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Aspire or Expire: Super-Adaptable Agents and Problematic Innovation

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Aspire or Expire: Super-Adaptable Agents and Problematic Innovation

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Abstract

Humans are unique as a species because, with the help of well-defined problematics, humans alone are capable of redefining reality. A problematic can be understood as an exceptionally-challenging intellectual objective (e.g., heavier-than-air flight, building the first atomic bomb, curing disease, landing humans on the moon, developing artificially-intelligent computers, *constructing faster-than-light speed spacecraft*, etc.) that requires knowledge-seekers to invent new facts and redefine reality in order to achieve the hoped-for objective. Although scientists prefer to think that scientific inquiry is constrained to an exploration of empirical facts, in truth, scientific progress is often instigated more effectively by the pursuit of a compelling problematic—in many cases, even by science fiction fantasies (Shatner, 2002)— rather than by an examination of established empirical facts (McGettigan, 2011). As such, science has proven to be the most effective means ever invented by humans to transform fantasies into reality.

Keywords: problematic, agency, reality, science, fantasy

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Aspirar o Expirar: Agentes Super-adaptables e Innovación Problemática

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Resumen

Los seres humanos son únicos como especie porque, problematizando la realidad de forma bien definida, ellos mismos son capaces de redefinirla. Una problemática puede ser entendida como un objetivo intelectual excepcionalmente retador (por ejemplo, hacer volar algo más pesado que el aire, construir la primera bomba atómica, curar una enfermedad, llevar personas a la Luna, desarrollar ordenadores con inteligencia artificial, *construir naves más rápidas que la velocidad de la luz*, etc.), lo que empuja a los científicos a inventar nuevos hechos y redefinir la realidad a fin de conseguir el objetivo deseado. A pesar que éstos prefieren pensar que la investigación científica está delimitada por la exploración de hechos empíricos, en verdad, el progreso científico a menudo está instigado más efectivamente por la búsqueda de una problemática apremiante –en muchos casos, incluso de fantasías de ciencia ficción (Shatner, 2002)- más que por un examen de hechos empíricos establecidos (McGettigan, 2011). Como tal, la ciencia ha demostrado ser uno de los medios más efectivos jamás inventado por las personas humanas para transformar las fantasías en realidad.

Palabras clave: problemática, agencia, realidad, ciencia, fantasía

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As a means of giving the US a psychological boost, in 1961 President John F. Kennedy embraced a manned-moon landing as the crowning achievement of his New Frontier goals. Interestingly, when Kennedy announced his plan for a successful lunar landing, his aspiration was more a product of science fiction than fact. As of 1961, the US scientific community lacked the technology —or even a workable plan— to send astronauts to the moon. But, brilliantly, JFK did not treat America's lunar-mission "knowledge gap" as a deal-breaker, rather, Kennedy seized upon it as an historic opportunity.

JFK's goal of sending astronauts to the moon by 1970 is an outstanding example of what I refer to as a "problematic". A problematic is a far-flung goal that is largely based upon imaginative speculation, and that (critically!) inspires knowledge-seekers to invent facts and redefine reality in order to transform the dreamed of goal into a reality. There are numerous examples of problematic innovation that have had an enormous impact on the course of human events: heavier-than-air flight, the Manhattan Project, finding a cure for polio (and the ongoing search for AIDS vaccines), Alan Turing's (and Marvin Minsky's) advocacy of AI computing, Martin Cooper's effort to invent a Star Trek communicator in the form of the cell phone, Aubrey de Grey's pursuit of human immortality, David Ferruci's goal of creating a talking computer (similar to Captain Kirk's) and the IBM Watson project, etc.

The virtue of problematics is that they inspire humans to engage in "super-adaptable" innovation. Whereas, as Karl Popper (1999) emphasized, other terrestrial creatures solve survival problems with their biology (i.e., Darwinian evolution), humans solve problems with their intellect. Thus, human "agents" can solve survival problems much more rapidly, and with greater specificity, than other creatures, however, this also means that humans have a penchant for creating new survival challenges at a faster pace and on a grander scale (e.g., overpopulation, pollution, global warming, nuclear Armageddon, etc.) than other terrestrial creatures. Fortunately, via the process of problematic innovation, humans have succeeded in "elevating their thinking" and, thus far, outpacing the survival challenges that we have generated.

I argue that humans will continue to enjoy success —and continue to outpace the crises that pose imminent threats to human survival— so long as humans remain committed to pursuing problematics. Once again, problematics enable super-adaptable human agents to elevate their thinking by developing solutions to far-fetched, seemingly impossible aspirations: cures for "incurable" illnesses, ending human mortality, creating artificially-intelligent computers, and not only shooting for the moon and planets, but building reality-redefining vessels that will enable humans to reach for the stars.

