering application(s) and metrics, including cost [ref. 109]. A very high level parsing of materials is into structural and functional. The seriously major breakthrough in materials is the utilization of data analytics and AI and computation to enable rapid optimization of combinatorial materials for specific functionalities. Typically, millions of prospective combinatorials are rapidly evaluated for simultaneous optimization of processing, utilization, and characteristics/capabilities (AKA material properties).

ISRU on Mars - The currently known resources on Mars are massive, including extensive quantities of water and CO_2 and therefore C, H_2 and O_2 are readily obtainable using advanced nuclear batteries for life support, fuels and plastics, and much else. The regolith is replete with all manner of minerals. In Situ Resource Utilization (ISRU) applicable frontier technologies include robotics, machine intelligence, nanotechnology, synthetic biology, 3-D printing/additive manufacturing, and autonomy. These technologies combined with the vast natural resources should enable serious, pre- and post-human arrival ISRU to greatly increase reliability and safety and reduce cost for human colonization of Mars. Various system-level transportation concepts employing Mars produced fuel or propulsive mass would enable Mars resources to evolve into a primary center of trade for the inner solar system for eventually nearly everything required for space faring and colonization. Mars resources and their exploitation via extensive ISRU are the key to a viable, safe and affordable, human presence beyond Earth and commercial deep space [ref. 110].

A Distributed Electric Economy – The ongoing shift to address climate, from fossil fuels to renewables is changing in major ways how energy is used, with interesting and major impacts. Essentially, the world is moving off of "fuels" per se to electrification. Renewables and storage are producing green electricity, as power companies move away from fossil fuels. As batteries have improved, transportation is moving from fossil fuels to electrics, which are much more efficient. Manufacturing is moving from fossil fuels to electrification, as are homes increasingly, the latter using efficient heat pumps. Also, the renewables and storage are increasingly scalable to the size of the energy user, termed distributed generation. This going forward would reduce dependence on a grid, which has serious vulnerability to expected intense solar storms and obviates the costs and losses associated with the grid. Electric motors are much more efficient then are heat engines, and the pollution reductions from reduced fossil fuel combustion saves many lives. The energy future is apparently green, electric, less costly, environmentally friendly, and distributed vice centrally produced [ref. 111].

Transhumanism – There are two basic capability improvement approaches which advanced technologies proffer for humans which can be mixed and matched: augmenting the wet electrobiochemistry or augmenting with "machines"/physically (termed cyborgism). The bio revolutions are making serious progress with respect to advancing human health and longevity. Recent life expectancy has increased by some 0.2 years or greater per year. With the bio revolution, projections for some approaches are positing an increase of a year per year. Comments regarding transhumanism include that we can and should eradicate ageing as a cause of death; that we can and should use technology to augment our bodies and our minds; that we can and should merge with machines, remaking ourselves. There is significant ongoing research and development regarding augmentation using both physiological/bio and technological approaches and the ongoing human evolution of the humans [ref. 112, 113].

Societal Threats/Issues

In general, human engendered threats including human altered natural related threats are nearer term with greater statistical probability than natural threats unaltered by humans.

Climate – The Industrial Revolution developed based upon increasing utilization of fossil fuels, including petroleum, coal, and natural gas. The combustion of these fuels emits such as CO_2, water, and nitrous oxides (NOx) into the atmosphere. The scale of the Industrial Revolution over centuries added enough of these to the atmosphere to alter the climate with increasingly serious societal impacts including temperature rise, ocean level rise, storms, floods, food and water issues, disease, fires, species extinction, ocean circulation changes, etc. Such changes are now readily apparent and projections by the Intergovernmental Panel on Climate Change (IPCC) and others are increasingly dire, even without yet full inclusion of the many positive feedbacks which acentuate the adverse climate changes. In fact, during the Permian extinction (also known as the Great Dying), the changes in ocean circulation increased anoxic ocean conditions, leading to an overgrowth of cyanobacteria (or blue-green algae). This algae produced hydrogen sulfide, which in small percentages in the atmosphere is a poison and damages the ozone layer, producing huge morbidity and species extinction.

