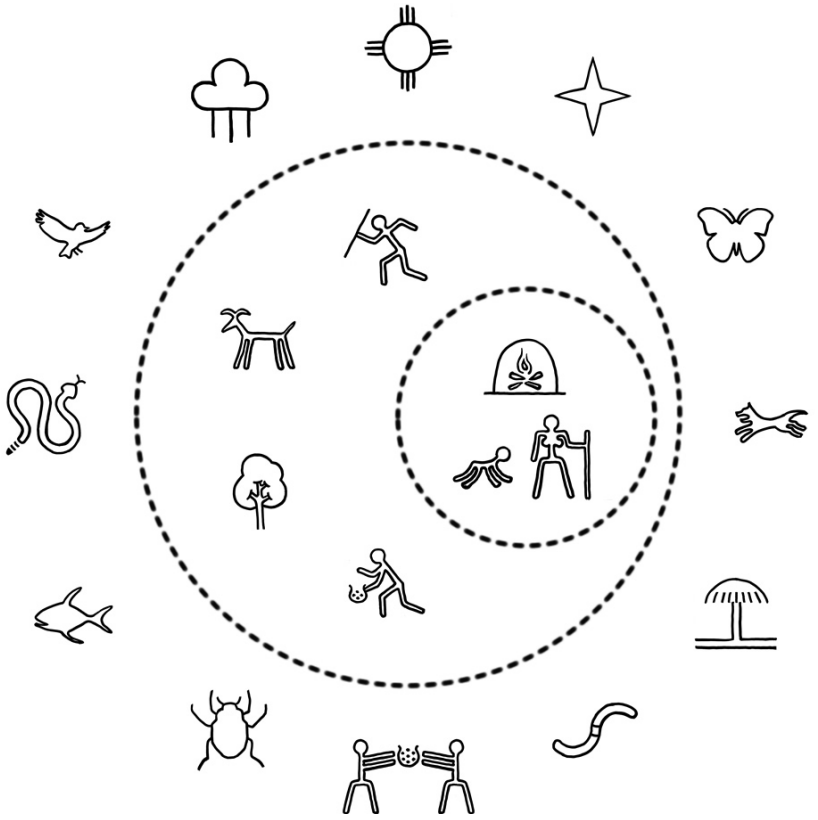
Rockets and Robots: Engineering Without Understanding

Max Carmichael



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1 · Overview

As a child, I was inspired by the space program of the Kennedy era. I loved science fiction, I was a prodigy in science as well as the arts, and I studied hard science before obtaining an engineering degree. But as I matured and gained experience with both nature and society, working in the field with biologist and anthropologist friends, I became aware of major historical fallacies underlying and undermining all the institutions of our dominant culture, and saw at first hand the widespread, ongoing destruction to local communities and natural habitats caused by technological innovation and exploration. Specialization ensures that engineers and other technologists are relatively uneducated in the broader context of the systems into which they introduce their creations; instead, they accept without questioning the historical fallacies of the dominant society, relying on these fallacies to rationalize and justify their work. Consumers, equally victimized by historical fallacies and misdirected by media, eagerly embrace the stimulation and personal power offered by new technologies, turning their backs on the social systems and natural ecosystems they need in order to thrive.

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2 · My Experience With Rockets, Robots, and Engineering

> *I used to be an astronaut, a spacewalker on the International Space Station...I remember holding onto a handrail on the outside of the Station...The terminator flicked over us, and, in the deeper darkness ahead and below us, I could see a huge lit-up city, glued to the curved Earth, sliding up over the rim of the world to meet me...To me, the city lights below represented human energy and hope. Most people work hard to better their own and their families' lives by struggling to get a bit more than they have. It's a laudable impulse; it's what got us out of caves and into villages, towns, and cities. This process has propelled civilizations forward: art, philosophy, engineering, and science all came from the cities where people interact, discuss, argue, and push the human reach a little further. (Piers Sellers, The New Yorker, 2016)*

Like many boys, I grew up reading science fiction, and like most Americans, I was inspired by the space program of the Kennedy era. My father was a rocket scientist who became a rocket engineer, and like him, I excelled in science and math. At the age of 12, at home, I built a laser from scratch. But I also excelled in – and loved – the arts, and in my adolescence, as the 1960s ended in cultural revolution and disillusionment with science and technology, I was torn by inner conflict between the arts and sciences.

I started college in fine arts and philosophy at the University of Chicago, but at the age of 20, financially dependent and insecure, with the national economy in recession, I switched to hard science – physics, chemistry, computer science, earth and space science – with a focus on advanced mathematics. However, I was still working at minimum wage and living in poverty, and desperate for some kind of career, I eventually transferred to a nearby engineering school.

After finishing my B.S., I moved to California to complete a Master of Science degree at Stanford in mechanical engineering, specializing in dynamics, the science of motion and change, which involved especially

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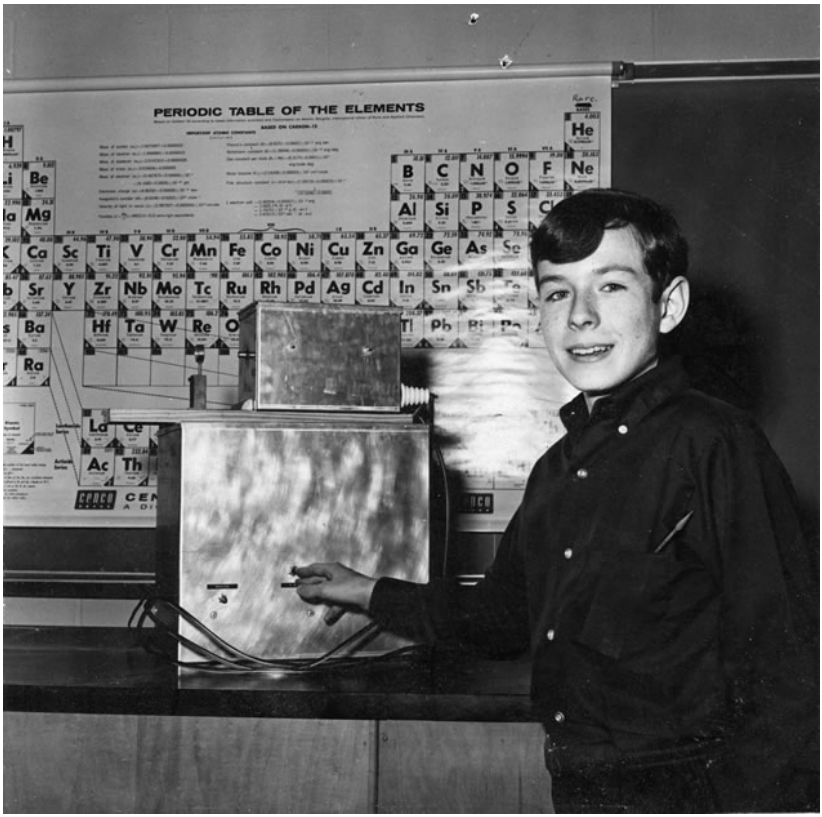
challenging mathematics. My graduate advisor and mentor had achieved international renown by reformulating the classical equations of motion for the computer age, and had become one of the heroes of the emerging science of robotics. But he'd also done groundbreaking work for NASA, and together we developed a novel technique for the difficult deployment of synchronous satellites into a low earth orbit.



But I was still writing and making music and art, and at that point, the artist in me had had more than enough of that left-brain dominance. Henceforth, I would give all my heart to the arts and exploit that engineer-

ing degree only when necessary to pay the bills.

As it turned out, those bills would never let me get away from engineering and engineers. I worked part-time, sporadically, for an engineering firm over more than a decade, in a role that was regulatory instead of technical, so I could stay out of the "critical path" of responsibility and preserve my precious free time. And then I reinvented myself as a creative professional in the internet industry, and found myself working with computer engineers.

Those engineers have turned out to be good people – well-intentioned, conscientious, sometimes even idealistic – and many of them have become my friends. I hope they will bear with me as I challenge beliefs they hold dear. Although I'm deeply critical of how technologists think, it's nothing personal – as you will see, it's actually an indictment of our entire society. And ultimately, it's an indictment of my own career as a designer of the screens that prevent us from accurately experiencing nature and society in meaningful context.

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3 · Blindsided: Brave New Heroes

> *From robots to medicine to space travel, 2015 was a huge year for science and technology. Tell my daughters at least every month... This is the most amazing time in all of human history to be alive. (Computer engineer, Facebook, 2016)*
>
> *One Saturday night, I put on a jacket and walked through central Stockholm...I talked with Sebastian, a grad student from somewhere he described as "like Westeros from 'Game of Thrones'...Sebastian's hero was Elon Musk, whom he had never met, but whom he considered a model human being. "I really think I'd take a bullet for that guy," he told me. (Nathan Heller, The New Yorker, 2016)*

After the idealism of the Kennedy administration was followed by a failed war and revelations of environmental destruction and social dysfunction, the space program declined for decades, while robots quietly began filling our factories and hospitals, out of sight and out of mind. As I became immersed in the arts and the exploration of nature, I more or less forgot about science fiction and assumed that the bankrupt fantasy of space exploration was over and done with.

But suddenly, during the past couple of years, science fiction technology has returned with a vengeance, and with a boost from free enterprise. Billionaires promoting robots and rockets have become culture heroes. Billionaire engineer Elon Musk is like a god to millenials, and many of my own peers seem to believe that people like him can save the planet. Musk competes with fellow billionaires Jeff Bezos of Amazon, Larry Page of Google, and Paul Allen of Microsoft to commercialize space and make us a "multi-planet species." I didn't see that coming, and it disturbs me more than anything else in our brave new world.