A Wake-Up Call

Sputnik changed everything. America's worst fears were realized when on October 4, 1957, the USSR launched Sputnik, the very first artificial satellite (Dickson, 2003). Although Sputnik was little more than a beach ball-sized radio transmitter, Sputnik represented a watershed moment in the US-Soviet race for global supremacy. For the first time, the Soviets had achieved a landmark technological goal before the United States (Cadbury, 2006). As every 96.2 minutes Sputnik whizzed overhead, all the while chirping its maddening birdsong, anxiety intensified among Americans. Though Sputnik posed no direct threat to America's national security, its mere existence was a nagging reminder of Soviet ascendancy. Not only had the USSR beaten the United States into space, but as the Soviet's dratted satellite streaked overhead, it became abundantly clear that the United States lacked the ability to respond tangibly (Brzezinski, 2007). If the Soviets could put satellites in orbit, then what else might they be up to? Imaginations ran wild. Lacking a credible counterstrike capability, the United States suddenly found itself at the mercy of its cold war nemesis. Americans would have no peace so long as the Soviets enjoyed a technological advantage over the United States.

However, as it turned out, Sputnik was only the first of a seemingly interminable series of Soviet precedents in outer space. On November 3, 1957, barely one month following the launch of Sputnik, the Soviets fired Sputnik 2 into orbit. Sputnik 2 was noteworthy for carrying a dog named Laika, the first living animal ever launched into space (Owen, 2004). More bothersome still, on April 12, 1961, the Soviets claimed the next great prize in the space race by launching the first human being, Yuri Gagarin, into space (Schefter, 1999).

Still, the Soviets would not lay sole claim to all of the major feats in space flight. A mere twenty-three days after Gagarin's groundbreaking flight, the United States followed suit by launching the first of its Mercury astronauts, Alan Shepard, into space. While Shepard's first flight was celebrated as a history-making achievement, nevertheless, one also had to acknowledge that, beginning with Sputnik, the United States always seemed to show up a day late and a dollar short in the race for technological supremacy.

Recognizing both the practical and political dangers of lagging behind the Soviets, President John F. Kennedy decided to announce a bold new goal for the United States space program. On May 25, 1961, JFK stood before a joint session of Congress and made an extraordinary commitment (French & Burgess, 2007). In 1961, with Sputnik whizzing by overhead, dominoes tumbling in the developing world, and swords rattling in Cuba, the United States appeared to be woefully outflanked by its adversaries. Yet, rather than buckling under the weight of those combined difficulties, JFK stunned the world by announcing that, instead of donning the label of international has-been, the United States would reassert its claim to international dominance by pursuing a goal that lay far beyond any other nation's wildest dreams. The United States would outdistance its rivals by aiming higher: the United States would shoot for the moon. Thus, Kennedy made the jaw-dropping announcement that, before the decade was out, the United States would send a man to the moon and return him safely to earth (Orloff & Harland, 2006).

Perhaps the most striking aspect of JFK's announcement was that, as of May 25, 1961, the prospect of landing humans on the moon was pure science fiction. Quite literally, as of 1961, the technology did not exist to achieve Kennedy's far-fetched goal. Indeed, it had taken a monumental effort just to launch Alan Shepherd a few miles above the earth's surface. In contrast with Yuri Gagarin, Shepard had not even orbited the planet. If the truth be told, there was even some doubt about whether Shepard's voyage had actually constituted a space flight; the Soviets insisted that Shepard's suborbital rocket ride had not even boosted him above the uppermost reaches of the earth's atmosphere (Chaikin, 2007). Thus, the United States scientific community's knee jerk reaction to Kennedy's newly revealed goal was, "It can't be done". In 1961, the United States simply did not have the technological know-how to send astronauts deep into space.

No one knew better than the scientific community how ill-equipped the United States was to launch a manned moon flight initiative in 1961. Indeed, had NASA scientists attempted to use early 1960s technologies to shoot for the moon, the missions would have failed (Erickson, 2005). Still, impossible as it may have seemed, Kennedy had thrown down the gauntlet. As a visionary leader, Kennedy had decided that, no matter what obstacles might lie in the path, the best chance of building a brighter future for the United States was to lift the nation's eyes, hearts, and minds toward the moon. The choice was ours. Americans could wallow in the muck and mire of self-doubt, or they could take flight with the dreams of a courageous leader. Thus, for NASA to shoot for the moon, they would have to find some way to achieve the impossible. In the end, they were able to do precisely that because, as humans had done so many times before, NASA scientists consciously revised the boundaries of the possible, i.e., they invented new technologies, created new organizations, developed new spaceflight procedures and, in the end, they re-invented reality.

Though the history of lunar space flight is rife with disasters and fateful near misses, nevertheless, on July 20, 1969, America realized Kennedy's vision (Harland, 2007). The United States became the first—and still remains the only—nation to send its citizens to the moon. Yet, apart from that important distinction, what was the real significance of this landmark achievement?

