OPINION

New Worlds & Final Frontiers— How the Existence of Open Frontiers Shapes Human Cultures

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ABSTRACT

Curiosity is fundamental to human nature according to those who believe that space exploration is our destiny. But not all cultures explored, and some abandoned exploration long before they ran out of frontiers. This paper examines the economic, cultural, and technological factors in exploration, what defines frontiers, and the psychological and cultural impacts of open frontiers. It suggests that the character of North American settlements was largely due to the open western frontier. If people did not like what was going on where they were, they could simply move west. That impacted society's notion of the proper reach of government. When western expansion reached its natural limit, attitudes changed rapidly. European migration to the Americas was initially limited by technology and cost. Only governments could afford to cross the Atlantic and build settlements. But by the early 17th century, small groups could also make the journey. This paper argues that current advances in space technology and recent vast cost reductions are creating another open frontier. Will a new mass migration of humanity cross that frontier? What will that look like and what impact will it have on those who remain on Earth? How will that affect the future of humanity?

PART I

In 1405, a large fleet of over two hundred great ships under the command of Admiral Zheng sailed west into the Indian Ocean and parts unknown. The ships were technological marvels and, according to some interpretations of old Chinese records, could have been up to four hundred feet in length with six masts and could carry four hundred men on four decks.

Seven successful voyages were made, reaching as far as Hormuz in the Persian Gulf, the Arabian Peninsula, and East Africa, the last in 1433. Then, for reasons not fully understood, although likely having to do with a shift of power at the imperial court, the great age of Chinese exploration came to a sudden halt. The great fleet was either left to rot at its moorings or burned. Afterwards, by imperial degree, no ship with more than two masts could be constructed.

We can only speculate how world history might have been altered had the Chinese westward explorations continued. It was only seventy years later that Vasco da Gama, in a comparatively small ship of 240 feet, reached the east coast of Africa coming from the west.

There can be little doubt that curiosity and the desire to discover what lies over the horizon is a fundamental characteristic of human nature, one often cited by those who believe the never-ending exploration of the universe is humanity's certain destiny. Yet human nature is complex, and there are other mo-

tivations. What is certain is that people adapt to survive, and if fortunate to thrive, within the boundary conditions of their time and place.

Those boundaries can be physical (like oceans), technological (no way to get from here to there), or psychological. The last is most important, because it is what we think and believe about who and what we are, the world we live in, and our place in it, that ultimately define the boundary conditions for all our choices.

We currently live in a time of rapid change driven by the accelerating interaction of culture and technology. It has become so rapid that each generation grows up using different technologies (computers, the internet, mobile devices, etc.) and forms distinct habits, characteristics, tastes, and artistic sensibilities. That is why we now give generations different designations: Boomers, Millennials, X, Y, and Z.

From our current perspective, it is easy to believe that frenetic change is the normal human condition. However, the long view of history tells us otherwise. The further we look back, the more spans of time seem foreshortened as if all the ancient civilizations followed one another in rapid succession, yet when you consider the actual time spans involved, it looks quite different.

Art reflects the sensibilities of cultures, and it changes as those sensibilities change. Consider the artwork in Egyptian tombs. It is elegant and refined, although when you look at the dates when the different tombs were constructed, it is shocking to realize that their art was consistent over five thousand years.

Egyptian culture was stable and unchanging over an unimaginable (to us) period. The controlling boundary conditions were the rise and fall of the seemingly eternal Nile and the pyramidal structure of the society that was built, layer upon layer, of social strata. The God–King was at the pinnacle, the priestly class below, and so on down to the great majority of the people at the bottom, who for century after century harvested crops when the Nile rose and constructed tombs for the Pharaohs the rest of the time. Pyramids, both physical and social, are extremely stable.

The course of human history is controlled on one hand by boundary conditions we cannot control (such as the laws of physics) and on the other by ones of our own design.

Columbus headed west five years earlier than da Gama headed east. He discovered a new world, a revelation that upon his return transformed both the physical and psychological boundary conditions of European civilization. The Atlantic was no longer a boundary; it could be crossed, and there was reason to—the endless possibilities of a new world.

The Atlantic could be crossed, although it was not easy; it required stout ships and solid funding to mount expeditions. Initially, only nation states could foot such bills; yet by 1600 and even before, small groups of adventurers, some seeking riches, others seeking to escape from the governments they lived under, began to make the trip and find new lives.

Over the next 150 years, populations increased, and the largest settlements eventually established borders with one another until the map of the new world resembled the map of the old, with each colony having a capital and a government. However, the social and cultural ground rules in the new world were very different.

In the old world, the national borders meant something; they were established over centuries of warfare, and the governments within those borders, composed of only a tiny fraction of the population, wielded almost unchecked powers.

In the new world, borders were just lines on a map, and to the west there were not even lines. This put an automatic check on the natural human tendency for the few to consolidate power over the many, which had been the general rule going back to ancient Egypt in every society that had borders individuals could not cross at will. In America, if you thought the local officials were becoming too controlling or had the effrontery to demand that you to pay a tax for something, you could pile your family and belongings into a wagon and head west where they could not reach you.