Most engineers are problem solvers. Due to the specialization and compartmentalization of our society, they normally don't get to formulate, or even to choose, the problems they solve. They just want a challenge – any challenge.

But most engineers grow up on science fiction, and if you give one a billion dollars, he may set out to create the future of robots and space travel that he's been dreaming of since childhood. That's exactly what the tech billionaires are doing now – without ever being asked to, and without ever asking the rest of us if that's what we want or need.

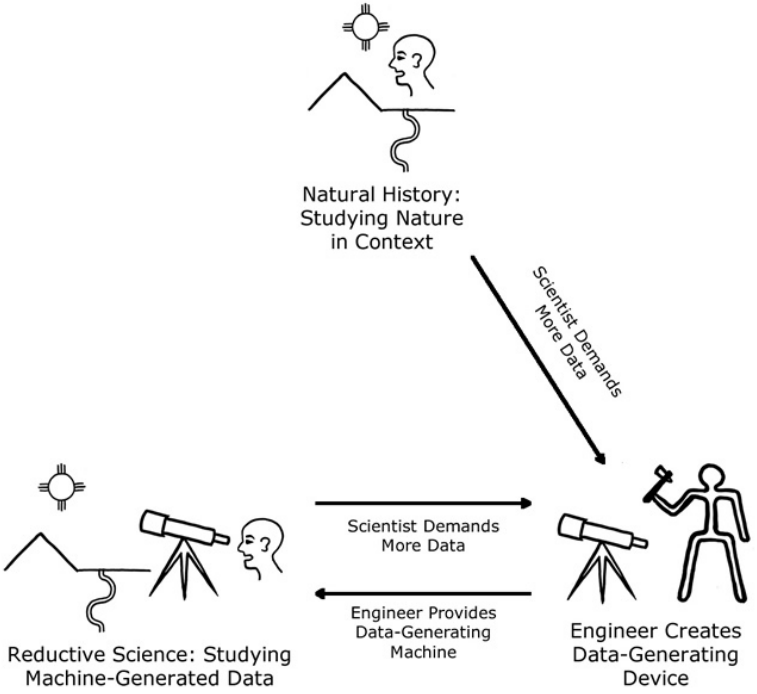
4 · The Power and the Glory: Rationalizing Desire

Musk and other billionaires can easily come up with justifications for their projects, because the world faces problems which are vast and nightmarishly complex, leading to endless confusion and controversy over proposed solutions. Engineers say that robots will improve well-being by liberating people from unpleasant or dangerous labor and by making their lives safer, more comfortable and convenient. Space travel will offer a safety valve for terrestrial population growth, reducing conflict and consumption of natural resources. Musk even proposes that he'll move everyone to another planet so the earth can recover from the failed engineering of previous generations. And of course, it's long been accepted in Anglo-European society that our destiny as a species is to continually explore, advance, and expand, to reach our farthest frontiers and our highest potential.

As my academic career revealed, science and technology are thoroughly interdependent, but often with divergent purposes. Science claims to study the complex physical world, unrestrained by practical applications, with the ultimate purpose of fully understanding and explaining nature. Engineers, by contrast, are only concerned with building things that work, in the here and now. Their goal is not to understand complex natural systems, but to replace them with predictable, manageable machines, manufactured materials, and engineered habitats. They begin with imaginary models that simplify reality, making assumptions about what is important and what can be ignored, without ever needing to understand the full context of their problems. And billionaires don't even need a problem. They're just trying to make their fantasies come true.

The unquestioned intersection between science and engineering is a self-reinforcing feedback loop. Scientists provide simplified models of nature and an insatiable demand for quantitative data; engineers further simplify the models and use them to design data-generating machines, which scientists then use to refine their models and their questions, leading to the demand for more data and better machines. More and more, science

becomes the study of abstracted mechanical data shaped by the machines provided by engineers, rather than the investigation of nature in its meaningful natural context. And as a result, our knowledge of the world becomes more and more instrumental, more oriented toward manipulation and exploitation.



...for subjects that are incredibly complex...the connection between scientific knowledge and technology is tenuous and mediated by many assumptions — assumptions about how science works ... about how society works...or about how technology works ...The assumptions become invisible parts of the way scientists design experiments, interpret data, and apply their findings. The result is

> *ever more elaborate theories — theories that remain self-referential, and unequal to the task of finding solutions to human problems. (Daniel Sarewitz, The New Atlantis, 2016)*

We all suffer when the fantasies of futurists are unleashed in society and in natural ecosystems, neither of which they have studied or seriously tried to understand. Even the smartest and best-educated advocates of technology have simply accepted the word of other specialists about what the world needs. And then they try to make that fit with their science-fiction fantasy of the future.

> *"Technology will solve our problems." This is an expression of faith about the future, and therefore based on a supposed track record of technology having solved more problems than it created in the recent past...But actual experience is the opposite of this assumed track record. Some dreamed-of new technologies succeed, while others don't...New technologies, whether or not they succeed in solving the problems that they were designed to solve, regularly create unanticipated new problems...Most of all, advances in technology just increase our ability to do things, which may be either for the better or for the worse. All of our current problems are unintended negative consequences of our existing technology. The rapid advances in technology during the 20th century have been creating difficult new problems faster than they have been solving old problems: that's why we're in the situation in which we now find ourselves. (Jared Diamond, Collapse)*

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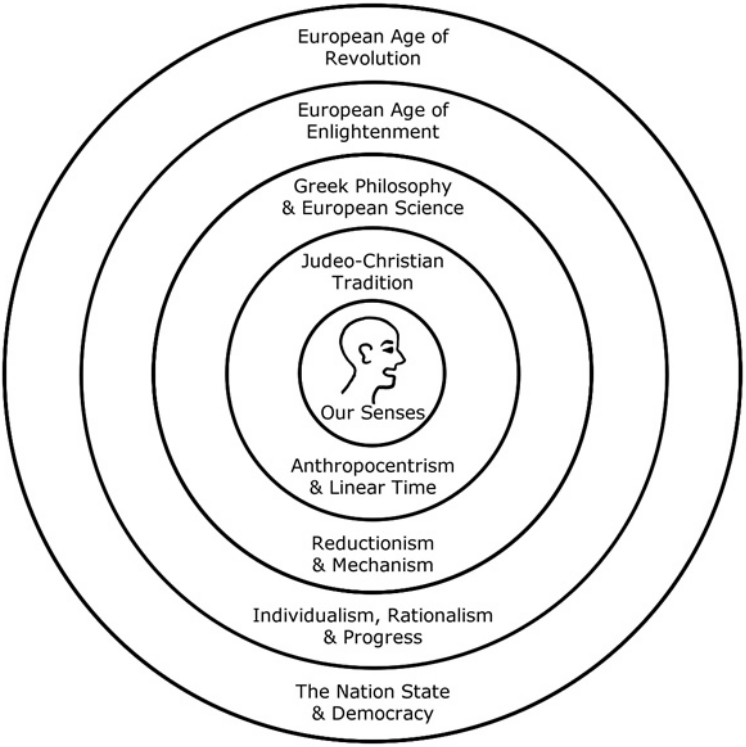
5 · The Cultural Baggage of Tech



Despite their passion for the future, technologists – like most of us – remain mired in unquestioned fallacies which are centuries, or even millennia, old.

> *It is surprising to discover, on the basis of empirical research, that human rationality is not at all what the Western philosophical tradition has held it to be...Reason is not completely conscious, but mostly unconscious…Real human beings are not, for the most part,*

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in conscious control of–or even consciously aware of–their reasoning...Every thought we have, every decision we make, and every act we perform is based upon philosophical assumptions so numerous we couldn't possibly list them all.... (George Lakoff and Mark Johnson, Philosophy in the Flesh)

5.1 · Anthropocentrism and Dominion

As European society advanced in wealth and power during the so-called Renaissance, its highest principle became *humanism*, secular society's unquestioned acceptance of the Biblical mandate of "man's dominion over all the earth." In humanism, "man is the measure of all things." By contrast, traditional subsistence cultures accept humans as mere participants in complex, mysterious ecosystems in which all other natural entities have equal importance, knowledge, and wisdom. Dominance – *dominion* – is implicit in Anglo-European society's *anthropocentrism*, providing moral sanction for its often violent conquest of the world, and its ongoing environmental destruction and replacement of natural ecosystems with engineered habitats. In its ultimate delusion, the fallacy of anthropocentrism enables technologists like Elon Musk to imagine that the universe itself is a construct of the human mind.

To me, the human move to take responsibility for the living Earth is laughable - the rhetoric of the powerless. The planet takes care of us, not we of it. Our self-inflated moral imperative to guide a wayward Earth or heal our sick planet is evidence of our immense capacity for self-delusion. Rather, we need to protect us from ourselves. (Lyn Margulis, Symbiotic Planet)

Aristotle's scala naturae...runs from God, the angels, and humans at the top, downward to other mammals, birds, fish, insects, and mollusks at the bottom. Comparisons up and down this vast ladder have been a popular pastime of cognitive science, but I cannot think of a single profound insight it has yielded. All it has done is make us measure animals by human standards, thus ignoring the immense variation in organisms' Umwelten. (Frans de Waal, Are We Smart

Enough To Know How Smart Animals Are?)

We continue...to assume without question our superiority to other species. Our technology is our evidence to support this assumption....Consider the beast that lives on the land, feeds itself by killing the fleetest of animals without using weapons, and survives the severest of weather without any of the technological crutches that we see as necessities. In the niche of the lion, we are not its superior.... (Harley Shaw, Soul Among Lions)

5.2 · Urbanism and Alienation

In the quote that opens my personal story above, astronaut Piers Sellars celebrates the common assumption that urbanization, the abandonment of "caves" for cities, has "propelled civilizations forward: art, philosophy, engineering, and science all came from the cities." But despite the popular illusion of the prehistoric "cave man," few humans have ever lived in caves, most humans have always lived in villages, and cities are never founded by artists, philosophers, engineers, or scientists. The primary function of cities is always to concentrate human wealth, power, labor, and consumption of natural resources, so that cities dominate the surrounding rural communities and habitats which produce the natural resources they depend on.