Super-Adaptable Apes

The fate of many creatures tends to be sealed, or determined (Hawking & Mlodinow, 2010; Pagel, 2012, p. 12, 130-131) by the circumstances that they encounter in their environment. The dinosaurs dominated the planet for millions of years until a catastrophic environmental shift brought about their sudden demise (Horner & Gorman, 2009).

On numerous occasions, Karl Popper (1999) made the point that "all life is problem solving". By that, Popper meant that survival for every life form is contingent upon efficacious problem solving: where to find food, how to stay warm, how to secure a mate, how to avoid predators, etc. Generally speaking, most creatures rely on their genetics to solve problems, e.g., furry little mammals were better suited than dinosaurs to capitalize on shifting environmental conditions at the K-T boundary (Koeberl & MacLeod, 2002, p. 261). In other words, for most creatures, problem solving is a purely biological process. Either creatures are equipped with the necessary genetic attributes to survive in a given ecological context, or they are not. Thus, lacking the necessary genetic attributes to withstand the K-T environmental transition, the dinosaurs went extinct.

However, for humans, problem-solving is not solely determined by the match between genetics and environmental conditions. More than any other creature, humans solve problems cognitively. Certainly, human cognition is a genetically evolved attribute. If humans have big brains, it's only due to long-term evolutionary processes that have conferred advantages on brainier hominids (Lynch & Granger, 2008). Thus, genes matter and the evolutionary process applies to all living things. That said, cognition has permitted humans to circumvent the constraints of purely biological adaptation. In other words, humans have become cognitively "super-adaptable" agents. Super-adaptability can be understood as the unique human capacity to develop intentional, non-random solutions to environmental problems at a pace that is far more rapid than the biological evolutionary process.

Whereas the fate of non-agents is determined by prevailing conditions in their environment (e.g., drought, flooding, global warming, cooling, etc.), super-adaptable agents (i.e., humans) have a unique ability to transform their environments in order to accommodate their needs—and, even more, their intellectual aspirations. This capacity for super-adaptable agency is what, more than anything else, is the crucial distinguishing feature between humans and all other life forms. All terrestrial creatures are related at the level of their DNA, however, only humans have managed to become super-adaptable, self-determining agents.

Just like every living creature, in their effort to survive humans routinely encounter environmental constraints (i.e., too little food, water, space, warmth, etc.). However, humans have been able to overcome such obstacles by super-adapting. In a very literal sense, this means that, upon encountering empirical or conceptual obstacles that hamper the achievement of a particular goal, humans have employed their capacity to imagine alternative realities in order to achieve their goals, e.g., conquest of the moon. In the process of super-adapting, humans routinely invent new facts and modify the parameters of reality. Where once, there were simply too many environmental barriers to seriously contemplate space flight, over the past half-century super-adaptable humans have gradually made extra-terrestrial travel commonplace (Carroll, 2009), and humans have accomplished this feat by literally redefining reality.

Redefining reality (McGettigan, 1999, 2011) is a process through which humans develop new, more truthful conceptual schemes for explaining facts. Creatures that lack the capacity for redefining reality can only mount biological responses to environmental challenges, i.e., they are either biologically fit for an environment or they aren't. Humans, on the other hand, have the ability to approach environmental challenges as intellectual problems (Diamond, 1998). Thus, the disconnect between environmental conditions and innate biological attributes (e.g., bare skin in cold weather), represents a problem that stimulates super-adaptable apes to redefine the status quo. In this instance, humans overcame the limitations of equatorial biology by developing cognitive solutions (i.e., utilizing fire, fashioning garments out of furry animals, living in shelters, etc.) to the problem of bare skin in colder climates. Consequently, instead of perishing as they made forays into non-native climes, humans developed super-adaptable, intellectual solutions to the many environmental challenges that they encountered (Gould, 1997, p. 220). In doing so, humans demonstrated their agency, or a unique ability to invent novel solutions to environmental challenges and limitations.

As a result of their super-adaptability, humans have been able to assert a much greater degree of control over the environment. In other words, humans have employed their intellectual abilities to construct increasingly synthesized living experiences. For example, instead of being limited by the food resources that are readily accessible in the environment, humans have developed various forms of agriculture as a means of augmenting the quantity and variety of food resources (Pollan, 2006). Not only do farmers produce bumper crops of food, but they cultivate agricultural products that have been optimized to suit consumer tastes (Schlosser, 2001).

Indeed, humans have become so adept at modifying the environment that in post-industrial societies the bulk of day-to-day experience tends to take place within elaborately synthesized environments. For example, rather than living in direct contact with nature, humans have developed increasingly elaborate synthetic envelopes, such as:

· Dwellings with built-in climate control, running water, artificial light, and processed foods —all of which are designed to increase comfort and, thus, decrease immediate survival challenges.

