

**Space Exploration and Cosmic Evolution**  
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**Introduction to the Cosmos**

*“...let us build a city and a tower,  
whose top may reach unto heaven.”*

*Genesis*

*“Space exploration holds the key to the origin of the universe,  
the fundamental workings of nature,  
and ultimately the survival of our species.”*

*Ian Pearson*

**Space travel** and the **colonization of the universe** has been one of the great dramatic themes within futuristic science fiction.<sup>1</sup> Equally, it has been one of the deepest cosmic and metaphysical dreams of scientists and philosophers in the modern era, though the idea of traveling into outer space goes back to ancient mythology and story telling.<sup>2</sup> Perhaps even the earliest Homo sapiens gazed upward into the night sky, wondering about the moon and the bright points of light above, thinking about their meaning and if they could be reached. In the final scene of the movie *Quest for Fire*, set tens of thousands of years in the past, the central male protagonist, after a great and dangerous journey of adventure and discovery across his primitive world, sits quietly beside a burning campfire with his beloved woman who taught him the secret of creating fire, and with a sense of questioning and awe in his eyes, looks toward the bright moon overhead, deep in thought, as if realizing that his destiny and the future meaning of human life is to be found in the mesmerizing lunar sphere above.

It is clear why traveling into outer space holds such great appeal and captures the imagination of humanity. It is the adventure of humanity into the cosmos, the journey into the mysteries of the universe. It offers the possibility of exploring a myriad of other worlds. Through space travel and colonization, humanity and life will spread through the universe and potentially diversify and multiply in mind-spinning ways. The further growth of science, technology, and civilization to depths and heights that would dwarf our present human reality are also part of the potential saga of space exploration. As we imagine the incredible expanse of the universe, there to be explored and settled, the future and the time needed to accomplish this immense and variegated journey stretches outward into thousands, millions, and even billions of years. Space travel also offers the possibility of contact with alien intelligent minds and strange and wondrous cultures. What will we learn, what will we see within ourselves, as a consequence of meeting other sentient beings? Perhaps the single most important event of the coming centuries, if not within the entire history of humanity, will be contact with our cosmic neighbors. With these hopes and dreams there are also great fears, for space is a metaphor for mystery and uncertainty. There are the fears, beginning with H.G. Wells' *The War of the Worlds*, and popularized so well in contemporary science fiction, that aliens will destroy us or inflict some great cultural shock upon us. For every one of the fantastic and uplifting dreams associated with the journey into outer space, there is a potential demon, nightmare, or unsettling reality lurking in the darkness. All told, space travel has been seen as a central metaphor on the future and the ultimate adventure of tomorrow, filled with both great uncertainties and promises, extending outward to the infinities of existence.

Within this chapter, I examine the various arguments for exploring and colonizing the heavens. I describe the history of space travel and the heritage and contemporary visions of science fiction that deal with outer space. Next I describe present efforts to explore outer space and in particular the solar system. I look at our present economic and technological capabilities and our plans to colonize the moon, settle and terraform Mars, mine the asteroid belt, and spread the seeds of life and human civilization to the outer edges of solar system. I review the significant connections between earth science, ecological concerns, the survival of life and humanity, and space exploration and technology. I discuss the economic, cultural, demographic, biotechnological, and information technological consequences of moving out into space. Next I consider the possibilities of alien contact, space cultures, and space civilizations. Then I leave the solar system and begin the journey to the stars and beyond. What types of vehicles and mechanisms could journey to the stars? Who and what will make these journeys? Will robots lead the way? Can the galaxy be explored and settled? How, and in what time frame? Can we move out of the Milky Way in the distant future and spread to the farthest reaches of the universe? Can we move through space and perhaps even time in ways that transcend or circumvent our present physical limitations? Are wormholes and faster than light technologies possible? As I move outward into space, I also move outward into time, and consider the significance of life, mind, and intelligence in the grand panorama of

the history and fate of the universe. Is our universe the ultimate boundary on what there is to be discovered and explored, or through some means yet to be understood, is there a multiplicity of strange and different universes that we can also explore? Within this broad cosmic context I draw a variety of connections between biological and cosmic evolution, the farthest possibilities of science and technology, and the quest for cosmic understanding. At the most fundamental level, space exploration is the search for an understanding of the universe and existence and the search for an understanding of who we are and our place and significance in the grand scheme of things. As Wyn Wachhorst states, “the dream of space flight” is a spiritual quest of the highest order.<sup>3</sup>