Climate is far more than warm days and wet feet. The projected climate related losses, especially those due to water rise and temperature increase, are becoming existential to the point where ever more inexpensive renewable alternative energy sources and storage approaches are increasingly replacing carbon fuels, with other technologies proffering additional inexpensive alternative energy. Other approaches are under development or already exist to counter climate, although one alternative approach, geoengineering, is deemed too indeterminate at this point to employ. Technology has reduced/is reducing the costs of these climate mitigation approaches to where they are being increasingly employed. Favorable econometrics appear to be essential to effectively counter "boiling frog" societal issues such as climate. The extant climate projections do not yet fully include the many positive climate feedbacks which some expect to greatly increase climate societal impacts much sooner [ref. 114].

AI, Artificial Intelligence - The increasing capabilities of computing including machine speeds, storage and software when combined with "big data," have enabled development of increasingly capable machine "intelligence". In circa 2012, the machines become capable of executing in a useful manner neural nets informed by big data in a process termed deep learning. This particular approach to AI has since grown rapidly with respect to capabilities, applications, research scope, intensity, market size, and importance to society across an ever-expanding spectrum of areas and problems. Observations of "Black Box" behavior/ideation/production of unique solution spaces by AI via processes opaque to humans suggests that human intelligence is not unique.

The societal risks and issues with AI include them being ever more capable, less costly, more efficient than humans, resulting in machines replacing humans with respect to employment. This has been increasingly happening and the recent AI developments involving machine ideation capabilities and massively increasing their knowledge by loading in the web have advanced AI performance to where some project that going forward, as the machines attain artificial general intelligence (AGI) at human level and beyond there are no jobs the machines cannot do far more economically and better than humans. An AI singularity (e.g., refs.115 – 121) has been discussed where the machines attain human or greater capabilities with expected consequent major societal changes, some beneficial, and some which could become seriously negative with respect to humans and society.

Over decades now, the expected timeframe for the singularity has moved closer in as AI capabilities have improved. Current projections include time frames before 2030. The other serious issue with AI going forward is as the machines attain AGI capabilities, they could in various ways harm, to "take over", to possibly exterminate human society/the humans on purpose or by accident. The AI societal issues spawned the Asilomar Conference of 2017 that developed a series of AI development principles in the area of research, ethics and values, and longer term issues. The bottom line with respect to limiting adverse effects of AI beyond the jobs issue is to ensure, somehow, that they are "friendly" to humans vice neutral to adverse, even accidently. Trying to cover all of the "accidental" potential human adverse AI/AGI occurrances has proven too difficult thus far.

AI is the fastest developing revolutionary technology and more effort is going into market development capabilities than into safety-for-society precepts. There is concern that the safety aspects, for which we have general targets but no cogent solution spaces/ways forward, will lag AI development such that they may be developed and instituted too late. Therefore, for this societal risk/issue, one of the more nearer term and worrisome ones, there are currently no real solution spaces, only increasing concern. The possible societal threats, and major potential benefits are the subject of major literature (e.g. refs. 121 – 143).

Electromagnetic Pulse (EMP) – The world is becoming increasingly electrified with respect to the spectrum of energy uses and users. Also society is increasingly enabled by electronics for nearly all functionalities. With the developing IT revolution, the electronics have become increasingly miniaturized. The result of these is a nearly total societal dependence upon electronics and electricity. There was a serious solar storm in the mid 1800s, the Carrington Event, which shorted out much of the then electrics. We are evidently due for another serious solar storm. Such a storm would couple into the long transmission lines and short out transformers whose replacement requires long time durations. Also, such a solar storm would disable much of the electronics that now enables and operates nearly everything. The Congressional EMP Commission indicated that the effects of such a solar storm would stop much of transportation, curtail much food and water production and delivery, and within just a year cause massive loss of life. This "natural" societal threat is amplified into an existential event by the massive adoption of electronics and electricity distribution from central power stations. Defense from such dire consequences includes faraday cages and decouplers to protect the electronics and distributed energy generation, switching from central generation to renewable generation and storage, other sources at point of use to avoid the coupling of the EMP fields into long transmission lines [ref. 144].

Pandemics, Synthetic Biology (Synbio) – The several biorevolutions, genomics, gene editing via CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats), synbio, etc., have provided the means to greatly improve human health and also, increasingly, to attrite human health. "Bio-warfare" long ago spawned chemicals and biologics that could be weaponized. The current biorevolutions enable inexpensive access, including via the web, to miniaturized components, machines and ingredients to create pathogen variations and new disease and adverse human biologics. Some of what used to require extensive laboratory equippage and specialized training is now doable in a kitchen sink using information and piece parts from the web. "Biohacking" is common. Such hacking could inadvertently result in global lethal pandemics as an end point and lessor impacts in addition to targeted effects by those with malintent. Pandemics including de novo pathogens are adjudged as among the greatest societal existential threats/issues. Transmission of pathogens is abetted by the extant and extensive transportation networks.