· Synthesized entertainment (TV, radio, cinema, streaming video), communication (phones, verbal and text messaging), information production and exchange (computers, Internet), and virtual interaction (social networking, tweeting) enable humans to become more deeply embedded in “unnatural”, but highly advantageous cyber realities.

Consequently, many humans have begun to lead lives that are almost entirely disconnected from the natural environment. Indeed, Jean Baudrillard (1989, 1994) argued that Americans have become so thoroughly cocooned in synthesized realities that it can be difficult to distinguish Americans from the simulacra in which they are embedded. Admittedly, Baudrillard’s observations often border on the absurd; however, he does make the valid observation that Americans are becoming increasingly wedded to information technologies—so much so that many find it distressing to unplug even briefly from their digitally-mediated realities (Dretzin, 2010). Certainly, there are reasons to be concerned about the negative health effects that can result from leading overly synthesized lifestyles (Louv, 2008). Nevertheless, in contrast with Baudrillard's fatalistic perspective (Gane, 1991), I argue that there is much to be gained by constructing increasingly synthesized realities.

Not-So Impossible Dreams

Artfully constructed fantasies often have a significant impact on the course of human events. For instance, in the nineteenth century, Jules Verne (1865, 1887) concocted outlandish visions of the future that thrilled his many readers. It would be an overstatement to suggest that Verne's science fiction fantasies laid the groundwork for the historical events that were to follow. Still, I believe it is fair to say that some of Verne's diehard readers have made a concerted effort to transform his fantasies into reality. For example, in Verne's day, a fully electronic submarine was a work of pure imagination. However, in the century that has followed, engineering marvels that bear striking similarities to the fictional submarine that Captain Nemo commanded have confidently plumbed the depths of the seven seas. Indeed, it is noteworthy that the first nuclear submarine in the United States fleet was named the Nautilus (Seelhorst, 2003). Thus, in some respects, the future is often inspired by fantasies. In addition, in from *The Earth to the Moon* (1865), Verne made the extraordinary predictions that the first manned moon mission would be undertaken by the United States, and the launch site would be located in south Florida.

Of course, not every fantasy has a transformative impact on reality (Montandon, 2008). There are plenty of far-fetched fantasies that will never be more than works of pure imagination, e.g., super-heroes that can lift trains over their heads, fly unaided through the skies, or blast laser beams from their eyes. On the other hand, fantasies can sometimes inspire humans to transform their relationship with the environment and, in so doing, radically redefine the boundaries of the possible.

As I mentioned above, in 1961, JFK's plan to send astronauts to the moon, was an outright fantasy. In fact, his proposal was very similar to the simulacra that animate Hollywood movies: an imaginative vision of an alternate reality which, in this case, resembled the plot for Stanley Kubrick's film, 2001: *A Space Odyssey*. In 1961, technologies to land astronauts on the moon existed only in imaginations (Thimmesh, 2006); and, some believed, only in hyperactive imaginations at that. Yet, fantastic as Kennedy's lunar landing scheme may have been, his wildly optimistic proposal created a set of challenges —or, what I will refer to as a problematic— that humans happen to be uniquely well-adapted to resolve. That is, ever since pre-humans began wielding sharp sticks and stones, humans and their ancestors have been purposefully redefining the course of events and the fabric of empirical reality.

Paradigms vs. Problematics

Paradigms are broad conceptual constructs that are intended to render the known universe intelligible (Kuhn, 1962). Paradigms play an important role in intellectual advancement by providing a framework within which to conduct normal scientific progress. When, at length, knowledge-seekers exhaust the limits of intellectual growth within a particular worldview, paradigms stimulate an altogether different level of intellectual innovation by inspiring the invention of revolutionary paradigmatic successors.

Problematics are somewhat different (McGettigan, 2011). Rather than providing a framework into which to incorporate facts, a problematic can be understood as call to action to resolve a particular scientific challenge, e.g. achieving heavier-than-air flight, building the first atomic bomb, landing astronauts on the moon, developing artificially-intelligent computers, etc. Thus, problematics instigate an entirely different approach to truth-seeking than is typical of the paradigm revolution process. Paradigms endure so long as they provide adequate explanations for the majority of available empirical evidence. While problematics can often stimulate the process of paradigm revolution, problematics are neither defined nor limited by extant facts. Indeed, a problematic can be as far-fetched as its author's imagination can stretch, e.g., inventing an airplane, creating an electric submarine, faster-than-light travel (Kaku, 2008), or even a time machine (Nahin, 1999; Wells, 1992). Thus, a problematic poses an extraordinary and, thus, an imaginary goal toward which knowledge-seekers can aspire. Upon formulating the problematic, the "problem" for those who happen to be inspired by the problematic, becomes a question of how to transform the proposed fantasy into a reality.