The main theses of this chapter are:

- Our self-understanding and our ability to thrive on the earth are intimately connected with space travel and colonization. There are immense social, psychological, economic, and spiritual benefits associated with journeying into outer space.
- Space travel and colonization will stimulate growth in all areas of science and technology, including physics, information and communication technology, ecology, and biotechnology.
- Space travel is necessary for the ultimate survival of our species and all other life forms on earth.
- Humans and other earth life species will spread into different alien environments and proliferate into new functions and forms through purposive evolution, as well as through natural selection processes encountered on other worlds and in outer space.
- The critical defining feature of the Third Millennium will be the journey of humanity into space, which will transform humankind and human civilization more deeply than any other previous event in the history of the species.
- Humanity, coupled with and empowered by robotic and artificial intelligence and redesigned through biotechnology, will explore and settle the solar system, the galaxy, and eventually the universe.
- The first phase of space exploration and colonization, which will occur over the next thousand years, will be the dispersion of humankind throughout the solar system, beginning with settlements on the moon and Mars, followed by the asteroid belt and the satellites of Jupiter and Saturn, eventually leading to a solar web of technologies and colonies enveloping the entire system and capturing the power of the sun. In the Third Millennium humanity will become a Stage II solar civilization<sup>4</sup>.
- Other worlds, stellar systems, and eventually galaxies will be redesigned and reconfigured. Spatial structures and systems of immense size and scope will be created throughout the cosmos. Technology will expand throughout the universe.
- The future history of the universe will reveal a plurality of life forms and intelligent beings participating in the cosmic evolutionary journey. Humanity and humanity’s descendents will hopefully participate in this

process and integrate with other intelligent life forms in cosmic cultures and civilizations.

- The journey into space will lead to a cooperative network with other alien beings in coordinating the universe. This integrative process will occur across all dimensions of reality, including the physical, psychological, social, and philosophical spheres.
- Space exploration and colonization are essential elements in the cosmic evolutionary development of mind and spirit. The physical and energetic embodiment of mind will evolve through various stages as intelligence spreads through the universe.
- The cosmos will develop a functional intelligence and communication system, as an evolutionary step in the direction of a cosmic mind. Intelligence will eventually coordinate the physical dynamics of the universe. The exploration and colonization of space is fundamentally the process of the universe becoming increasingly alive and self-conscious.

Presumably Arthur C. Clarke stated, “Dinosaurs didn’t survive because they didn’t have an effective space program.”<sup>5</sup> The most popular contemporary theory regarding the extinction of the dinosaurs is that the earth was hit by a “**killer rock**”, as Easterbrook would describe it, and the collision so drastically affected the atmosphere and biosphere of the earth that the dinosaurs, as well as many other species, perished in the catastrophe. If the dinosaurs had the intelligence and technology, by some wild stretch of the imagination, to have been able to detect the impending collision and prevent it, they would have survived.

Many arguments have been presented, including humanity’s very survival, for why we should journey into outer space. Literally leaving all of our eggs in one basket, the planet earth, we are sitting ducks in the event of some possible spatial collision with a sufficiently large asteroid or comet that could wipe us out. It is best that at least some of us get off the planet and spread around. Statistically speaking, sooner or later, something big is going to come at us on a collision course. It has happened before; it will happen again.<sup>6</sup>

I discuss in more detail, as the various specific relevant topics come up in later sections, the many reasons for journeying into space, but by way of introduction and to set the stage for the overall philosophical thrust of this chapter, it is important to highlight one basic point for pursuing space travel and colonization. The point is **survival**, but at a deeper level than simply ensuring that human life is not destroyed by some cosmic catastrophe or collision. Recall from the last chapter Easterbrook’s argument that the goal of life involves spreading outward and multiplying and diversifying. The essence of life is to grow. Easterbrook also connects the evolution of life with the evolution of mind. Following the logic of Murray Gell-Mann and Kurzweil, who describe life as a system for learning and enhanced information processing, life and mind both fall on the evolutionary continuum of increasing intelligence. The growth of mind and intelligence occurs through the process of exploration; as life reaches outward into new potential ecological niches, mind and consciousness actively reach out

into the world to understand and learn. Curiosity is a fundamental psychological motivation of all advanced animate forms of life. Exploration is the means by which the mind grows.