Ecosystem Degradation - Fundamentally, humans have been too successful as a species. We have pursued ever greater human numbers and a mantra of economic growth without considering the finite size and capacity of available resources. The ecosystem provides the essentials for life, including water, air, food, soil, plants, and minerals, and we are now seriously degrading it at our peril. Water regulation, pollution filtering, waste-sink functionality, soil retention, nutrient cycling, and waste decomposition are all becoming degraded. Ever greater growth with a fixed resource is only possible by using technologies and approaches to alter resource utilization, by controlling population, or both.

For many centuries, as humans depleted local resources, they have simply moved to other regions where resources were available. That is no longer an option as the present technologies and processes are degradating the entire planet. Humanity is now short by about half a planet's worth of resources. As world population growth continues and living standards rise, that shortage will increase to some three planets' worth of resources. We will have to reduce ecosystem resource use and dumping considerably. Altering technology and approaches to adapt to such growth is termed sustainability, with various alternatives termed green growth, reusability, and the circular economy. It also involves valuing, protecting, and strengthening ecosystem services. Some specific ecosystem improvement/reduced degradation approaches include: ocean mineral extraction using inexpensive energy instead of hard rock mining, which is a major source of pollution, recycling (aka the circular economy) for nearly everything, including solids, liquids, and gases, and utilizing atmospheric nitrogen for agriculture, incurring far less fertilizer costs and runoff.

On less than a half-acre and with help from developing technologies, we could grow own food, print what we want or need, recycle on site, use distributed renewable energy generation, conduct tele-education and telemedicine, and utilize five-senses virtual reality and teletravel. This could all be done with the need for far less physical travel. Given the rapid development of personal air vehicles, many in the gig economy and those telecommuting can live just about anywhere off roads and wires. Also, the ongoing major shift in wealth generation from exploiting natural resources to inventing things has a far smaller ecosystem impact in general [ref. 145].

Asteroid Impact - There are some 26,000 near Earth asteroids with some 12,000 greater than 140 meters in size, which are adjudged to decimate country-sized or greater areas. The one that hit Mexico 66 million years ago was some 10 km in size, causing an extensive "winter" and 75% species extinction. This is much less a near-term societal issue as available detections/locations suggest we should not be impacted for a least 100 years. The mitigation approach is sensing, tracking, impact, and consequent deflection. Shattering would still allow impacts of the resultant piece parts. Therefore, current technologies suggest launch and impact of one or more heavy, fast rockets to deflect potentially harmful asteroids [refs. 146 – 149].

Volcanoes – Volcanic eruptions can and have put sufficient materials and CO_2 into the atmosphere to alter climate significantly for years to decades. There are 12 supervolcanoes, Yellowstone being one of them. The threat to humanity is substantial. The eruptions of the Siberian Traps volcanoes put enough CO_2 in the atmosphere to cause the Permian Extinction, termed the "Great Dying", with over 90% global species extinction. Within some 1,000 km of an eruption of a super volcano there would be some 90% human morbidity, with many more dying worldwide from ingesting the ash and the resultant climate effects. There is a 1 in 6 probability of such an eruption occurring in this century with climate change increasing the eruption possibility. Overall, societal effects are comparable to those of a 1 km size asteroid impact and the probability of occurrence is higher. Mitigation of this threat is thus far limited to sensing and preparation to reduce the ash and climate effects [ref. 150].

Space Debris – Over the past decades, much of the global telcom and sensing technology has moved to space at GEO and below. The overall global in-space operations during that time has resulted in a daunting amount of space debris composed of launch vehicle piece parts and satellites past end-of-life. Even the smaller pieces, given the closure speeds, can create worrisome effects upon impact. Collisions in space have increased the debris population numbers still further. In the literature, this cascading of collisions producing ever more debris until the space region is essentially unusable is termed the "Kessler Effect." Estimates have indicated that we are just a few collisions from closing off LEO. Given the major and increasing worldwide reliance upon space assets, our "positional earth utilities," has made space debris an increasingly serious problem. The value and importance of passage through the space debris will increase as the cost of space travel decreases. The zeroth order mitigation approach is detect and avoid, which given the increasing density of the debris will lose feasibility going forward. Additional mitigation approaches include increasing requirements for satellites to have deorbit equipage onboard when launched and active capture and removal from orbit. The latter is expensive if they employ fueled rockets for manuevering in space. Large cost reductions for such capture and removal operations are possible using tethers working off the earths magnetic field and powered by either solar PV or the new nuclear weak force batteries which scale well, and are small and light weight in solid state.