The European Renaissance, like other periods of increasing human wealth and power, saw the rise of city-states and larger urban-based political units in which urban elites managed both labor and resources to their personal advantage. Their increasing wealth led to the rise of merchant and professional classes which could also exploit rural producers to provide both raw and manufactured goods to each other and to elites.

Increasingly distanced from the rural production of natural resources, urban *consumers* became increasingly alienated from nature and the subsistence lifestyle. Losing touch with their origins, they began to feel themselves superior, citing the luxuries which economic exploitation brought their way. Since their only familiarity with subsistence living came in the

form of the degraded communities they dominated and exploited, they began to view subsistence living as primitive and miserable, resulting in a vicious cycle of disrespect, abuse, and rural-urban migration.

Historian Theodore Roszak eloquently exposed the fallacies of urbanism in his book *Person/Planet: The Creative Disintegration of Industrial Society*:

> *...the city comes into existence by withdrawing people from the primary production of their life needs–fuel, food, raw materials. Those who leave the land must draw upon the labor of others...If those of us who belong to its culture and economy could see ourselves in the full perspective of urban history, we would recognize that we constitute the oldest imperial interest in the world–the empire of cities, incessantly forcing itself upon the traditional, the rural, the wilderness at large....Whatever holds out against us–the peasant, the nomad, the savage–we regard as so much cultural debris in our path...Today, all decisions that are being made about the future of our planet are being made in cities by city brains. We take it for granted that this should be so.*

The vast infrastructure that supplies the basic needs of urban consumers is hidden from their sight and omitted from their worldview. Food is trucked in from distant farms, since nearby real estate is too "valuable" for farming. Water may travel hundreds of miles in canals and pipelines from distant reservoirs. Clothing and building materials from anonymous locations halfway across the globe miraculously appear in urban emporiums. Energy to run their myriad machines – mostly hidden in industrial zones and the "utility" rooms of homes, apartments, and workplaces – comes from distant power plants. Waste is piped or hauled to processing plants or landfills sited in poor neighborhoods or undesirable rural sacrifice zones.

> *Think of the life-sustaining traffic that must come and go between the source and the use of the goods that feed us, warm us in our homes, clothe us. Think how costly it is merely to remove our daily wastes. In the midst of this busy apparatus, we who fill the cities begin to look like so many million astronauts, hermetically sealed*

into some strange science-fiction vehicle that is constantly dependent on life-support systems of enormous expense and complexity.

5.3 · Linear Time and Progress

You can't turn back time. (Popular expression in Anglo-European society)

Also during the European Renaissance, with the emergence of science, the advance of technology, and the expansion of the merchant class, as more and more people became *alienated* from their subsistence in natural ecosystems, the peasant's traditional dependence on natural cycles was replaced in the towns and cities by a *linear view of time*. *History*, the official narration of phenomena considered important by the urban power structure of the dominant society, began to validate the notion of *progress*, the relentless improvement of society and human welfare.

…the idea of history is itself a Western invention whose central theme is the rejection of habitat, the formulation of experience as outside of nature and the reduction of place to location…Its most revolutionary aspect was its repudiation of the cyclic pattern of events, its insistence on the truly linear flow of time, and its pursuit of its own abstract, self-confirming truth as opposed to indicators and signs in the concrete world. (Paul Shepard, Nature and Madness)

Divorced from the seasonal, cyclical nature of subsistence, the work of the growing merchant and professional classes was linearized into project schedules defined by human milestones rather than natural phenomena. Although consumer society retains vestigial seasonality in holidays, vacations, and sports, important projects may begin or end at any time during the year. And electric lighting frees people to do anything at any time during the day or night, leading to unhealthy individual schedules conflicting with biological rhythms and disrupting the social support of one's family and community.

Science achieved the ultimate reduction of the complexity of temporal

phenomena to the one-dimensional variable *t* in the Newtonian *equations of motion*, which became accepted as an explanation of all phenomena of motion and change. Since scientists – along with merchants and the aristocracy – could rely on lower classes to provide their basic needs, they were free to "transcend" the cycles of nature that dominated subsistence cultures and focus on continual *innovation*, the abandonment of tradition through *revolution*, and forward *progress* to an ever more glorious "future."

The expression "you can't turn back time" confuses complex, diverse natural phenomena with the man-made notion of progress. Linear time is not natural time, it's engineered time. Subscribing to progress takes us farther and farther away from natural cycles and healthy living. Yes, dominant societies and technologies increase in power, just as humans mature physically. But these are temporary advances, followed by decline, death, and replacement. We deny and ignore natural cycles at our peril.

5.4 · Individualism and Free Enterprise

Yet another emerging value of the European Renaissance was *individualism*, the gradual prioritization of individual wants and needs over those of the community. With the rise of capitalism and the merchant class, individualism became enshrined in the sacred principle of *free enterprise*, which would ultimately unleash the *progress* of technological innovation. Subsistence communities, in which everyone is responsible for providing basic needs and dependent on the nonhuman mysteries of natural ecosystems, tend toward communalism and cooperation, but stratified, individualistic societies liberate individuals to *compete* for resources and power, and to accumulate surplus resources and power over others, leading to conflict and the decline of social support networks, and resulting in hierarchical, dysfunctional communities which attempt to manage their members' behavior via coercion and punishment.

> *While Moderns are preoccupied with "finding themselves," the Amish are engaged in "losing themselves."... Uncomfortable to Moderns, who cherish individuality, losing the self in Amish culture*

brings dignity because its ultimate redemption is the gift of community. (Donald B. Kraybill, The Riddle of Amish Culture)

To the ecological balance [of traditional African society], there corresponded another in the field of human relations...Individuals might have rights, but they had them only by virtue of the obligations they fulfilled to the community...The good of the individual was a function of the good of the community, not the reverse. The moral order was robustly collective. Out of this came its stability, its self-completeness, its self-confidence in face of trials and tribulations. (Basil Davidson, The African Genius)

The recognition of symbiosis as a major evolutionary force has profound philosophical implications. All larger organisms, including ourselves, are living testimonies to the fact that destructive practices do not work in the long run. In the end the aggressors always destroy themselves, making way for others who know how to cooperate and get along. Life is much less a competitive struggle for survival than a triumph of cooperation and creativity. (Fritjof Capra, The Web of Life)

5.5 · Exploration and Imperialism

Community values were then replaced by corporate values as European individualism elevated irresponsible deadbeats into heroes during the Age of Exploration, the Heroic Age of Arctic and Antarctic Exploration, and the newly revived Space Age. Media, one of the main pillars propping up Anglo-European society, used propaganda to convince us that *Exploration* is just as essential to our identity as Innovation. But historical investigation reveals that the acclaimed explorers – from Columbus to Shackleton – have abandoned their responsibility to family and community, consuming precious resources from back home, experimenting with new technologies in distant pursuit of corporate profits and national advantage in places out of common sight, where they could plunder ecosystems and trash habitats without community oversight.

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> *Conservation biologist Michael Soule has pointed out that "the most destructive cultures, environmentally, appear to be those that are colonizing uninhabited territory and those that are in a stage of rapid cultural (often technological) transition." (Gary Paul Nabhan, Cultures of Habitat)*

The impacts of exploration on these distant places, often already inhabited, included the spread of disease and invasive species, the degradation or destruction of native ecosystems, the *expansion* of imperialism, and the establishment of colonies to dominate and exploit native peoples and habitats. The "*Frontier*," romanticized in so many books and movies, tends to be dominated by violent sociopaths like the British outcasts who "won the west" by terrorizing Native Americans, committing atrocities to rival or exceed those of the 21st century Islamic State. What we think of as the ideal of Exploration has always been the tragic vanguard of imperialism and the expansion of Anglo-European dominance.

> *The very essence of the frontier experience lies in the extent of its resources, and when resources are boundless, why conserve them or even utilise them efficiently? The principal goal is to exploit them as quickly as possible, then move on. It is this frontier attitude to resource utilisation that lies at the heart of much capitalism, and which presents such a challenge to conservationists today. (Tim Flannery, The Eternal Frontier: An Ecological History of North America and Its Peoples)*

> *Our God expelled us from the Garden of Eden and forced us to wander the Earth...We worship the voyages, the explorers, and the very trails that carried us into new lands. Our discoveries in science and technology are an extension of this biblical mandate, and even though science has long since parted from religion, scientists still, unconsciously, follow the values of the biblical mandate–the values of exploration, discovery, creation, invention–the values of technology. (Douglas Preston, Talking to the Ground)*

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5.6 · Reductionism and Mechanism

> *The material universe, including living organisms, was a machine for Descartes, which could in principle be understood completely by analyzing it in terms of its smallest parts....The belief that in every complex system the behavior of the whole can be understood entirely from the properties of its parts is central to the Cartesian paradigm. (Fritjof Capra, The Web of Life)*

The 17th century French philosopher Rene Descartes has become famous for popularizing the view of nature as a machine assembled from elementary particles and forces. The popular form of his natural philosophy is encapsulated in the terms *reductionism* – the view that complexity arises from simple building blocks and can be understood by reductive analysis – and *mechanism* – nature as machine. In this view, physics, the study of elementary particles and forces, is the foundation science, followed by chemistry, building upwards in complexity to the earth sciences, life sciences, and space sciences, all of which are explained by means of their underlying physics and chemistry.