If the human mind stays curled up in its womb and birthplace it will die. As Wyn Wachhorst states, living systems naturally reach out into their surround. In his mind, life explores or expires. Wachhorst goes even further and argues that evolution and exploration are inseparable, in essence connecting growth with survival.<sup>7</sup> Life either grows or dies. Since existence is dynamic, the choice being to move forward or move backward; there is no standing still. Walter Kistler, one of the leading figures in contemporary space technology, also argues that humans need to explore and be creative or we will become stagnant. Although it will be on a much vaster scale with potentially much greater effects, Kistler compares the imminent journey into outer space with the exploration of the New World five centuries ago, and how the opening up of the New World stimulated the growth and transformation of all aspects of human civilization.<sup>8</sup> For Wachhorst, humankind needs to explore and needs to evolve, and traveling into space provides the next avenue for expressing these fundamental imperatives within our being. This evolution and extension of the human mind and human spirit into the heavens above will not only breathe continued life into our own existence, but following the argument of Easterbrook, will facilitate the deep drive within all of life to spread and evolve beyond its present environment.

With exploration comes increasing understanding, and if the underlying drive of mind and consciousness is to make sense out of the world in which it finds itself, then the journey into the cosmos is a cognitive and epistemic inevitability, for the answers to the deepest questions of existence are to be found by leaving the limiting perspective of our solitary and tiny world and exploring the breadth and depth of the cosmos. Space exploration is the quest for cosmic understanding and **cosmic consciousness**. The mind, by its very nature, wants to know, has to know if it is to survive, and the knowledge lies “out there”. The journey into space is motivated by the human mind’s need to create a grand vision and theory of the cosmos.<sup>9</sup>

But although “outer” space can be seen as something beyond our home and our world, it is also, in a more fundamental sense, our real home and the physical “ground” and medium of our existence. When we look up into the night sky, standing on the terrestrial surface of our planet, the stars appear to be above and separate from us, hence the origins of the dualism of earth and heaven. Yet we cannot see from this vantage point due to the occlusion effect of the earth beneath our feet that we actually live in that dark and starry space above us. We are looking into our neighborhood and for someone or something else looking outward from some other location into the same neighborhood, we would appear as a bright point of light suspended in the dark, vast emptiness of space. Until we really go out into space, discounting for the moment our few brief expeditions to the moon, as a species we haven’t even stuck our nose out of the nest to see where we are.

Therefore, although the quest for understanding connected with space travel involves the primary psychological need to grasp the big picture, the quest

is also to find our roots and the real foundation of our reality. We are children of the sky, as much, if not more so, than children of Gaia, for the earth and the very matter of our bodies was created and remains embedded in the swirling vast energies of space. We are grounded in space.

According to Wachhorst, the quest for understanding and enlightenment that underlies *The Dream of Spaceflight*, which is the title of his book, involves many of the most basic philosophical and spiritual questions of existence. It includes the search for the big picture and the search for our roots, but it also includes the quest for self-understanding, for meaning, and God. In traveling out into space, we will be able to see ourselves from afar, as witnessed by the revelatory experience of seeing the earth from the moon - and how jolting and enlightening that vision was! But yet further, as we explore and interact with whatever realities we find in outer space, our self-understanding will grow. All self-understanding is ecological in the sense that we see and define ourselves within the context of the environment in which we live. Living in space provides an ecological context that will put us in a much more vivid and expansive framework than anything we have experienced before. We will see ourselves revealed in the same way that the earth was revealed to us once we left its limiting confines. We will find ourselves and see our place within the context of the whole.<sup>10</sup> It is the modern, and better still, futurist expression of Spinoza's philosophical recommendation that in order to achieve the truest form of self-understanding we should view ourselves through the eyes of the cosmos and eternity. But further, space is not simply a place, but an adventure in evolution, and as we explore we will be transformed. Reciprocally, if in some metaphorical, literal, or futurist sense, journeying into the heavens is reaching out to see the face of God, which in fact is what happens in Olaf Stapleton's *Star Maker*, then our self-enlightenment is even further enhanced in the process.<sup>11</sup> Space is both an odyssey of **self-discovery** and **self-transcendence**.