Although scientists often insist that science progresses on the basis of facts (Popper, 1959), problematics have long played an essential role in the advancement of scientific knowledge. As mentioned above, instead of using facts as a departure point, problematic science identifies an appealing goal (e.g., heavier-than-air flight, moon landings, nanotechnology, artificial intelligence, faster-than-light space travel, etc.) and then sets about the process of creating the facts that are necessary to transform the problematic goal from a fantasy into a reality. In this context, truth is still generated through a process of redefining reality; however, the facts upon which new truths and new realities are founded are themselves inventions of human agency. Thus, truth must always be founded upon facts, however, via the problematic scientific fact-production process, there is almost no limit to the facts —and, by extension, the mind-blowing new realities— that creative human agents can invent.

Any Job Worth Doing

In 1961, JFK confronted a situation in which the facts seemed to suggest that the United States was falling hopelessly behind the Soviets. From Sputnik to Vostok, the Soviets had claimed every major technological achievement during the fledgling space race (Cadbury, 2006). Thus, for many, the evidence appeared to support the ominous conclusion that the United States was steadily falling behind the more enterprising Soviets.

As already discussed, any particular set of facts can be interpreted in a variety of ways —depending upon one's preferred paradigm. For instance, in the case of the space race, the facts seemed to suggest that the Soviets had achieved an impressive level of technological superiority over the United States. Yet, rather than embracing such a denigrating interpretation of the facts, President Kennedy decided to assert that the Soviets' apparent victories were naught but anomalies. From Kennedy's perspective, the truth could not be determined through a superficial examination of the facts. Rather, the truth about the United

States could only be understood with reference to a modified reality that, Kennedy insisted, *his nation would soon invent*.

Whether Kennedy was an unflagging optimist, or whether he was engaged in a calculated exercise of political gamesmanship remains an open question. What is evident, however, is that Kennedy's bold vision for the United States' space program provided Americans with an entirely new conceptual lens through which to appraise their potential as a people and a nation. Although the logistical difficulties were monumental, Kennedy brushed aside the perceived difficulty of sending astronauts to the moon. In fact, Kennedy was of the opinion that, the more difficult the task, the greater its potential benefits:

> We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win... (Address at Rice University on the Nation's Space Effort, President John F. Kennedy, September 12, 1962) (Kennedy, 1962-1964).

For Kennedy, the logistical challenges of sending astronauts to the moon were of secondary concern. Kennedy's primary goal was to create a new outlook for the nation. Whereas a climate of self-doubt had descended upon Americans, Kennedy strove to banish that mindset and replace it with an altogether different way of thinking; a new problematic if you will.

Problematic Innovation

The point of all this is to emphasize that super-adaptable humans have an extraordinary capacity to shape the future. JFK made the goal of a pre-1970 moon landing a top national priority. However, inspiring as JFK may have been as an orator, his verbal commitment alone was not sufficient to make his far-fetched dream a reality. Redefining reality is a process that begins with inventing new ways to reveal truths about the empirical universe. However, the act of imaginative reconceptualization is only the first step in the process of redefining reality. Once knowledge-seekers create a problematic vision, it is necessary to generate sufficient evidence to resolve the new problematic. Thus, Kennedy blazed a conceptual path to a new frontier, but it required the herculean efforts of an energized scientific community to make the dream a reality (Thimmesh, 2006).

Kennedy knew only too well how improbable his goal of a pre-1970 moon landing was. Had the United States been unable to transform JFK's dream into a reality —and there were plenty of points along the way where the hoped-for outcome was gravely in doubt (Erickson, 2005)— then history would have been less charitable to Kennedy. No president wants to be perceived as a failure. Thus, Kennedy had to craft a new problematic for the United States that, while boosting the nation out of its doldrums, promised a real chance for success.

Certainly, Kennedy was a gambler. In order to reach the moon, the United States would have to elevate space science to an entirely new threshold. However, Kennedy cleverly motivated the people of the United States in a way that energized not only their creative character, but, perhaps more importantly, their spirit of competitiveness. The American public threw their support behind the Apollo program in part because it was an inspiring technological goal, but, more importantly, because it created an opportunity to stick it to the Russkies. At long last, the United States was determined to beat the Soviets to a major goal in the space race. Even for Americans who lacked any interest in space exploration, that was a goal worth shooting for.

So, the United States turned its attention to the problematic of landing astronauts on the moon. Through an extraordinary commitment of time, resources and political will, the United States managed to progress in stages —from Mercury, to Gemini, to Apollo— toward its final goal. Step by step, NASA deployed solutions to the environmental obstacles that stood in the way of landing astronauts on the moon. In the end, NASA not only generated the facts that confirmed the truth of JFK's bold prediction, but NASA also redefined the relationship between humans and the cosmos. Where once humans were entirely earthbound, over the course of the 1960s, humans became extra-terrestrials.