Food, Water – Approximately 70% of the Earth's freshwater goes to agriculture. Climate change is producing serious, prolonged droughts resulting in reduced food supply. Other climate change effects also alter food production. The overall impacts such as the Colorado River drying up would be massive over a large region. The mitigations for this include seriously and rapidly mitigating climate change, the major causative. Another orthogonal approach, sooner in effect and potentially both profitable and huge in impact, would be to grow food on deserts and wastelands using Halophytes (salt plants) and saline water from saline aquifers or seawater, pumped using the abundant solar available on large tracks of wastelands and deserts. Growing food (many of the numerous and diverse halophytes are food plants) this approach both supplies abundant food and frees up the 70% of the freshwater now used in agriculture for direct human use. Then there are, from biologics, manufactured, dark, and air foods [refs. 151, 152].

Individual Destructive Power –Very rapid technology and consequent societal changes are destabilizing portions of society. Humans have the amygdala, the part of the human brain that promotes conservatism. The very rapid tech engendered changes challenge the amygdala, resulting in road rage, psychosomatic illness, depression, and destabilization. The tech revolutions are also placing in the hands of individuals capabilities to create major havoc, sometimes referred to as constituting an army of one. Available at low to moderate cost to individuals are computers which can be used for cyber attacks, bio, chemicals, and equipage to create and means to distribute pathogens, printed weapons, robotic delivery, and vulnerabilities determination. Mitigations for this involve many forms of increasing surveillance enabled by the tech revolutions. The frequent occurrence of school shootings suggest that society is not there yet with respect to mitigation regarding societal unstable individuals.

Humans Merging with the Machines – This is fundamentally due to the concomitant increasing enablements in AI, IT, nano, and bio. One major direction of the rapid human evolution of the humans is cyborgism or non-human piece parts including ears, eyes, hearts, organs, limbs, brains, etc. Originally these piece parts were to correct deficiencies with respect to capabilities, but increasingly they are being utilized to increase capabilities and augment humans. This has evolved over many decades, with the brain chips and direct machine-to-brain advances alerting society with ongoing major shifts in what it means to be "human". The societal threat associated with this is a major and rapid shift from the historical, naturally evolved wet electrochemistry human biology to a combined human and machine, with a wide spectrum of variations. The end result of these developments could be uploading the brain into a machine and doing away altogether with the troublesome wet electrochemistry, becoming our "mind children". The mitigation here is societal acceptance of the ongoing diversification of what it means, or not, to be "human". Along the way various levels of societal discord could occur. This is another aspect of societal "diversity".

Shift from Growth Mantra to a Circular Economy - This is another societal disruption issue. Society has long been on a econometric growth mantra, which worked when we were far fewer and once we had used up an occupied area, we moved elsewhere and kept doing such. Now there are far too many of us demanding too much of the environment, short half a planet now, driving the environment further into arrears and requiring an econometric shift to a green, sustainable, circular economy. This is doable to the extent that such shifts are profitable. With respect to renewable energy not much happened until it was lower to far lower in cost than fossil carbon fuels, then rapid growth and change occurred. The developing technologies posit many ways to reduce human pressure on the environment including reuse of materials, shifts to bioproduced materials, mitigating climate change, renewable energy, ocean mining vice land mining, etc. The possibilities to successfully shift to serious sustainability is accelerated with the development of seriously profitable approaches, but that major shift in econometrics will involve societal angst and shorter term destabilization.

Nuclear Winter - Nuclear winter refers to catastrophic environmental impacts due to extensive use of nuclear weapons. Debris produced by a series of nuclear exchanges is expected to occlude the Sun for decades, reducing global temperatures and severely reducing agriculture/food production. Morbidity estimates are some 5 billion humans. This is in many respects the human production of climate impacts associated with natural occurrances such as supervolcanoes and astroid impacts, with the addition of harmful radiation effects. Mitigation zeroth order is to avoid nuclear war, which due to proliferation is becoming more difficult. Space technology is developing manufactured and dark foods, and other technologies could be effective to much reduce morbidity in connection with surviving prolonged darkness.