For Carl Sagan, space exploration is a "**candle in the dark**".<sup>12</sup> As Wachhorst comments, once the term "stars" was most commonly associated with the stars of the night sky, but now the term more frequently evokes the meaning of media celebrities. Once the word "star" was a symbol of a transcendent reality, worthy of reverence and justifiably inspirational. Wachhorst, who is highly critical of our contemporary individualist and relativist culture, believes that space could save modernism from drowning in a "black hole of solipsism", providing a transcendent and cosmic vision to pull us out of our self-centered and shallow mindsets. Space will bring meaning and wonder back to our world. (Perhaps our lost of wonder toward nature is symptomatic of a loss of wonder toward anything.) The quest and dream of space travel is not, in Wachhorst's mind, fundamentally a practical aspiration; it is a vision fueled by fascination. Thus, in the truest sense, the adventure of space is highly practical, for it will save us from the darkness and death of spirit within our present modern society. It is the "candle", the light that will illuminate and stimulate the mind. It will bring wonder and cosmic understanding, facilitating the evolution of intelligence and self-identity. Without it, we will truly die.

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Included in the notes for this chapter is a list of websites on space travel and exploration.<sup>13</sup> I have also included a number of websites on science fiction writers who have dealt with the topic in their novels and stories.<sup>14</sup>

## **The Heritage, History, and Contemporary Reality of Space Travel**

***“Let us create vessels and sails adjusted to the heavenly ether and there  
will be  
plenty of people unafraid of the empty wastes. In the meantime, we shall  
prepare for the brave sky-travelers maps of the celestial bodies.”***

***Johannes Kepler***

***“Some part of our being knows this is where we came from.  
We long to return.”***

***Carl Sagan***

Stories of leaving the earth and venturing upward into the sky and even landing on other worlds date back to ancient times, but these stories were more fantasy than reality and the true dimensions of outer space were in general vastly underestimated.<sup>15</sup> In ancient times most Europeans viewed the sky as the vault of heaven, having a distance in the same range as the horizon. The objects in the sky, including the sun, the moon, and the stars, were believed to be smaller than the earth. It is only with the Scientific Revolution in the 16<sup>th</sup> and 17<sup>th</sup> Centuries that a more accurate understanding of outer space began to be achieved. Although still incomplete and inaccurate in many regards, Copernicus, Kepler, and Galileo gave us the beginnings of a scientific picture of the structure, make-up, and dimensions of the solar system. Distances were much vaster than had generally been believed and Jupiter, as Galileo discovered, was another world with its own set of moons. The universe began to open up in all of its great complexity and mystery and we saw that the tiny points of light in the sky were other suns and other worlds, that outer space was a great gulf of at least millions of miles in expanse.

How could such distances be crossed? Kepler, in his book *Somnium*, imagined traveling to other worlds in outer space but, in spite of the scientific and technological sophistication he displayed for his times, his suggested mode of traveling was more magical than scientific. Yet beginning in the late 19<sup>th</sup> Century,

especially in the writings of science fiction writers such as Jules Verne and H.G.Wells, various types of spacecraft were imagined, including huge balloons, rockets, anti-gravity machines, and projectiles shot off of the surface of the earth. As Nikos Prantzios notes, it was only with Verne and Wells that imagined journeys into outer space involved thoughtful efforts to be technologically plausible.<sup>16</sup>

From the earliest visions of traveling to other worlds, one of the most intriguing aspects of space travel is the possibility of contact with **alien intelligence**. Within early science fiction stories, not only did people of the earth travel into space, but alien beings traveled through space to the earth. Right from the beginning, science fiction stories of space travel were populated with aliens from other worlds, whom we visited or who visited us. Of course, many times these alien visitations were invasions, as in Wells' classic tale of Martians attacking us in *The War of the Worlds*.<sup>17</sup> Wells' story of Martians invading the earth, published in 1898, was to a significant degree inspired by the popular idea circulating at the time that there were canals on Mars, a possible indication of intelligent life on the planet. Giovanni Schiaparelli had reported in 1877 that he had observed *canali* ("channels") on the surface of Mars, and inspired by Schiaparelli's report, Percival Lowell in 1895 announced that he observed numerous canals on the surface of Mars. The idea of alien cultures and alien beings brings with it the same dual mixture of great hope and great apprehension associated with journeying into outer space in general. The dark mystery of the "beyond" both inspires and terrifies the human heart.