As long as there was an open frontier to the west, individuals and families could find land where they could keep to themselves if they desired; cooperate, establish towns and businesses, and generally enjoy the benefits of civilization more normally without being minutely regulated or taxed by a strong central government.

This phenomenon invalidated the perennial narrative that without a powerful central authority from above, humans' baser instincts would prevail, and society would descend into savagery. It is no wonder, then, that modern democracy, based on freedom for individuals and without hereditary social class structures first took root in the American colonies. By our current sensibilities, it is shocking to recall that one ostensible reason for the rebellion of the thirteen colonies was the imposition of a 5% tax on tea.

When the American frontier was closed and people could not escape local jurisdiction, when we no longer had the example of people living prosperously without regulation, the old narrative that people would run wild without it reappeared quickly.

The example of the life on the American frontier soon became the target of revisionist history by the yellow journalists of the early twentieth century who depicted the Wild West as a violent and brutal society of rampant murder and theft. Yet the fact that we know the names of the most notorious outlaws of the time, such as Jesse James or Billy the Kid, and that the crimes they committed were relativity tame, like robbing trains and banks, is strong evidence that the times were not so wild as we have been told.

Early in the twentieth century, with the realities of what living on the frontier largely forgotten, Oliver Wendell Holmes, Jr. would say "Taxes are what we pay for civilized society," a dictum that was at the time and remains to this day generally regarded as an obvious truth. Since that time, the growth of government in our society has been staggering, as what was once a society based on the radical notion that if you just left people alone, they would mostly mind their own business and prosper appears to be transforming into the same kind of pyramidal society that has been the general rule throughout history.

Human nature has not changed at all during recorded history, but the boundary conditions within which that nature manifests itself can change radically, resulting in vastly different societies. History, it is said, does not repeat itself; but it does: rhythms—patterns are repeated.

PART II

By 1600, the existence of the new world was common knowledge throughout Europe, and many people stood on the Atlantic shore looking westward and dreamed. At that point, very few had made the journey. Today, dreamers look up to see an endless frontier of new worlds, but as yet, very few have made the journey. There are more similarities than differences.

It might seem that it was easier for the European migration to pick up momentum because North America presented the kind of natural environment in which humans evolved, while life in space requires that we drag a piece of our natural habitat with us. Technology is a great leveler. In any case, the American colonists could not just walk ashore and expect to survive. They too had to bring a critical mass of technology along with them, and even then, many perished.

Today, there are two major impediments to mass migration off Earth. The first is the cost of the trip; the second is that we need to decide where exactly we want to go.

Until very recently, only nation states had the means and the will to develop space transportation systems. The cost of transporting an item to low earth orbit via non-reusable rockets like the space shuttle was estimated at more than its weight in gold. Yet all that is starting to change. A few wealthy private individuals have travelled into space, and we are now seeing the development of reusable commercial launch systems that are reducing costs by orders of magnitude.

If the SpaceX Starship system achieves the reusability and launch rates SpaceX is aiming for, it could be as game changing as the transcontinental railway was to the American expansion westward, except that the railway heralded the closing of the American migration west, while Starship and the other reusable systems that will surely follow could be the enabling technology of a new migration.

A migration to where exactly? SpaceX is aiming for Mars. Making humanity an interplanetary species is a laudable and inspiring goal, especially in light of the real possibility of another species-destroying asteroid coming for Earth. Who will go?

There will always be a few adventurous spirits who will risk all to experience a great adventure, to be the first to look upon an alien horizon, or to see, in the midst of familiar constellations, a new star and realize you came from there. A migration of many thousands (a million has been spoken of) will only happen if the vast majority believe they will live a better life in the new world than they are living in the old.

In any case, we are positing that significant numbers of people will be leaving comfortable and familiar environments and be willing to endure danger, while experiencing hardships and deprivations in search of a better life. That is what the settlers in North America did. We know their motivations, one a pull and the other a push: they came for economic opportunity they did not have at home, to escape political oppression, or both.

Unfortunately, lack of economic opportunity and political oppression are both in abundant supply on Earth in our era. Ideally the scourges of poverty and oppression could be solved at home where they exist, but if the fundamental thesis advanced above about how human nature manifests itself within given boundary conditions is valid, an open frontier may be the only realistic path to the universal betterment of the human condition in which these things will be left behind forever.

The new frontier may be opened because things get worse here on Earth, building up pressure to leave it, or because the pull becomes more attractive, or a combination of the two. The European migration to the new world was not a result of central planning, it

happened as the result of many uncoordinated influences. Must we as a species wait passively to see what happens, or can we devise an optimal plan?

An optimal plan would be one in which the great migration into space happens not because things are bad here but because we have engineered places to live off planet that are even better. Probably the best vision for human habitats in space that do not entail hardships and deprivations are the visionary space structures first described by Princeton professor Gerald O'Neill in 1974.