> *People's image of science is unfortunately often based on physics and a few other fields with similar methodologies. Scientists in those fields tend to be ignorantly disdainful of fields to which those methodologies are inappropriate. (Jared Diamond, Guns, Germs, and Steel)*

Reductionism and mechanism were embraced and institutionalized into the structure of science because they were *instrumental* – they enabled the building of machines that in turn enabled Anglo-Europeans to pursue their Biblical mandate of dominion over all the earth. As science spread, reductionism and mechanism solidified into the unchangeable departments and faculties of thousands of universities and research institutions, the careers of millions of professionals, trillions of dollars of investment, and hundreds of years of habit.

> *The great shock of twentieth-century science has been that systems cannot be understood by analysis. The properties of the parts are*

> *not intrinsic properties but can be understood only within the context of the larger whole....Accordlingly, systems thinking concentrates not on basic building blocks, but on basic principles of organization. Systems thinking is 'contextual,' which is the opposite of analytical thinking. (Fritjof Capra, The Web of Life)*

During the radicalized 1970s there was a brief movement in academia to reject reductionism and mechanism and replace them with "systems thinking," a more holistic science that studies phenomena in meaningful context, as opposed to the reductive approach of isolating elements which can more easily be manipulated. But meanwhile the computer revolution, and the parallel revolution in genetics, were proving anew the awesome power of reductive science to achieve dominion over all the earth, and all opposition was swept aside.

> *...in the old paradigm physics has been the model and source of metaphors for all other sciences....physics has now lost its role as the science providing the most fundamental description of reality. However, this is still not generally recognized today. (Fritjof Capra, The Web of Life)*

5.7 · Invention and Innovation

> *Change was not regarded as an automatic good by the Greeks. They preferred stability, and were suspicious of alteration. It is therefore not surprising to find that as the large cosmopolitan cities of the Hellenistic age replaced the small-town poleis (city-states) of Greece, Greek writers began to stress the superior virtues of the older agricultural life, when even town dwellers could have farms within walking distance, and people were closer to the land. (J. Donald Hughes, Ecology in Ancient Civilizations)*

As stratified European kingdoms developed into empires, and then into nations in which hereditary aristocracy shared power with the merchant classes, technological innovation became institutionalized as the primary tool of modern man's dominion over nature and less advanced societies.

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Whereas subsistence societies with their strong communal bonds might control technology and prevent its abuse by individuals, dominant societies saw technology as an unequivocally positive force and strove to accelerate innovation and free it from all controls and limits, under the protection of free enterprise. *Inventors* – Leonardo da Vinci, Gutenberg, Edison, Tesla – became a new form of hero.

> *By carefully restricting the use of machine-developed energy, the Amish 'have become the only true masters of technology.'...By holding technology at a distance, by exercising restraint and moderation, and by accepting limitations and living within them, the Amish have maintained the integrity of their family and community life. (John A. Hostetler, Amish Society)*

Critic Neil Postman summarized much of the historical baggage of Anglo-European technology in his book *Technopoly*:

> *The idea that if something could be done it should be done was born in the nineteenth century...the great stress placed on individuality in the economic sphere had an irresistable resonance in the political sphere....Technocracy gave us the idea of progress, and of necessity loosened our bonds with tradition....Technocracy filled the air with the promise of new freedoms and new forms of social organization....Time, in fact, became an adversary over which technology could triumph. And this meant there was no time to look back or to contemplate what was being lost.*

The United States, a former British colony which remains dominated by ethnic Anglo-Europeans and their history and culture, took over the mantle of Technocracy that began in the European Renaissance:

> *...the success of twentieth-century technology in providing Americans with convenience, comfort, speed, hygiene, and abundance was so obvious and promising that there seemed no reason to look for any other sources of fulfillment or creativity or purpose. To every Old World belief, habit, or tradition, there was and still is a technological alternative. To prayer, the alternative is penicillin; to*

> *family roots, the alternative is mobility; to reading, the alternative is television; to restraint, the alternative is immediate gratification....*

As a child, I briefly fell under the spell of nuclear technology, which according to engineers offered a future of "unlimited cheap energy." But by examining our history, Postman and Jared Diamond revealed that a new technology never functions purely as it is designed to function. Designed using models which simplify or ignore the complexity of natural and social systems, a technology is released into society and nature, where it begins an unplanned, unanticipated life of its own:

> *There can be no disputing that the computer has increased the power of large-scale organizations like the armed forces, or airline companies or banks or tax-collecting agencies...But to what extent has computer technology been an advantage to the masses of people?...Their private matters have been made more accessible to powerful institutions. They are more easily tracked and controlled; are subject to more examinations; are increasingly mystified about the decisions made about them; are often reduced to mere numerical objects. They are inundated by junk mail. They are easy targets for advertising agencies and political organizations. The schools teach their children to operate computerized systems instead of teaching things that are more valuable to children.*

5.8 · Statism and Coercion

The world that we take for granted, divided into nation-states, was an invention of European imperialism that took shape in the 15th through 20th centuries. First, the monarchies of Europe established global empires, sending out their commercial agents – the "heroic" explorers – as scouts, followed by armed extractive enterprises like the Spanish Conquistadors and the British East India Company that conquered distant societies and imposed Eurocentric governments on their colonies. Then, the European monarchies underwent revolutions during which they gradually became "democratic" nations, and finally, their worldwide colonies rebelled and established Eurocentric nations of their own, resulting in the current

"post-colonial" world map.

But throughout human history, societies defined by nation-states have been vastly outnumbered by an endless variety of decentralized regional societies composed of subsistence communities which were often egalitarian and governed primarily by consensus. In this broader context we can see that nation-states, like the earlier monarchies, are based on the coercion of citizens by means of a political hierarchy culminating in the central authority, whether king or president. Whether democracy or oligarchy, the act of bringing many communities together under a central authority replaces local consensus with remote coercion by a minority of powerful elites.

> *Throughout the greater part of its evolutionary history, the human population of Africa has lived in relatively small groups, demonstrating that people are perfectly capable of living peacefully in small communities for millennia without establishing cities and states. Indeed, the most distinctively African contribution to human history has been precisely the civilized art of living fairly peaceably together not in states. (John Reader, Africa: A Biography of the Continent)*

In an oligarchy, the elites are self-perpetuating and citizens unrepresented. In a democracy, a majority of citizens has limited ability to choose some of the ruling elites, resulting in coercion of minorities by majority rule. Under both paradigms, an individualistic culture like that of Anglo-Europeans will increase inequality, because in an individualistic culture individuals are permitted and encouraged to compete and accumulate unlimited wealth and power. Both paradigms are unstable and unsustainable, resulting in the life cycle of nations and empires, from birth and expansion to final collapse and disintegration. Meanwhile, highly resilient subsistence communities like the Amish may succeed in retaining enough of their autonomy to avoid destruction by the dominant society, resisting the coercion of nations and the coercive behavior that condemns centralized societies.

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5.9 · Media and Misdirection

In our youth, we begin to develop our worldview – a framework for our knowledge of the world – in school, which is organized around the pillars of Anglo-European culture: anthropocentrism and individualism (Humanities), linear time and progress (History), reductionism and mechanism (Science), statism and coercion (Civics).

But from our earliest childhood until our death, we're also bombarded by information from *media*, formerly consisting of newspapers, magazines, books, movies, radio and TV, but now primarily delivered via the screens of networked devices. After our formal education ends, the media take over, perpetuating all the fallacies of the dominant culture.

What we think of as media are actually technologies that have been developed in Europe during the past millenia. The "news" media we look to for current information about the world are organized not only according to the Anglo-European paradigms described above, but, because media providers are businesses, the information provided by media is carefully edited in order to attract more and more of our attention.

Rather than providing meaningful, useful information on the health of our local community, habitat and ecosystem, media direct our attention to distant, central authorities, reinforcing a vicious cycle in which local communities are neglected and rendered increasingly dysfunctional. Media develop and maintain a cultural hierarchy which validates stars, celebrities, and the competitive, hierarchical state culture. Rather than meaningful social and ecological topics, newspapers and news websites are structured around national politics and celebrities, national and international "disasters" involving human deaths and suffering in distant places, corporate games ("sports"), business, and entertainment, misdirecting our attention to topics we have no control over. This is a business strategy which increases our anxiety and helplessness while threatening that if we stop watching, we will miss some new stimulation or danger.

> *This mythic commitment to continuing economic growth is such that none of our major newspapers or newsweeklies considers hav-*

> *ing an ecological section equivalent to the sports section or the financial section or the arts section or the comic section or the entertainment section, although ecological issues are more important than any of those, even more important than the daily national and international political news. The real history that is being made is interspecies and human-earth history, not nation or internation history. (Thomas Berry, The Dream of the Earth)*

But even when the media deliver information which is relevant to our lives, the supply chain – photography and videography, interviews, electronic transmission, authoring, editing, and screen display – strips away the original, multidimensional context which could enable us to accurately interpret the information. We are left with unverifiable, undigestible "news bytes." This is why, as media proliferate, so does misinformation. And because all of society is misled by the same fallacies, this is nearly as true in specialized media – for example, scientific and environmental reporting – as it is in mainstream media.

5.10 · A Perfect Storm of Fallacies

Working together, the Anglo-European fallacies of anthropocentrism and dominion, urbanism, linear time and progress, individualism and free enterprise, imperialism and exploration, reductionism and mechanism, statism and coercion, media and misdirection, accumulated as our unquestioned historical baggage, ultimately ensuring that technological innovation would become one of the highest values of our dysfunctional society, amounting to an addiction on both the individual and societal levels.