In addition to equipping Americans with the ability to travel in the lifeless void of space, the struggle to win the space race also modified reality on the surface of the planet. Whereas the United States emerged from the 1950s at a technological disadvantage, the United States hurtled out of the 1960s as the unparalleled leader in space science. The Soviets could not come close to matching the United States' feat of landing astronauts on the moon (Chaikin, 2007). Ultimately, as the United States laid the groundwork to become the leader of the information society, the Soviets finally gave up the ghost. In 1991, George H. W. Bush declared that the cold war was over. The United States had won and, as a prize, Bush proclaimed America's ascendancy as the world's only superpower in a new world order. Arguably, the turning point in its long struggle against the Soviets was that defining moment when JFK dedicated the United States to victory in the space race.

The United States had succeeded in the space race and, ultimately, in the cold war by making intentional decisions about how to construct the future. This is not to say that people can create any future that they desire simply by putting their imaginations to work. As illustrated above, the future is modifiable to the extent that humans can invent viable problematics and then apply themselves to the arduous task of transforming their hoped-for objectives into reality. If dreamers are unable to tether their fantastic problematics to a firm foundation in empirical reality, then their dreams will remain naught but fantasies. However, for gifted visionaries, such as JFK, the future is a fantasy, but a fantasy that can be realized through the resolution of a particularly inspiring problematic.

Born to Adapt

Humans evolved from humble origins —from scavengers, no less (Rufus & Lawson, 2009). Even among scavengers, pre-humans would have numbered among the least intimidating creatures competing for scarce resources. Lacking long, sharp teeth, or deadly claws, pre-humans were poorly equipped to compete with their more well-endowed rivals. However, all of this changed when, due to some unknown inspiration, pre-humans began tinkering with technology.

The first tools were found objects (Reader, 1981). In other words, early tools were nothing more than the sticks and stones that pre-humans stumbled upon in their environment. The earliest tool-users would have lacked the ability to fashion tools, rather they would simply have utilized objects that were ready to hand in a moment of need; perhaps hurling a rock at a carnivore that was intent upon making a meal of the tool-wielder. In such a scenario, if the stone-thrower survived, the utility of the life-saving tool would likely have imparted a lasting impression. Such success could also have inspired tool use in other situations, e.g., driving ferocious scavengers from kill sites with a barrage of sticks and stones.

It is not perfectly clear under what circumstances pre-humans first began using tools (Dunsworth, 2007). However, once they did, it was a habit that stuck. Archaeological sites reveal that tools became more numerous, varied and complex as humans evolved. Indeed, there appears to be a striking correlation between the development of tools and the evolution of modern Homo sapiens (Diamond, 2006). As pre-humans crafted ever more cunning tools, the very physiology of the creatures that wrought them, and their brain cases in particular, changed dramatically. Modern Homo sapiens, the wisest of animals, evolved as a result of the unique advantages that tool use confers (Lenski, 1966; Lenski & Nolan, 2006).

Be Careful What You Wish For

I should emphasize that, under no circumstances am I suggesting that either genetics or environmental conditions are irrelevant in the struggle for human survival. Humans, like every other living creature, are products of the combined influences of their biology and environment. Genetic attributes, which certainly include the capacity for cognition, have made it possible for humans to capitalize on an extremely broad array of environmental opportunities. In addition, environmental factors have always played an important role in the disposition of human affairs: more than once, great civilizations have met their demise by failing to adapt to changing environmental circumstances (Diamond, 2005; Reisner, 1993). That said, rather than having their fate entirely determined by environmental conditions, the capacity to problem-solve cognitively enables super-adaptable human agents to modify their environment in a way that other creatures simply cannot. For example, whereas many creatures solve problems associated with decreasing global temperatures by randomly evolving beneficial genetic attributes (e.g., more copious hair, downier feathers, thicker blubber, etc.), humans solve such challenges by problematizing the situation. What humans can't achieve with genetics, they orchestrate with reality-redefining problematics: flooding desert environments with life-giving water, building warm underground dwellings in Antarctica, constructing nuclear submarines that can sustain life under the seas, or assembling space stations in the extra-terrestrial vacuum, etc.

Of course, success usually begets new challenges, or as Popper argued, solving one problem generally evokes an entirely new set of problems (Popper, 1999). Perhaps the clearest indicator of super-adaptive success has been the steady rate of human population increase. Whereas most populations are strictly controlled by available natural resources, it has been possible for humans to far outstrip environmental carrying capacities in nearly every corner of the globe. Yet, explosive population growth has also been the cause of many other problems, such as environmental degradation, resource shortages, widespread disease, etc. (Ehrlich & Ehrlich, 1991).