Cyber – The cyber societal issue is related to, but somewhat less destructive, than serious solar storms/EMP. The vulnerability is the same, essentially complete societal reliance upon electronics and computing, including increasing AI. Nearly everything has been hacked, with some cyber attacks causing nearly world wide impacts. Society is muddling along trying to deal with issues such as ransomware attacks. Then there is the development of quantum computing, which will need TBD "cyber" protection. What would greatly mitigate this issue is utilization of the quantum vector/scaler potential communications which are not electromagnetic and to first order cannot be detected or intercepted. This reduces the need for cyber protection regarding the manufacture of cyber devices and their servicing/repair.

Potential Combinatorial Technology Impacts Upon Society Going Forward

Overall, the machines, the web, and AI/autonomy continue synergistic development, producing superb ideation and knowledgeability enabled by the web, global sensor grid, and AGI. This combinatorial becomes capable of substituting for humans at less cost and with greater capabilities/productivity, resulting in major additional wealth creation. During the development of this there will be much effort to work, enable, develop, and deploy human-machine partnering, greatly enabled by brain chips and direct brain-machine communications.

This additional wealth is used to fund a guaranteed annual income. Humans no longer need to labor at a "job" per se. Putative human activities include "hobbies", "gig economy" constructs, creative activities, socialization, and back-to-the-future living off the land/self sufficiency on a small holding off roads and wires via personal air vehicles, distributed green energy generation, the bio revolutions, printing manufacture, tele-everything including medicine and education, serious DIY, and prosumerism.

- The various parts of the bio revolution and cyborgism extend human lifespan significantly. Given the available finite planetary resources, technologies can enable the resultant greater population density, increase the carrying capacity of the planet up to the point of "uncomfortable". These technologies include low cost, green energy, the bio revolution including dark, air, and manufactured foods, bio materials, machine ideation, printing manufacture including at the nano scale for 5X plus material properties, electrics, ocean mineral extraction, recycling, agriculture employing nitrogen from the atmosphere, and tele-everything/reduced physical travel.

- Humans increase their shift toward cyborgism, physically and mentally, enabled by the bio and IT revolutions including direct brain to machine communications, augmented brains/brain chips, and physical replacements/augmentations for organs/limbs/senses. This enables increased merging with machines.

- Ever cheaper renewables and storage, halophytes, and LENR affordably solve climate.

- Halophytes, using what we have a plethora of – cheap saline/seawater and cheap wastelands/deserts solve land, water, food, energy, and climate concerns.

- Well into the Virtual Age, beyond the IT Age, tele-everything, tele-work, travel, politics, socialization, commerce, shopping, education, medicine, local printing manufacture. This is enabled by superb 5 senses plus machine inputs into the brain, virtual reality, the metaverse, and holographic projections.

- Energy rich enabled by ever less expensive and more capable renewables and storage, halophytes, LENR, and distributed energy generation. Enables less energy efficiency for reducing acoustics, longer service, safety, operability, etc. Enables ocean mining vice dry land mining, months to years long batteries for electric transportation for land, sea, air, space, independent living, and lower energy costs.

- Affordable and safe human pioneering and colonization of Mars, establishment of a separate Mars economy, enabled by inexpensive space access, Mars ISRU, frontier energetics, dark and manufactured foods, AI/autonomy, and fast transits.

- Autonomous, brilliant, connected "everything" enabled by AI, quantum technology/sensors, IT, global sensor grid, and less expensive energy.

- Abundance, ever less expensive to live enabled by AI produced efficiencies, reduced energy costs, tele-everything, autonomy/robotics, printing manufacture, global mind, reduced medicine costs due to the bio revolution, miniaturization, materials research, electrification/distributed generation, and digitization global sensor grid [ref. 153].

- Ecosystem improved by green energy, AI, tele-everything, materials research, electrics, mitigating climate, return to the land, reusability, conservation, efficiency improvements, circular economy, virtual age, and halophytes.

- Possibility of a nonlocal physics theory of everything that explicates quantum entanglement, other observations, and proffering interstellar transportation.

- Global mind, enabled by the web, AI, the global sensor grid, IOT, and tele-everything.