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6 · Humbled By the Mysteries: Discovering Context in Ecology and Anthropology

> *Normal human beings are blind to anything they're not paying attention to....That means it's practically impossible for a human being to actually see something brand-new in the first place.... because they can't consciously experience the raw data, only the schema their brains create out of the raw data....Normal people see and hear schemas, not raw sensory data. (Temple Grandin, Animals in Translation)*
>
> *I shall never rest until I know that all my ideas are derived, not from hearsay or tradition, but from my real living contact with the things themselves. (Goethe, Italian Journey)*

My education, like most peoples', consisted of ever-increasing loads of book learning designed to instill the paradigms of Anglo-European culture, including the fallacies described above. But I was fortunate to enter college during a cultural revolution, when "Question Authority" was not just an empty motto on a bumper sticker. Radicalized mentors, like the pastor of my hometown church and my college sociology professor, encouraged me to question and challenge everything the dominant culture tried to show me or teach me. So I kept my eyes and mind open.

As time went by and I fell in love with the desert, hungry for knowledge about its native ecosystems and peoples, I re-engaged with science – but a different kind of science – field biology and anthropology – which often resists reductive and mechanistic analysis. I learned about nature and society not by reading books or following media, but by joining cutting-edge research in the field. And my biologist and anthropologist friends, and the ecosystems and societies we've studied together, began to expose the fallacies of anthropocentrism, linear time, progress, individualism, statism and coercion, while revealing the ultimate context for human knowledge and wisdom: the infinite complexity and mystery of the natural world which has created and sustained us.

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In the computer model of cognition, knowledge is seen as context and value free, based on abstract data. But all meaningful knowledge is contextual knowledge. (Fritjof Capra, The Web of Life)

Even the most primitive tribes have a larger vision of the universe, of our place and functioning within it, a vision that extends to celestial regions of space and to interior depths of the human in a manner far exceeding the parameters of our own world of technological confinement. (Thomas Berry, The Dream of the Earth)

6.1 · Natural Ecosystems

All true wisdom is only to be found far from the dwellings of men, in the great solitudes; and it can only be attained through suffering. Suffering and privation are the only things that can open the mind of man to that which is hidden from his fellows. (Inuit hunter Igjugarjuk, recorded and translated by Knud Rasmussen)

...the part of the plant that we think of as the apple tree is, in fact, a fairly insignificant part of the full plant....In some ways, the tree really seems to be at the bottom of its enormous root system....a plant's real beauty, its true purpose, might not lie aboveground....To know the land for what it is, to find its heartbeat, to expose its soul, you have to go underground where it lives and breathes...worms, through their actions, substantially change the earth. They alter its composition, increase its capacity to absorb and hold water, and bring about an increase in nutrients and microorganisms. In short, they prepare the soil for farming. They work alongside humans, extracting a life from the land...When the worms reached for fallen leaves and twigs around their burrows, they were selecting the best material available. They evaluated, they experimented, they made decisions. (Amy Stewart, The Earth Moved)

Whereas the achievements of technology suggest to many that science is rapidly converging toward the final understanding of nature, and laboratory scientists make ambitious claims based on their observations of

phenomena isolated from their natural context, field scientists know that the more deeply you investigate nature, the more questions you raise. And science's Anglo-European baggage and innate conservatism ensure that your questions will be biased, so that for generations you may miss important phenomena. This past summer, I stumbled upon an exciting new field of biology addressing a complex terrestrial life form, a diverse community of organisms, whose ecological significance is yet to be determined. Yet it was long ignored, partly because it exists humbly beneath our gaze, at ground level, and develops over a time scale beyond human perception.

When I launched my *Pictures of Knowledge* project, trying to figure out my purpose here on earth, I didn't take anything for granted. I began by analyzing our basic needs as humans, and where those resources and services came from. You can't begin to grasp what keeps us alive, and what keeps us healthy, without immersing yourself either in subsistence living or in ecological field work. This immersion forces us to abandon our anthropocentrism, our linear view of time, our reductionism and mechanism, and the hubris that deludes us into thinking we can control or reinvent nature.

> *Although scientists now understand many details of the ways ecosystems work, most urbanized Homo sapiens do not value the services ecosystems deliver. The average city dweller, for instance, has no idea what is involved in supplying his or her food and has a mental picture of environmental hazards that often ranks them in reverse order of their seriousness...." (Paul R. Ehrlich, Human Natures)*

Ethnobotanists like my hero, Gary Paul Nabhan, have revealed how the presence of wild, unmanaged habitat surrounding farmland is essential for the diversity and resilience of food species that we ultimately depend on, as wild species like pollinators and insect predators do their ecological work, and genes flow across the wild-domestic interface, enriching the diversity and hardiness of cultivated crops.

Anglo-European anthropocentrism began with the Biblical mandate of man's dominion, and continues in the present with a long series of

unproven assertions about human superiority and exceptionalism. Scientists who study animal behavior and cognition are in process of invalidating all of these assertions. What is left is the acceptance of "might makes right" through which members of dominant societies validate themselves and their actions.

Field biologists begin to recognize that each species has its unique *Umwelt* – a perception of the environment that we can't detect or measure, but is essential to that species's success. Therein lie the limits to reductive science and human understanding. We rely not only on other species, but on entire nonhuman ecosystems, to produce the food and other basic resources we need. Businesses and factories may keep us alive for a while, but they don't keep us healthy in the long term. The more we try to engineer the ecosystems that, for example, provide our food, the more vulnerable we become, because natural systems embody the knowledge and wisdom of countless other entities that are beyond our comprehension and are necessary for ecosystem resilience and adaptation to changing conditions.

6.2 · Healthy Societies

> *I grew up on my grandfather's farm where two of his sisters, aged 18 and 19, are buried due to TB, only a few hundred meters from my backyard. For me, growing up and entering the world as an adult carried the hope that those sorts of trivial losses of human potential - and the subsistence existence that my family on both sides experienced - would one day be forever banished. (Computer engineer, Facebook, 2015)*

> *There is no time in history, since white occupation began in America, that any sane and thoughtful person would want to go back to, because that history so far has been unsatisfactory. It has been unsatisfactory for the simple reason that we haven't produced stable communities well adapted to their places. (Wendell Berry, Orion, 1993)*

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Beneath the veneer of civilization, to paraphrase the trite phrase of humanism, lies not the barbarian and animal, but the human in us who knows the rightness of birth in gentle surroundings, the necessity of a rich nonhuman environment, play at being animals, the discipline of natural history, juvenile tasks with simple tools, the expressive arts of receiving food as a spiritual gift rather than as a product, the cultivation of metaphorical significance of natural phenomena of all kinds, clan membership and small-group life, and the profound claims and liberation of ritual initiation and subsequent stages of adult mentorship. (Paul Shepard, Nature and Madness)

We ate our bread in the sweat of our brows, entirely happy with our choice, and thankful to be free from that voluntary slavery which most accept in order to earn a living...we were earning our living in the most delightful and interesting way we could imagine, and would not be likely to complain of attendant labor. (Chapter 8, Shantyboat: A River Way of Life, Harlan Hubbard)

Misled by the fallacies of Anglo-European history, the computer engineer quoted above mistakenly conflates disease with subsistence living. Disease isn't a problem in subsistence societies - it's a problem of urbanized states, with their industrial agriculture, landscape engineering, concentration of wastes and broad transportation and distribution networks. I grew up in a healthy, long-lived family and community that had succeeded at farming and was proud of its hard work and track record. The last farmer in my family was my grandfather Carson, and the only thing that ended the tradition was that all of his six daughters married city people. This wasn't a failure of subsistence culture – it was a failure of an individualistic society obsessed with competition and innovation. The members of the Amish community to the south of us supported each other in their farming way of life, rejecting the economic competition and technological innovation that encouraged my family and community to migrate and disintegrate, and today the Amish in my home county continue to thrive, whereas the non-Amish community is an empty shell, rife with drug addicts on welfare and disability.

Despite the misconceptions of people like astronaut Piers Sellers, humans

did not uniformly "advance" from miserable caves to glittering cities. If you want to understand what makes a society healthy, you need to study healthy societies – humble societies, often obscure or unknown to us, that successfully care for their members and habitats, avoiding some of the myriad problems of our own society. Anthropology forces us to abandon the hubris of our cultural exceptionalism, the unacknowledged assumption that might makes us right. Listen to anthropologist Elizabeth Marshall Thomas in *The Old Way*, a book about the Ju/wasi of southern Africa:

> *I remember my disappointment upon learning of a professor of zoology who visited the Ju/wasi briefly as a guest/consultant of the Harvard group. While there, he evidently quizzed the people about the natural world and then returned to tell his fellow academics that the Ju/wasi "knew almost as much as we do" about the plants and animals...the professor missed the fact that when it came to matters of their own environment, the Ju/wasi knew considerably more than we do.*
>
> *The process was essentially the same for every person and started early in life, not by sitting at the feet of some elder who imparts bits of wisdom by telling stories...but by accompanying adults, watching what they did, overhearing their talk, and participating when possible...By these methods, young people absorbed a body of knowledge that their ancestors had been accumulating since the rain forests withered, the knowledge that would help each generation reach reproductive age in good condition, ready to educate the next generation. Thus, over the millenia, inaccuracies were filtered out, leaving the oldest and purest scientific product–solid, accurate information that had often been put to the test.*
>
> *I...feel that I saw the most successful culture that our kind has ever known, if a lifestyle can be called a culture and if stability and longevity are measures, a culture governed by sun and rain, heat and cold, wind and wildfires, plant and animal populations.*

And these lessons from subsistence cultures of North America, South America, and the Pacific Ocean:

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The Amish...have succeeded simply by asking one question of any proposed innovation, namely: "What will this do to our community?" That, to me, is an extremely wise question, and most of us have never learned to ask it. If we wanted to be truly progressive, if we were truly committed to improving ourselves as creatures and as members of communities, we would always ask it. (Wendell Berry, in Orion)

The Piaroa view competition as leading to cannibalism. They feel that competition over resources and over the power to transform the resources of the earth into human goods is the primary force producing human violence. (University of Alabama Department of Anthropology, Peaceful Societies Project)

Tikopoia Islanders inhabit a tiny island so far from any neighbors that they were forced to become self-sufficient in almost everything, but they micromanaged their resources and regulated their population size so carefully that their island is still productive after 3,000 years of human occupation. (Jared Diamond, Collapse)

Truly sustainable societies don't pursue increasing power and mechanization through technological innovations like electric cars and wind farms. They maintain their resilience to respond to environmental challenges by adapting – minimizing their dependence on technology so they can rapidly change their way of life – instead of trying to control their environment through engineering.