In the early decades of the 20<sup>th</sup> Century, both science fiction and the science and technology of space travel evolved. The Russian scientist, Konstantin Tsiolkovsky first described in 1903 the modern concept of **rocket ships** ("reaction machines") as the appropriate vehicle for traveling into outer space. He proposed the use of liquid hydrogen and oxygen as fuel and also first described the idea of spacesuits as a way to survive in outer space. Further, as a man of great vision, well ahead of his time, he advocated the exploration and colonization of other worlds throughout the universe.<sup>18</sup> Within the following two decades, Robert Goddard, who according to Wachhorst identified the basic principles and machine design for taking man to the stars, articulated the essentials of rocket propulsion, guidance systems, and multi-stage vehicles, and launched the first liquid fuel rocket into space in 1926.<sup>19</sup> Inspired by the ideas and accomplishments of these early pioneers in space technology, as science fiction matured in the early 20<sup>th</sup> Century, imagined spacecraft evolved to mind-boggling capabilities and proportions. Armadas of mile long rocket ships, both human and alien, soon populated the pages of science fiction magazines, and we quickly sailed in our imagination beyond the confines of the solar system to the stars.

As science and astronomy in the 20<sup>th</sup> Century explored the deeper regions of the heavens, discovering the existence of innumerable galaxies beyond our own and the true size and complexity of the Milky Way,<sup>20</sup> science fiction writers moved outward as well, exploring the Milky Way in their imagination, and setting forth on journeys to other galaxies and increasingly stranger alien encounters beyond. In the 1930's, Olaf Stapledon wrote his epic space adventures *Last and*

*First Men* and *Star Maker*, in which he describes the human colonization of the solar system and various advanced alien civilizations that stretch across the universe.<sup>21</sup> By the 1930's and 1940's, within science fiction we had traveled to the limits of the known universe (and even beyond), created enclosed space cities that went on journeys of thousands and millions of years, discovered numerous scientific and technological ways to exceed the speed of light, fought epic space wars with countless alien civilizations, and settled on many strange and wondrous alien worlds.<sup>22</sup> During this period, science fiction art also evolved providing compelling visualizations of the mystery of outer space and other worlds. The images of science fiction writers, Wachhorst states, speaking in the visual metaphors of adventure, took us to strange and wondrous places that spoke to our hearts and drew us into the growing dream of space travel.<sup>23</sup>

Also in the 1930's, the great cosmic philosopher and scientist, Vladimar Vernadsky, who invented the concepts of the biosphere and the noosphere, described his vision of how humanity could in the future expand throughout the universe and gain control of the universe. Vernadsky extended the idea of the noosphere to cosmic proportions, arguing that mind and intelligence could envelop the entire universe. He produced a grand synthesis of science, religion, ethics, and utopian ideas in his *Cosmic Philosophy*, published in 1932, in which he attempted to integrate all the fundamental dimensions of human reality in discussing the future of humanity in outer space.<sup>24</sup> The exploration of outer space, though it clearly involves a technological dimension, will involve the expansion and evolution of all facets of human civilization. Vernadsky, as well as many great science fiction writers, have realized that all aspects of human existence need to be considered and re-thought as humankind moves outward into this new environment.

On the technological side of things, in the 1920's Hermann Oberth, another great passionate soul and early advocate of space travel, instigated the beginnings of the German Rocket Society, which stimulated the growth of rocket technology in Germany and eventually led to the creation of the **V-2 ("vengeance weapon")** in 1942.<sup>25</sup> Wernher von Braun, who was one of the leading members of the German team involved in the development of the V-2, came to the United States after World War II and became instrumental in the development of space rocket and technology design in the United States. By the late 1940's the United States was launching large rockets into the skies above.

As can be seen while our imagination was soaring ever higher in science fiction and philosophical speculation about outer space, our technological and scientific efforts to break the bounds of the earth progressed steadily through the 20<sup>th</sup> Century. Airplanes and other types of powered aircraft invaded the skies in the first few decades of the century. Experimental rockets were being shot into the atmosphere within a couple of decades and by World War II we were launching more sophisticated rockets through the skies at each other. After the end of World War II, led by the efforts of Wernher von Braun and others, realistic designs were developed for rockets that would travel to the moon and to Mars and space stations were envisioned that would circle the earth.