Taking advantage of the engineering possibilities to construct vast structures in zero-g, the O'Neill cylinders, which could theoretically be extremely large, feature highly Earth-like living environments in which people could feel truly at home in a permanently benign shirt-sleeve environment, apparent Earth gravity, and natural sunlight.

What would it be like to live in one of these new worldlets? For anyone newly arrived from the home planet, living on the inside of a cylinder instead of the outside of a sphere might take some getting used to. However, humans are adaptable, and someday it is possible that most humans will be born in these habitats and will have to adapt if they visit earth.

Terrestrial human communities grow organically and haphazardly upon whatever landscape is at hand. Building an O'Neill habitat would present an opportunity to design an entire small world as a single polished work of art. The interiors could feature artfully designed landscapes covered with forests, fields, and moving water, punctuated by elegantly designed structures, incidents not accidents in the environment. The feeling will be more like a return to nature—only nature a bit more refined—as a Japanese tea garden looks natural while at the same time being a bit more perfect than unaided nature. The vision is of living more in a paradise than in deprivation.

To build such a structure would require huge resources and a space-based economy to support it. How can that be brought about? We can imagine a slow evolution driven by commercial possibilities starting with orbital hotels and then small orbital factories and then people living in tiny habitats to support those factories. Gradually over years as money is being made, some of it will be reinvested to solve the logistical and engineering challenges of bringing building materials first from the moon and then the asteroids to construct ever larger habitats.

This is a plausible scenario. Possibly even a likely, one that requires no overarching optimal plan. It will be a long road, possibly taking as long as the one from the first settlement of New Amsterdam to modern Manhattan, roughly four hundred years.

Must we wait until 2425 for these trends and changing boundary conditions to bring this future about in the fullness of time, or is there an optimal plan to accelerate things?

The technological wildcard is robotics and the kind of artificial intelligence that goes beyond today's data science applications to machines that have human-level knowledge of engineering and construction operations or beyond. We can build space-based robots designed in turn to build both the O'Neill cylinders and the supply infrastructure that will bring raw materials from the moon and asteroids and other robots to build and maintain the construction robots. This will obviously need a small-scale start with the first human-built robot generation and then involve letting the robots scale themselves and their products up.

With unlimited material resources, unlimited energy from vast solar collectors, and an unlimited supply of workers who do not need to be paid, this architecture, with little human involvement, could eventually result in the proliferation of O'Neill habitats in unlimited numbers to the point of being free or virtually free on a highly accelerated time frame.

PART III

What might the state of humanity be under this scenario when it reaches maturity, whether that comes in four centuries or perhaps much sooner?

The greater part of humanity now lives in O'Neill cylinders of many sizes corresponding to small town-sized communities in close proximity to others up to communities with the population of terrestrial cities. Mostly they make their way around the sun in proximity to the Earth–Moon system, but others are scattered around the solar system for the sake of commercial opportunities or scientific research.

Some too, may be located in the outer reaches because their inhabitants do not wish to participate in mainstream human culture at that point in time. Their choice. Possibly a few larger habitats, having achieved perpetually balanced and self-sustaining environments capable of supporting generation after generation of humans, have set sail toward the stars, confident their descendants will arrive safely.

Genuine artificial general intelligence and the robots it enables has brought unlimited industrial productivity, and the basic necessities of life are free or nearly so. Parents no longer need to caution their children to choose a profession that leads to a well-paying job but instead encourage them to follow their own

individual paths to happiness.

Universal prosperity from unlimited resources and productivity, combined with political freedom engendered by the permanent safety valve of an endless frontier, leave people with nothing to fight over. Humanity has finally and permanently outgrown the scourge of war.

And what has happened to the old world, to Earth while all this has been going on above it?

Mining, manufacturing, and agriculture have all been fully moved off planet and are mostly being performed by robots. With greater opportunities for employment and adventure or just more attractive living conditions, we imagine our home planet will have relatively few permanent inhabitants. Earth has been transformed into a vast nature preserve and terrestrial DNA bank. Its seas and skies are once more teeming with life, and pristine forests and prairies spread cross the continents.

Human activity now has zero impact on terrestrial environments or climate. Humanity, guarding from above, now has the means to prevent disastrous asteroid impacts and even to prevent naturally occurring climate events such as Ice Ages to preserve the Earth as we came from it—if we choose.

The remaining cities are lovingly preserved for their cultural value and as tourist destinations. Some have reconstructed themselves to recapture their appearance at their time of their greatest historical glory, and both residents and visitors from the worlds above delight to become re-enactors of those bygone eras when it suits them.

A happier view for humanity's future can hardly be imagined. Universal plenty, universal freedom, the end of war, the Earth preserved, humanity on the way to the stars. Meanwhile legions of robots continue to build and place new mini worlds around the solar system like the uninhabited islands of old Earth before the age of exploration, free to whomever can reach them.

And, if anyone should grow bored with paradise, adventure is always an option—ship out across the final frontier and find a new world of your own.