Members of sustainable societies don't continually strive to "better their own and their families' lives by struggling to get a bit more than they have." They focus on sustaining their well-being under stable conditions – consistently caring for their members and habitat from generation to generation – and adapting to crises, protecting their members during transitions to a new form of stability. They operate on a small, face-to-face scale, engaging active adults in a reciprocal, restorative subsistence ecology. Individuals submit to the welfare of the community, decisions are achieved by consensus rather than coercion, individuals are prevented from accumulating wealth or power over others, aggression is sup-

pressed, and elders accumulate and perpetuate long-term wisdom for adapting to environmental or external crises.

> *Although the cultural norms of Amish life circumscribe personal freedom, they also lift the burden of choice from the back of the individual. They liberate the individual from the incessant need to decide. In Amish culture, the burden for success and failure leans on the community; in the modern world, the weight of success and failure rests on the individual, who may lack the support of a durable group. (Donald B. Kraybill, The Riddle of Amish Culture)*

> *A bureaucracy that places pupils together within narrow age limits and emphasizes science and technology to the exclusion of sharing values and personal responsibility is not tolerated. The Amish appreciate thinking that makes the world, and their own lives, intelligible to them. When human groups and units of work become too large for them, a sense of estrangement sets in. When this happens the world becomes unintelligible to them and they cease participating in what is meaningless. (John A. Hostetler, Amish Society)*

What I've come to think of as the true foundation sciences – ecology and anthropology – can humble us with their revelations, but shouldn't frustrate or threaten us. They can give us new respect for our mysterious world and our non-human partners that help keep the ecosystem functioning. They can shift our focus from the fantasies of a manufactured, human-dominated world to the infinite and much richer complexities of a world we share with the rest of nature, where we accept our limits in order to thrive within them.

7 · Vicious Cycles of Engineering and Technology: How Dominant Societies Fail

In its broadest form, technology simply refers to the making and use of tools. Humans are not alone in this; other animals also make and use tools, but without the destructive and self-destructive impacts of human technologies. At what point in cultural evolution does technology become dangerous and destructive?

7.1 · The Engineering of Habitat

One idea that's popular among radical environmentalists, conservation biologists, and critics of civilization is the notion that agriculture was invented in the Middle East 11,000 years ago, enabling the accumulation of surplus food and the growth of communities, leading to centralization of power, hierarchical civilizations, and the gradual destruction of nature as growing societies expanded and consumed more habitat. So, these people see agriculture as our first and biggest mistake. Of course, this misconception is itself based on the fallacies of linear time and progress. In traditional societies, rather than an irreversible innovation, agriculture is always part of a varied, adaptive toolkit for subsistence, available to be used or abandoned as the environment changes.

> *To modern people, dams, timber, and great cities are part of the vision of paradise, engineers are priests, and the forces of nature are mere puzzles with certain solutions. (Carolyn Servid and Donald Snow, The Book of the Tongass)*

Recent excavations have revealed that engineering, not agriculture, is what brings down civilizations. The engineering of habitat – not just our homes, but the environment that produces our subsistence – is the fatal mistake:

> *Angkor – which Chevance and Evans describe as 'an engineered*

> *landscape on a scale perhaps without parallel in the preindustrial world'...was an urban center extending over nearly 400 square miles...The sheer ambition of the Khmer kings, their re-engineering of a jungled landscape into an urban one, sowed the seeds of destruction...Over time, the artificially engineered landscape almost certainly led to topsoil degradation, deforestation and other changes that drastically reduced the capacity to feed the population and made Angkor increasingly difficult to manage. (Joshua Hammer, Smithsonian, 2016)*

For us, habitat engineering begins with local and regional infrastructure projects like roads, canals, dams, and bridges, and develops into national and global interventions like factory farms, industrial mines, oil and gas fields, power plants, railroads and shipping lines, superhighway networks and airlines, pipelines and transmission corridors and undersea cables, communications networks and satellites, and of course the ultimate engineered habitats: cities. These structures and systems are always reductive and mechanistic, hugely wasteful of energy and material resources, and ultimately unsustainable.

> *Human beings, the Greeks thought, tend to violate the order of the universe whenever, in their pride, they try to make major alteration in what is already present in the natural environment. Canals across isthmuses, for example were strongly discouraged because they would have made islands of what were naturally peninsulas. (J. Donald Hughes, Ecology in Ancient Civilizations)*

Anthropocentrism, combined with statism, marshalled the onslaught of technology against nature, ensuring that a world of robust, diverse natural ecosystems would be transformed into a machine for supplying human needs. In the anthropocentric delusion of members of dominant societies, including engineers like Elon Musk, the world is thus a man-made place containing islands of nature called parks and preserves, which are believed to be sufficient for our recreational and spiritual needs:

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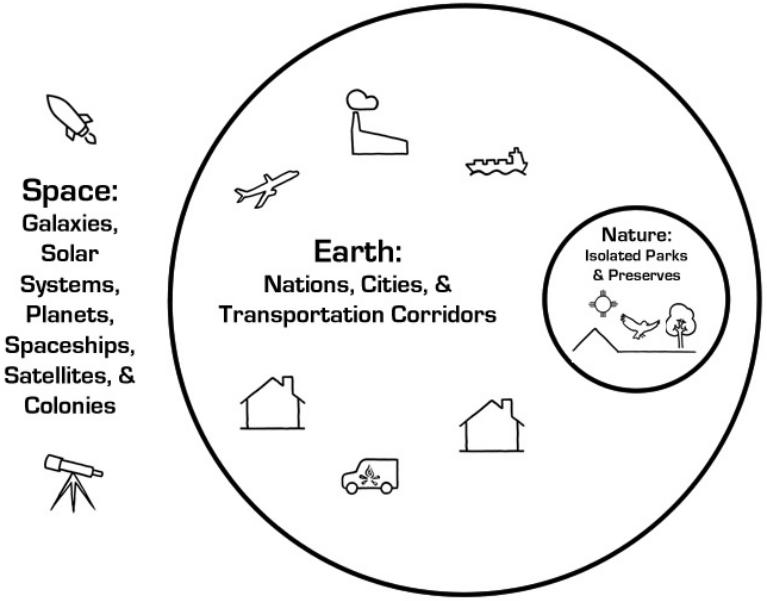
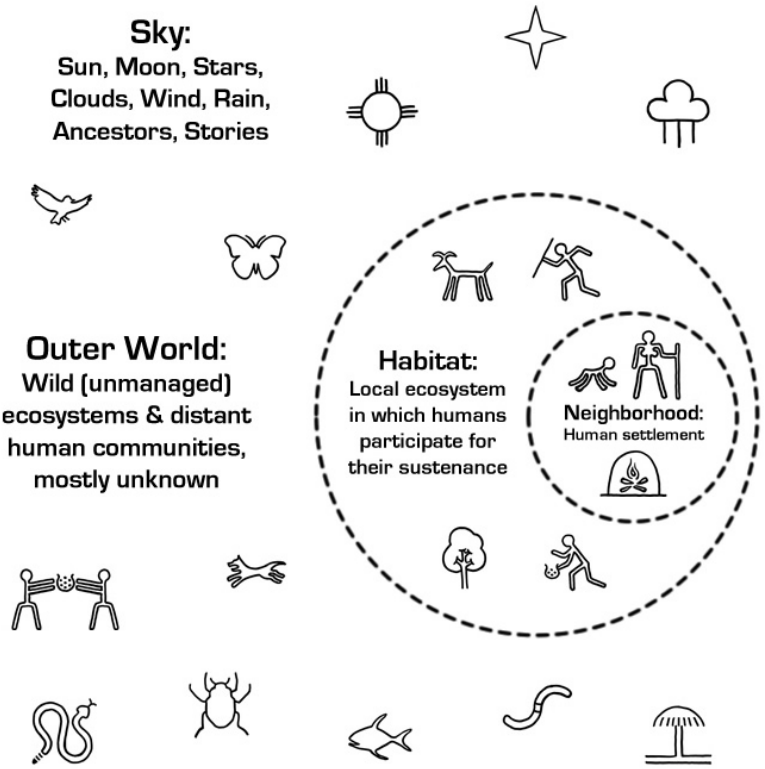


By contrast, sustainable societies recognize their dependence on unmanaged, unengineered natural ecosystems, and live within their limits:



7.2 · Vicious Cycles

Why do dominant societies engineer their habitats and pursue technological innovation, and how are these behaviors so destructive?

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First – combining anthropocentrism and individualism with competition, statism, aggression, dominance, and coercion – individual comfort, convenience, power and security are elevated over the health of the community and habitat. This leads to two parallel processes:

- Engineering of natural habitat (diverse ecosystem) for sole human use (urbanization and industrialization)

- Innovation of technology to meet goals of individual comfort, convenience, power and security

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Habitat engineering leads to growing population, which in turn leads to *increasing hierarchy* and *centralization of power*, resulting in *increasing inequality* and *lack of accountability* of leaders for the consequences of their actions. And growing population adds a feedback loop, requiring even more habitat engineering, stretching ever farther outward to regional and even global networks, in a vicious cycle.