In the 1950's the continuing development of space technology became a politically motivated competition between the United States and the Soviet Union and the "**space race**" was on. The Soviet Union successfully placed the first **satellite**, Sputnik, in orbit in 1957 and also put the first human in space, Yuri Gagarin in 1961, followed soon thereafter by the first American in space, Alan Shepard. In less than a decade, during the 1960's, animals and humans were placed into orbit, people walked in space, probes hit and then soft-landed on the moon, and finally in 1969, Apollo 11, with Neil Armstrong and Buzz Aldrin on board, landed on the moon.<sup>26</sup>

The Apollo program, begun in 1961, eventually achieved six manned moon landings from 1969 to 1972. But the **Apollo program** was motivated by political and military goals and was exceedingly expensive, costing 24 billion dollars.<sup>27</sup> According to Dyson, the Apollo program was a false start to the manned space program. Dyson states that the program was too costly and unsustainable and did not open the sky to human exploration.<sup>28</sup> Further, though the images of the earth from the moon generated a "re-enchantment of our world", the moon appeared, to quote Buzz Aldrin, as a "magnificent desolation". After innumerable fantasies and images of what we would find when we landed on the moon, the cold, still, and barren reality we encountered was exceedingly anti-climatic. Where were all the moon men? For Wachhorst, there was no infusion of wonder and mystery in the whole endeavor; successive moon landings became monotonous and boring. For these reasons and other ones, by the 1970's the public lost interest in the space program.<sup>29</sup>

Still, amazing progress was made in the first two-thirds of the 20<sup>th</sup> Century. We went from hot air balloons that traveled a few miles above the surface of the earth on the currents of the wind to walking on the surface of an alien world, the moon. Beginning with Goddard's earliest efforts in rocket engineering, the United States space program eventually constructed the largest engine ever built, the **Saturn rocket**. Though a clear example of the incredible costs involved in space technology, the Saturn rocket lifted 6.5 million pounds off the surface of the earth, using 15 tons of fuel per second for an average mileage of 5 inches per gallon of fuel.<sup>30</sup> Even if the American-Soviet space race and the Apollo program were false starts that were motivated for the wrong reasons at great financial costs, we had begun the journey into outer space.

Although the 20<sup>th</sup> Century has witnessed great progress in humanity's ability to venture off the surface of the earth into outer space, after the moon landings the space program in the United States slowed down, and the earlier optimistic predictions of human landings on other planets by the end of the century were not fulfilled. Space exploration became increasingly too expensive for any one country; there were numerous tragedies and disasters along the way, including the Challenger explosion in 1986, and various pro-earth and environmentalist reactions against space travel and exploration significantly slowed down the rate of technological advance.

Yet space technology and exploration, in many ways, still moved forward in the last third of the 20<sup>th</sup> Century. Over the last few decades, the solar system has been explored and studied more closely than ever before via a series of

unmanned probes. Beginning in 1962 with *Mariner 2* and the first successful flyby of another planet, Venus, humans landed probes on both Venus and Mars in the 1970's, flew by Mercury and Jupiter in the same decade, and in the 1980's sent *Voyager* probes by Saturn, Uranus, and Neptune. These probes sent back a great deal of new scientific information on the planets, moons, and overall make-up of the solar system. Moving even further out into the cosmos, in 1983, *Pioneer 10* left our solar system, carrying the message to the stars. Additionally, in the early 1970's both the Soviet Union and the United States established **space stations**, *Salyut 1* and *Skylab 1*. Through the 1970's and early 1980's the Soviet Union sent up six more space stations in the *Salyut* series. In 1986 they launched *Mir*, which was the largest permanent space station put in orbit by humans in the 20<sup>th</sup> Century. *Mir* provided a testing ground for studying the long-term effects of humans living in space, with some cosmonauts staying on the station for over a year. In 1997, the United States *Pathfinder* rover landed on Mars and set video pictures back to Earth, re-igniting some level of public interest in space exploration as it moved about the Martian surface.<sup>31</sup>

Also in the 1980's, starting with the *Columbia*, the United States **Space Shuttle** program began developing reusable, short-range space vehicles. A decade later the **Hubble telescope** was launched and after successful repairs being carried out in orbit, it has been sending back the most detailed and penetrating images of outer space and the universe in the history of telescopic astronomy.<sup>32</sup> Yet the most visible and influential development in the space program in recent years is the vast and ever growing satellite network encircling and monitoring the earth.<sup>33</sup> It is ironic that this product of space technology contributed immensely to one of the social-scientific movements that actively worked against the space program in the 1970's and 1980's.