Long ago, Thomas Malthus (1798/2003) argued that, although humans might be able to outpace nature's carrying capacity in the short-term, in the long run the mathematics of population growth would precipitate disaster. According to Malthus' original predictions, widespread starvation was inevitable due to the fact that food production could only increase arithmetically (i.e., expanding the acreage of arable land one field at a time), whereas population growth was exponential. During Malthus' day, without the advantage of family planning technologies, offspring in typical pre-industrial families could easily outnumber parents by an exponential factor. Consequently, Malthus felt certain that, as populations exploded, demands for food would necessarily exceed available supplies. When that occurred, widespread starvation would ensue with the end result being a catastrophic population crash.

Interestingly, Malthus published his first predictions about overpopulation in the year 1798. At the beginning of the nineteenth century, the global population stood at approximately one billion people. In the years since his prediction, global population has indeed grown exponentially. As of 2011, global population has climbed to about seven billion people. Although it is safe to say that population has mushroomed precisely as Malthus predicted —during the twentieth century alone global population quadrupled from 1.5 billion to six billion people— the global food crisis that Malthus predicted has not occurred. Certainly, there have been persistent and tragic food shortages all over the planet, particularly in the developing world. Nevertheless, the calamitous food crisis that Malthus predicted has not yet transpired. Thus, one must wonder: How have humans avoided such a fate?

Seeing the Future through the Past

It turns out that, like many great thinkers, Malthus attempted to predict the future through the lens of the past. Time is structured such that human experience is always located in the present. In turn, the present can be understood as a dynamic temporal transition point through which time flows toward the future and away from the past. It's as if we are all time-surfers; we skim forward on an apparently static foundation in the present while time washes by from the future to the past. Given the one-way flow of time, humans have direct experience with two of the three discernible temporal domains: we occupy the present while preserving memories and other records from the past. Once again, due to the uni-directional flow of time, the temporal dimension with which humans lack direct experience is the future. Never having lived in the future, its specific attributes are largely a mystery. The flow of time would need to reverse in order to acquaint time-travelers with the same level of insight about the future that we currently accumulate about the past and present. Thus, no one can predict the future because neither the future, nor the fate of humanity is yet determined. At best, we can make educated guesses, based upon extrapolations from the past and present, about how the future might unfold. Still, because of the extraordinary capacity that super-adaptable agents have to modify the course of events in utterly unpredictable, we will never know what the future holds until the future arrives.

Essentially, the future is a process. The fact that the earth has been revolving around the sun for eons is a fairly strong indicator that it will continue doing so in the future. However, as Popper (1959) argued, past circumstances, no matter how long they may have persisted, provide no absolute guarantee that similar events will transpire in the future. Though the probability is minuscule, an asteroid just might pulverize the earth tomorrow. Thus, the future is a combination of phenomena that give shape to the present blended with dynamics that stimulate change in the future. As such, the future is a construct that is constantly undergoing a process of evolutionary and often unpredictable change. Indeed, one of the most unpredictable instigators of change is the often improbable impact that human agents have upon the structure of unfolding events.

Thus, Malthus gazed into the future through a paradigm that was comprised of eighteenth century expectations. Within the context of the eighteenth century, there was no conceivable means by which to sustain exponentially-increasing populations. As a result, Malthus was convinced that the end was near. Interestingly, in the late eighteenth century, the world as Malthus knew it was about to end, but, importantly, not in the way that Malthus had predicted. Malthus published his prognostications about the presumptive fate of humanity as the age of agriculture was coming to a close. Being unacquainted with the sweeping social, political, economic, and scientific changes that would accompany the Industrial Revolution (Ashton, 1948), Malthus was unable to foresee the innovations that would amplify food supplies sufficiently to keep pace with exploding populations. Technologies such as higher yield grains, fertilizers, pesticides, herbicides, and petroleum-powered machines have generated astounding increases in agricultural yields throughout the industrial era (Pollan, 2006).

Without doubt, the problems that Malthus identified were real. Just as it would have been impossible for NASA to safely land astronauts on the moon using 1950s space technologies, so too would it have been impossible to avert the Malthusian nightmare using seventeenth century agricultural techniques. Exploding populations represented a dire problem, and as Popper argues, all life forms must find ways to solve problems, or they will die. In response, super-adaptable humans dealt with the problems associated with population growth and impending food shortages by pursuing an entirely new problematic: industrial society. Having thus dramatically redefined the substance and structure of human society, nineteenth century Europeans set about the process of transforming the social, political, cultural, and technological landscape to make the machine-age a reality.

Mitigating Problems through Progress

In the industrial era, the food supply problems that Malthus foresaw have largely been mitigated. Again, in recent centuries, global population has expanded exponentially, and, in spite of nagging problems with food distribution, the total supply of food has kept pace. Though Malthus would be surprised by this outcome, Popper would not. Again, Popper argued that humans are extraordinarily adept at developing intellectual solutions to survival problems. In successfully identifying such solutions, old problems often become non-issues: in industrially-advanced nations, farmers have been able to produce more food than consumers can eat. In fact, instead of being plagued by shortages, Americans are increasingly plagued by the problem of overabundance (Schlosser, 2001; Spurlock, 2004).