In an additional parallel process, habitat engineering for human use results in *declining quality of habitat and basic resources* (air, food, water, etc.) – not only from pollution, but also through the elimination of beneficial wild organisms essential for our healthy biota – and much of this damage occurs in distant locations, out of sight and mind, preventing the accumulation of useful knowledge and wisdom.

Technological innovation results in new technologies empowering youth and disempowering elders, leading to the *declining role of elders*, *declining communal memory and contextual wisdom*, and *increasingly dysfunctional communities*.

In parallel, innovation in a money economy leads to *commodification of resources and social services*, isolating individuals as *consumers*, leading to the *breakdown of social networks, declining quality of social services, and increasing consumption of natural resources* by isolated individuals who would otherwise be able to meet their needs socially.

One of the most destructive results of technological innovations like the telephone, the automobile, and the airplane is *increased human mobility*, which enables and encourages individuals to become isolated from their families and communities, so that families and communities break down and individual health declines as we become dependent on machines rather than the rich, contextual face-to-face communication, touching, and physical sharing we need.

The increasing concentration of power and wealth in the hands of elites, resulting from habitat engineering, added to the increasing community dysfunction resulting from technological innovation, combine to *reduce the quality of social services* (emotional support, healthcare, childcare, jus-

tice, wisdom, etc.) available to the disempowered and disadvantaged majority.

> *...the industrial household was, by virtue of its isolation and insecurity, a savagely competitive bundle of self-interest that neatly reinforced the fierce aggressiveness of the capitalist market place...Still today, the troubled families that come to pieces all about us are reeling in those great winds of change. They are pitted against the brutal historical fact that wherever the industrial city takes over, it comes, not to preserve families and strengthen community, but to erect cities, assemble a work force, build an economy. And for that, it needs power at the top and helpless human fragments at the bottom. (Theodore Roszak, Person/Planet: The Creative Disintegration of Industrial Society)*

The declining quality of habitat and basic resources resulting from habitat engineering and isolation of consumers from social support, combined with the declining quality of social services resulting from both engineering and innovation, combine to produce a general *decline in human health* and an *increase in conflict*, especially in distant locations where resources are extracted, out of sight and mind, for the benefit of urban consumers in dominant societies.

These problems place an even greater demand on technological innovation to further increase individual comfort, convenience, and security, feeding back to the beginning in a vicious cycle, until conflict becomes *violence, suffering, and death* – all resulting from an anthropocentric, individualistic, statist worldview and value system.

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8 · Engineering Without Understanding

8.1 · Unquestioning Idealism

> *Idealism, whether of the pastoral peaceable kingdom or the electronic paradise of technomania and space travel, is…a normal part of adolescent dreaming, like the juvenile fantasies of heroic glory… The difficulty for our time is that no cultus exists, with its benign cadre of elders, to guide and administer that transition. (Paul Shepard, Nature and Madness)*

Like the rest of us, most engineers are specialists, cogs in the machinery of society, doing work that is determined by someone higher up. Like most of us, engineers unquestioningly inherit the Anglo-European cultural baggage. Like the rest of us, some are selfish or cynical, while others are idealistic. But like most of us, engineers have no experience with field ecology or anthropology, and as a result, have little or no understanding of society or its context in nature. Like astronaut Piers Sellers, they mistakenly conflate the historical fallacies of anthropocentrism, urbanism, progress, individualism, exploration, reductionism and mechanism with the realities of nature and human society.

Tech evangelists Elon Musk and Ray Kurzweil carry the Biblical fallacies of anthropocentrism and dominion over nature to new heights. Musk exhorts us to fulfill our "destiny" as a "multi-planet species," transcending the natural limits of terrestrial ecosystems through space travel and habitat engineering. Kurzweil promotes life extension technology to transcend the natural biological processes of aging and death.

As in all fields, some technologists are more ambitious than others, and more adept at business. Some time ago I read a profile of Elizabeth Holmes, who founded biomedical technology company Theranos as a teenager. Ms. Holmes is an engineer-entrepreneur like Elon Musk. What struck me about the profile was her emphasis on the importance of living a "life of purpose," an expression she had picked up from her father. I thought, "That's one of those loaded cliches that ambitious people use as

some sort of private code – what the hell does it mean to her?"

It eventually appeared that to the Holmeses, a "life of purpose" meant making an impact on society at a high level, by acquiring wealth, power and influence. Apparently a simple farmer, or a classroom teacher, has no purpose in this world. Theranos initially skyrocketed to short-term success, then began to crash and burn as it underwent criminal investigation by the government for irresponsible or unethical practices.

> *The vast bulk of scientific research undertaken by the biotechnology companies is subject neither to peer review–the accepted norm anywhere else in science–nor available for publication. (Simon Conway Morris, Life's Solution)*

8.2 · Medical Technology: The Ultimate Rationalization

Medical technology, the ultimate rationalization of progress, is an outstanding example of innovation without understanding. The ostensible goal of medicine is to relieve suffering and save lives, and the most vaunted result of medical innovation is the reduction of infant mortality and the increase in life expectancy in affluent societies. Tech billionaire Mark Zuckerberg of Facebook pledges to "rid the world of all disease" via scientific research and medical engineering.

But historically, disease is largely a byproduct of urbanization, technological innovation, statism, and imperialism. Concentration of pollution and waste makes cities an unhealthy environment, and industrial agriculture breeds new diseases and reduces the quality and diversity of our diet. Epidemics are nurtured and spread by the increase in human mobility facilitated by technology, statism, and imperialism. Assistive technologies like the automobile and industrial food processing degrade health and fitness, triggering epidemics of obesity, diabetes, and cancer, and consumerism results in epidemics of stress disorders, depression, drug addiction, and Alzheimers. Medical technology is a band-aid on the dysfunction of dominant society; healthy societies don't need it, because they

focus on raising caring providers rather than needy consumers.

In natural ecosystems and subsistence cultures, death is the necessary passage in the cycle of life that transfers resources to others, particularly the young. We should live just long enough to pass on our knowledge and wisdom to those who are prepared to use them for the welfare of the community. To live longer is selfishness.

> *A 50 percent mortality rate among the newborn is a gift of life and health to the survivors. The modern medical reduction of that rate is an enormous alteration in human biology that we, as a species, may not be able to afford. The birth rate in hunting-gathering societies is kept down by a variety of means, including contraception and induced abortion…small families appear to be superior in terms of quality of offspring and likelihood of survival…. (Paul Shepard, The Tender Carnivore and the Sacred Game)*

In the context of an aggressive, coercive society with a reductive, mechanistic worldview, medicine becomes warfare: the war on polio, the war on cancer, the war on diabetes, the war on obesity, and even the war on aging.

> *Medicine is about disease, not the patient. And what the patient knows is untrustworthy; what the machine knows is reliable....we see the emergence of specialists–for example, pathologists and radiologists–who interpret the meaning of technical information and have no connection whatsoever with the patient, only with tissue and photographs...Nature is an implacable enemy that can be subdued only by technical means; the problems created by technological solutions (doctors call these "side effects") can be solved only by the further application of technology. (Neil Postman, Technopoly)*

> *Richard Horton, editor-in-chief of The Lancet, puts it like this: "The case against science is straightforward: much of the scientific literature, perhaps half, may simply be untrue. Afflicted by studies with small sample sizes, tiny effects, invalid exploratory analyses, and flagrant conflicts of interest, together with an obsession for pursuing*

> *fashionable trends of dubious importance, science has taken a turn towards darkness."...an economic analysis published in June 2015 estimates that $28 billion per year is wasted on biomedical research that is unreproducible. Science isn't self-correcting; it's self-destructing. (Daniel Sarewitz, The New Atlantis, 2016)*
>
> *In Health Shock, Martin Weitz cites the calculations of Professor John McKinley that more deaths are caused by surgery each year in the United States than the annual number of deaths during the wars in Korea and Vietnam...We also know that, in spite of advanced technology (quite possibly because of it), the infant-survival rate in the United States ranks only fourteenth in the world, and it is no exaggeration to say that American hospitals are commonly regarded as among the most dangerous places in the nation. (Neil Postman, Technopoly)*

Medical scientists are only recently becoming aware of the importance of wild organisms found in soil, and microorganisms found in healthy bodies, to our health – organisms which are eliminated by the engineering of urban habitats and the technological "war on disease." And whereas immersion in natural, unmanaged ecosystems restores and sharpens our minds and bodies, assistive technologies and engineered environments weaken and degrade our abilities and senses – with repetitive stress, allergies, artificial memory, air, noise, and light pollution.

Focusing on individual welfare at the expense of community, ignoring the broader impacts on society and ecosystem, expensive technology – inevitably biased toward elites – artificially prolongs unproductive lives, consuming a disproportionate amount of limited natural and social resources, and increasing inequality and conflict. The science and technology of life extension represent the ultimate selfishness.

Saying that technology makes life better is like saying that money can buy happiness. You shouldn't need data or statistics to recognize the naivete in that. Anthropocentric, individualistic societies which pursue habitat engineering and innovation become increasingly dysfunctional, losing the unity which could restrain their members from abusing technology

and taking advantage of each other. In our society, a "man of action" generally turns out to be a man of hubris, selfishly pursuing a goal without trying to understand its context.

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9 · Robots: Weakening and Killing Us, Threatening Nature and Society

> *My grandfather said the white man would create something in his own image. I'm not sure, but I think he meant the image of a human mind, put into one of these super-powerful computers...It'll be a mind in a machine, and you'll lose control. Like you've lost control of all your inventions, the atom bomb, gasoline, electricity, cars. (Navajo woman, quoted in Talking to the Ground by Douglas Preston)*

Many engineers dream of a world filled with robots. Robots are machines designed to replace human labor, or to extend human labor into realms humans can't easily reach, for example the inside of the human body, or distant, hostile environments.