The emerging environmentalist and ecological trend in popular culture significantly helped to subdue and counteract the force, spirit, and aspirations of the space program. Over the last few decades we have become more concerned about our home than outer space. Yet, it has been through space technology and our satellite system that our most vivid and detailed pictures of the earth have been produced. In space, the earth appears as a unique and highly integrated system: a bright blue sphere covered in whirling waves of clouds, suspended in the vast, cold and dark expanse of space. Satellite technology and communication and monitoring systems have produced a much more comprehensive and detailed image of the meteorological, geographical, and geological patterns on earth than ever before.<sup>34</sup> More generally, it is the satellite system of the space program that anchors the telecommunication system and that is helping to turn our world into a global society by allowing people from around the world to instantly communicate with each other.<sup>35</sup> Satellite technology has given us a much better understanding of the earth and it has brought the people of the earth much closer together.

Aside from various military goals and aspirations, such as the proposed American **Star Wars** program, satellite technology could serve a variety of constructive purposes in the near future. The weather could be modified, solar energy could be harnessed on a much vaster scale, and the **global satellite**

**communication system** could provide access for everyone, everywhere on the earth.<sup>36</sup> As the Internet and World Wide Web continue to grow our satellite system of communication will provide one of the central networks of transmission within the global information system.<sup>37</sup> For the sheer awe-inspiring effect of it, we may soon be able to "virtually" experience the earth from up above as the astronauts do, by connecting into a satellite hook-up and a virtual reality system.

Presently, as we enter the 21<sup>st</sup> Century many of the space technology initiatives begun in the last few decades are continuing to advance. As Dyson states, one of the most pressing and immediate challenges facing space technology is reducing the costs of launching vehicles into space.<sup>38</sup> The United States is developing the X-33 *Venture Star* as the next stage in less expensive, re-useable launch vehicles.<sup>39</sup> Besides the efforts of the United States space program, many private corporations are also working on re-useable rockets, motivated by the X Prize Foundation offer of 10 million dollars to the first company that can send 3 people into outer space, and using the same vehicle, do it again within 2 weeks.<sup>40</sup> Over 20 companies, including Kistler Aerospace, one of the leaders in private space technology, are actively involved in this competitive race.<sup>41</sup> Whereas in the latter half of the 20<sup>th</sup> Century, the development of space technology almost exclusively involved a competitive race between the United States and the Soviet Union, which led to huge costs for both governments, increasingly private companies are getting involved in finding less expensive ways to travel into outer space.

International cooperation is another way to share expenses and reduce costs. The **International Space Station** is the first large multi-national effort in space and when completed it will have the passenger-working space of two jumbo jets. Kistler reports the cost of the station at 35 to 40 billion dollars, more than the entire Apollo program. It will involve the contributions of over a dozen nations.<sup>42</sup> Prantzios estimates the cost at 50 billion dollars, making it the most expensive human construction ever built.<sup>43</sup> The International Space Station is the largest space station yet to be built and it has been the subject of great controversy.

Still, continuing in the line of earlier stations created in previous decades, it will provide an expanded testing ground for humans learning to live and work in outer space. A central challenge in the development of space stations is how to create a hospitable internal environment for humans that is relatively self-sustaining within the emptiness of space. It is interesting that ecological science is also contributing to this area of research. Scientists, to recall, are studying the nature of self-sustaining, self-enclosed living environments in installations such as Biosphere II.<sup>44</sup> Both space stations and enclosed living habitats, on earth as well as under the sea, will function as test prototypes for eventual settlement installations on other planets.