The fact that the population quadrupled during the twentieth century is an undeniable indicator of human problem-solving ingenuity. However, as the population has grown, the degree to which humans have taxed the environment has also increased. For example, our love affair with hydrocarbons (Houghton, 2004) has had a dramatic impact on global climate, including elevating sea levels, shrinking cryosphere, expanding deserts, etc. Thus, successful exploitation of fossil fuels has produced entirely new problems.

Frustrating as this situation may seem, Karl Popper would not be troubled by such developments. Popper argued that, in the game of life, successful solutions to one set of problems invariably generate an entirely new set of problems (Popper, 1992, 1999). When Popper argued that all life is problem solving, he literally meant that survival for every living creature is contingent upon developing workable solutions to environmental problems. Living creatures either develop effective strategies to secure the necessary sustenance, space, and security that they require, or they will expire. Most life forms develop new survival strategies through the genetic evolutionary process. Random genetic mutations that enhance a creature's ability to solve environmental problems (e.g., accessing new food sources, dissuading predators, expanding into new territory, etc.) confer advantages in the struggle for survival. However, as creatures successfully adapt, they inevitably encounter new survival challenges to which they must adapt afresh (e.g., marine mammals successfully reconquered the sea only to encounter hungry sharks in their new environment). Thus, evolution is a never-ending process because every creature must constantly re-adapt to changing survival conditions. Humans are subject to the very same survival pressures as other creatures.

Having taken full advantage of hydrocarbon-age technologies, humans are now confronted with an entirely new set of problems: global warming, ozone depletion, unsecured nukes, pollution, depletion of resources, etc. In spite of our success, the problems that plague humanity seem, if anything, larger and more insoluble than ever. Yet, strange as it may seem, that's actually a good thing.

It is certainly true that, if nothing changes, the problems that humanity currently faces will be irresolvable. Just as Malthus gazed at the burgeoning problems in the eighteenth century and concluded that, for citizens of that era, the situation was hopeless, the same will be true for citizens of the twenty-first century. Einstein summed up this situation thus: "The significant problems we face cannot be solved at the same level of thinking we were at when we created them" (Albert Einstein cited in Fripp et al. 2000, p. 135). In other words, we can't possibly hope to solve existing problems with existing knowledge. While that might seem to be a hopelessly pessimistic perspective, it is simply a statement of truth —but it is also a call to action. President Kennedy knew that Americans would never be able to solve their problems by malingering in the present. For humans, the key to solving existing problems has always been to create problematics though which to invent entirely new futures.

Indeed, as a result of Kennedy's problematic, the problems that plagued the United States in the early 1960s seem almost comical in hindsight: fear of Soviet expansionism, being on the short end of a strategic technology gap, being at the mercy of the enemies of democracy, etc. JFK inspired the United States to grapple with the most difficult problematic that he could possibly invent. To successfully resolve the problematic, Americans had to aim for the stars. Certainly, along the way, Americans also solved the problem of safely landing astronauts on the moon, but in doing so they accomplished so much more. In striving to achieve JFK's impossible dream, Americans redefined themselves, their nation, and their future.

Americans have had the great fortune to arrive in the twenty-first century as citizens of a powerful, wealthy and technologically-advanced nation. Yet, having solved so many difficult problems in the past, Americans and the entire global community are now faced with even bigger problems. If we have learned anything from the past, it should be that the surest route to a brighter future is to challenge ourselves with the most difficult problematics that we can possible imagine. Though we will never live in a trouble-free world, we can feel safe in the knowledge that, so long as we have the courage to dream of doing the impossible (Kaku, 2008), no problem will ever be too challenging to overcome.

The Next Great Frontier

As America's terrestrial problems escalate, critics have charged that space flight is little more than a futile and expensive hobby. After all, what hope is there that NASA (or DARPA) programs will ever resolve practical problems such as winning the war on terror, reversing global warming, reducing the spread of AIDS, or eliminating global hunger? Indeed, space flight is so atmospherically insulated from the real world that NASA programs often appear to be little more than distractions; diverting scarce resources from a plethora of intractable social issues and blasting them into the boundless void of space. In short, what possible benefit can earthlings hope to derive from the billions of dollars required to keep space programs afloat?

History has shown that humans have got all the brains, wherewithal and fortitude to achieve the impossible. We can build a brighter future. All we need are visionary leaders who are prepared to lead the charge toward the Next Great Frontier.

So, why bother with space travel? Because, quite simply, the stars light the way to a brighter future. Space travel paved the way to Kennedy's New Frontier in the 1960s. If the United States remains committed to accomplishing ever greater feats in the future, then we should look to the stars to light our way. Thus, space travel is not a distraction. Space travel represents the path to America's —nay, humanity's— next Great Frontier.

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