> *This discrepancy between difficulty and danger is our civilization's signature, from machine guns to atomic bombs. You press a pedal and two tons of metal lurches down the city avenue; you pull a trigger and twenty enemies die; you waggle a button and cities burn. The point of living in a technologically advanced society is that minimal effort can produce maximal results. Making hard things easy is the path to convenience; it is also the lever of catastrophe. (Adam Gopnik, The New Yorker, 2015)*

Because robots are designed to work without direct human manipulation or control, they must be *programmed* by someone. Hence they embody the worldview, assumptions, and biases of the programmer, who is typically an engineer – without ensuring any accountability of that anonymous designer for the end result.

Human labor is sustained by the energy found in food. But as machines, robots require and consume electrical energy, which comes from a vast, unaccountable global network of factories and other infrastructure, involving massive amounts of waste and pollution, from the toxic elements used in batteries to transmission losses in powerlines and heat

losses in turbines and power plants.

As noted above, the pursuit of individual power and convenience – which includes the replacement of human labor with robotic labor – is one of the fundamental mistakes of dominant societies. Mass production in factories is an alienating, destructive practice whether performed by humans or robots. It should be reduced and eliminated, not made easier through automation. But when humans perform factory tasks, they tend to be more accountable for their consumption of natural resources, since they can see how materials from all over the world are assembled into consumer products.

An equally fundamental argument against robots is the importance of labor to human health, both individual and social. Reliance on assistive technologies like autonomous vehicles weakens us and makes us prone to disabilities like obesity, as well as launching us on a vicious cycle of individualism and social dysfunction. Commuting long distances for work or school is an unhealthy practice we should work to reduce and eliminate, not make easier and less social with self-driving cars.

> *...the truth is that the work ordinary people do in traditional societies remains a thoroughly dignified and intrinsically engaging use of life....In premodern society there is no such thing as "unskilled" labor; there are no workers who exist simply as the routinized adjuncts of machines or assembly lines; there is no one, below the level of the privileged orders, whose life's work is a scam or a boondoggle. (Theodore Roszak, Person/Planet: The Creative Disintegration of Industrial Society)*
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> *Working the soil keeps one close to God; hard physical labor is good in itself. Farming helps to hold the family together, living and working as a unit in a way that would not be possible if the members worked away from home. (Carolyn Meyer, Amish People: Plain Living in a Complex World)*

The ambitious field of artificial intelligence, which aims to guide the cutting edge of robotics, relies on the Cartesian fallacy of the brain as

machine, isolated from its social and ecological contexts. No human can survive on the basis of individual intelligence; we need the minds of our community as well as the unknowable intelligence of our ecosystem partners to sustain and to adapt to new challenges. Intelligence isn't assembled from neurons, synapses, or even individual brains – it evolves in the larger social and ecological context.

Robots are being developed by dominant societies, which are characterized by their aggression and use of violence to coerce weaker communities into submission. And the greatest danger of robots to humans is in surveillance and warfare. Covert drone warfare, practiced by our government, is the form in which robots first became widely known in our society. Rather than demanding an end to this, civilians have eagerly embraced airborne drones as toys and photographic aids.

The ecological threat of robots may be even greater than their danger to humans. Like transoceanic shipping, the railroad, and the automobile, which have devastated native ecosystems and changed global climate, triggering mass extinctions and threatening civilization, robots extend the destructive power of humans to a much broader realm, threatening wildlife in uninhabited parks, preserves, and wilderness areas, on glaciers and polar ice sheets, to the depths of the sea, and to microscopic flora and fauna. People who consider themselves nature lovers think nothing of disturbing wildlife with drones, in order to get spectacular pictures and videos of nature.

10 · Space Exploration and Colonization: War on the Sky

What we dominant societies think of as "outer space", populated with worlds to conquer, begins as the sky of people in more humble, sustainable, subsistence-based societies. Rather than worlds to conquer, traditional peoples see the all-powerful sun and moon, dominating the natural cycles we depend on for our subsistence, the wind and clouds that renew our habitat, the birds, bats, and insects that teach us and feed us. The night sky is sacred space, reflecting myths and legends that bond people to their heritage and to each other, reminding them of the wisdom of their ancestors, and thrilling them with the Great Mysteries.

Sending even small numbers of people and machines into space requires tremendous amounts of energy generated by consuming terrestrial resources and damaging terrestrial habitats and ecosystems. The financial investment required can only be provided by national governments and huge corporations, and the explorers who are sent into space become agents of empire who abandon their homes, families, and neighborhoods, furthering corporate agendas rather than the welfare of their communities. Space exploration and colonization are imperialism – the aggressive expansion of dominant societies.

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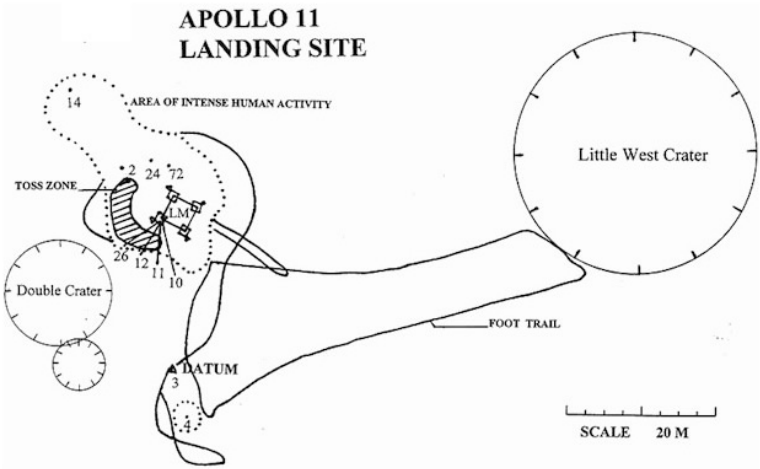

The reality of exploration: lunar landing site with "toss zone" for trash. Traditional societies honor the moon's influence on our lives in rituals and festivals; our "advanced, pioneering" society litters it with 400,000 pounds of trash, including over 70 abandoned machines and 69 bags of urine, feces, and vomit.

The "outer space" we learn about from telescopes, rockets, and space probes is like the "matter" we learn about from the atom smashers of particle physics. It's engineered space, decontextualized space, dead space that teaches us nothing about how to live healthy, successful lives on earth.

The colonization of space not only requires the destructive consumption of massive terrestrial resources in "getting off the ground," it naively assumes that the habitat of humans can be created from scratch in an extraterrestrial environment. As noted above, humans can't engineer a healthy habitat for themselves – healthy human habitats are created and sustained by an infinite diversity of nonhuman creatures whose roles and functions are beyond scientific understanding and management. Habitat

engineering is the fundamental mistake of dominant societies, and the creation of new habitat from scratch can only be conceived by people who have no experience with subsistence living or field ecology, and no understanding of the natural, unengineered, unmanaged ecosystems that produced us, and that we need in order to thrive. The colonization of space is perhaps the most naive and arrogant project ever devised by alienated human minds.

11 · What We Can Expect

Blockbuster movies romanticize space exploration and the heroism of explorers and colonists. Even if a movie shows a dystopian future, the technology, and even the violence, are exciting and fun to watch. My local library engages kids by teaching them to program computers and work with robots. The media decry the shortage of women coders in the computer industry, pressuring male-dominated tech companies to hire more female workers. General-interest magazines with the widest circulation regularly devote entire issues to tech, innovation, and "genius" inventors. Pundits continually emphasize the importance of science and math curricula in schools, and parents worry that their kids will not be competitive enough in the tech-dominated job market. Technology which is designed for military use in surveillance and weaponry is then sold to, and unquestioningly accepted by, civilian consumers – sometimes, as in the case of drones, in the form of insidiously destructive toys for children and adolescents.

Technology is especially pernicious in its exploitation of the young, who lack the experience, knowledge, and wisdom to evaluate and reject or use it responsibly. Technology, embedded in rampant consumerism, seduces the young by offering them unfair power over their elders, addicting them to devices which further isolate them from human contact and alienate them from nature. In this vicious cycle, elders gradually cease to function in society, since the same process has previously alienated them from even older generations.

Even without the addition of new innovations like rockets and robots, non-reductive sciences like climatology, ecology, and sociology struggle to catch up with and understand the damage being done by older technologies. As Jared Diamond noted, innovation creates more problems than it solves. One of the worst, least studied, and most ignored results of 20th century innovation is the unfolding catastrophe of microplastics in aquatic environments, but the production and use of plastics just keeps accelerating and threatens to persist as long as human-caused climate change.

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The bottom line is that even if we could convince technologists that their fantasies are not solutions to our problems – and that we neither want nor need them – we're not going to stop billionaires from forcing those fantasies on us. Tech is cool – it seduces us with power, convenience, and stimulation. Even a dystopian future seems cooler than the slower, less exciting world of our parents and grandparents. Our individualistic society rewards ambition and greed and rejects any restraints on individual consumption. Robots and space travel are supported at the highest levels of our society. The only thing that will stop them will be their own failure, and the best we can do is to seek and cultivate ecological and social refuges here on our home planet, in which our children may be able to survive the catastrophic impacts of exploration and innovation.

> *Where do the little people of the world turn when the big structures crumble or grow humanly intolerable? At that point, it becomes important for us to know what a political and intellectual leadership devoted to the big system orthodoxies will never tell us: that there are small alternatives that have managed to bring person and society, spiritual need and practical work together in a supportive and symbiotic relationship. (Theodore Roszak, Person/Planet: The Creative Disintegration of Industrial Society)*

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