- Space debris removed affordably via LENR, solar or advanced nuclear batteries powering tethers vice using fueled rockets to maneuver/capture and either deorbit or collect in a space junk yard for repurposing.

- Near replacement of experiments by the combination of computation and measurement of initial boundary conditions, enabled by quantum computing, AI, global sensor grid, and quantum technology.

- Replacement of automobiles by personal vertical takeoff and landing (VTOL) fly/drive, electric safe, affordable personal air vehicles, enable living off roads, major savings in ground transportation infrastructure costs and reduced climate impacts.

Prospective Technology Enabled Societal Characteristics Going Forward, AKA "Where Is It All Going?"

Comcomitantly climate is remediated, the ecosystem is improved, the virtual age/tele-everything/the metaverse, much longer life spans, living costs reduced, guaranteed annual income, a portion of society increasingly merging with the machines, a multi-planet society, a circular economy, option of living anywhere, off roads and wires, migrations to rural, climate retreat, to the virtual world, to space.

The prospective spectrum of human societal instantiations in the future or "then year", resulting from the ongoing, ten million times faster than natural evolution, human evolution of the humans, including post biological:

- Historical humans – option of living off grids, serious DIY, self sufficient off roads and wires, back to the land
- Biologically augmented humans
- Physically augmented (cyborg) humans
- Combinations of physical and biological augmentations
- Brains uploaded into the machines, eschewing wet electrochemistry

Putative "Then Year" Status Of Worrisome Societal Issues

Climate is remediated, AI/AGI capable of taking "all the jobs", EMP/solar storms defense (distributed generation, Faraday cages, etc.) deployed, partial defense against pandemics/bio hacking instituted, ecosystem improved, asteroid defense available except for the larger, planet killer sizes, sensors deployed to warn of super volcano eruptions, dark and manufactured foods and LENR/energetics available to mitigate impacts of eruptions, space debris removed, halophytes solve food and water limitations, individual destructive power mitigated by global sensor grid and AI/AGI, cconometrics shifted to a circular economy, quantum vector/scaler potential non E-M communications mitigate cyber concerns, and hopefully humans will have defused the nuclear winter possibilities on the basis of survival.

Afterword

This report discusses ongoing frontier technology developments, worrisome societal issues, technology-centric societal changes, the resulting impacts of those changes upon society, and worrisome societal issues. Overall, a technological centric view of forseeable human futures. The frontiers of the technologically responsibly imaginable. Futures projections are difficult, imprecise, and often incorrect. The possibilities discussed here are technological estimates only, based upon combinatorial frontier technological applications, societal issues, and rudimentary econometrics. However, technical instantiations are subject to societal regulation and alteration of tech impacts and time frames, local tech adoptions, econometrics, etc.

What actually occurs/develops involves a huge assortment of happenings, strictures, non-technical/societal considerations affected by the human amygdala which tends to keep us conservative, except when we chose to ignore it, as happens. These and much more are why futuring is not a science but rather an assortment of possibilities, usually considered in the context of a particular technology. This report attempts to consider nascent, emerging techs as well as those at increasing technology readiness levels (TRLs) and their combinatorials. How they manifest in the future is dependent upon the decisions society makes. What is needed, in the wholistic context also, is planet wide societal consideration of decisions with respect to and planning for what type of future humans want/need going forward given the totality of societal concerns, non-technology issues, frontier technologies and their developing capabilities. The classic statement with respect to this is "If you do not know where you are going, any way will get you there". That is the current societal situation on a planetary scale. Society is trying to cope with a plethora of current issues, but reacting in ways that may not be conducive to long range societal conciliency.

As discussed, many of the developing technologies could be very powerful, life changing and some posit potential dire human consequences [refs.154 – 158] along with huge benefits. In this context, societal regulation of these technologies can lag by decades now for technologies that can develop much in a week or two. We need foresight, a plan, produced with holistic knowledge of the developing technology spectrum of possibilities. The requirement for the plan is necessitated by the large number of often synergistic developing technologies with major and very wide spectrum societal impacts, the flat, competitive technology landscape worldwide, the hugely increasing knowledgeability and its applications of/from the web by AI/AGI, the current lack of such a plan, the seriousness and breadth of prospective consequent alterations going forward with respect to the human evolution of the humans and the increasing capability of frontier technologies and individual humans to wreak massive harm to society. Serious application of the precautionary principle is required.

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