In the future, orbital space stations could also provide connecting links along the pathways of further exploration into the solar system. They could also serve as construction sites for space technology.<sup>45</sup> Kistler sees the International Space Station as becoming a hub for industrial and space tourist activities.<sup>46</sup> In

general, space stations are a step to the planets and the stars, and hopefully toward international cooperation in the exploration of outer space.

The exploration of the solar system through space probes is also continuing. Europa is one of the largest moons of Jupiter and many scientists speculate that there might be water and possibly life under its surface of ice. The Europa orbiter will be taking detailed pictures of the icy surface of this provocative moon of Jupiter. Within the next couple of years, the *Cassini* probe will be sending a landing device down to the surface of Titan, the largest moon of Saturn. Additional landings of probes and robotic vehicles are also being planned for Mars in the next few years.<sup>47</sup>

Surpassing the capacities of the Hubble Telescope four-fold, the Next Generation Space Telescope (NGST) should be launched within the decade. In the search for life in the universe, one important step is the identification of planetary systems surrounding other stars in space. Astronomers have already identified various planets in other solar systems in the last decade, but the NGST will provide the most sophisticated and powerful detection systems yet to be deployed to look for other planets outside our local system.<sup>48</sup>

As noted above, private companies are becoming increasingly involved in space technology and exploration. As a general point, even if the exploration of outer space appears to have fallen out of favor with the general public, there are a number of highly active and popular space organizations and groups around the world who are supporting the continued growth of the space initiative. I list a number of web sites of these non-government organizations and groups, including Marshall Savage's Living Universe Foundation, Robert Zubrin's "Mars Direct" and The Mars Society, and the Artemis Project advocating a permanent settlement on the moon.<sup>49</sup> The vision and passion of outer space is not only alive and well but growing in both financial support and the planning and implementation of various space projects in the near future.

In the last section I discussed the issue of survival as one central reason for journeying into outer space. Survival was described in the broad context of not only physical and biological survival, but the survival of the human psyche and spirit and the evolutionary need to grow, diversify, and spread outward. In the space race, survival took on a very practical meaning, for space technology was seen by both the United States and the Soviet Union as a military imperative. Each government saw the deployment of satellites, space stations, and even bases on the moon as both defensive and offensive points of operation, providing strategic advantages in the event of war between the two super-powers.

Yet, there was also an element of national pride and ego and even ideological destiny involved in the space race. The "**Conquest of Space**" became a slogan and philosophy of the burgeoning space programs hark back to the historical and militaristic visions of conquering the "New World" and nationalist ideals of "Manifest Destiny". Even if space is an adventure filled with uncertainties, many past and present advocates of space technology and exploration believe that the journey into outer space is the destiny of humanity. The contemporary futurist, Michael Zey, supports the idea that space exploration

is the destiny of humans. He argues that there is something important and special about humanity's place in the universe, and just as leaving the bounds of earth may be necessary for the survival of our species, the spreading of humanity throughout the cosmos may be necessary for the survival of the universe. The universe needs intelligence. As Easterbrook has argued that humans have a special place in the evolution of life on earth, Zey believes that humanity has a special role to fulfill in the evolution of the cosmos. Zey, founder of The Expansionary Institute,<sup>50</sup> believes that humanity is destined to spread throughout the cosmos, vitalizing and humanizing the universe.<sup>51</sup>

If Zey advocates a "dominionization" of outer space by humans, perhaps at the other end of the continuum is Wyn Wachhorst, who sees space travel as embodying a quest to achieve "oneness" with the cosmos. In the last section I described Wachhorst's view that spaceflight as a journey of enlightenment serves the dual functions of enhanced cosmic understanding as well as self-understanding. Wachhorst describes these two functions in reciprocal and dialectical terms. Leaving the confines of earth is an expression of autonomy and self-assertion, a separation of humanity from its nest and mother earth. But equally, as a cosmic quest, spaceflight is an effort to find our roots in the cosmos and reconnect with the whole. Deriving his philosophical inspiration from Richard Tarnas, for Wachhorst, journeying into outer space involves the paradoxical dialectic and union of **self-assertion** and **integration**, of finding a moving synthesis of the "male" and "female" minds.<sup>52</sup> He describes space travel metaphorically as the union of being contained and protected within the "womb" of the spaceship while venturing forth naked and isolated into the vast emptiness of space, at once enclosed and exposed. As with all fundamental realities, Wachhorst contends that the quest of space travel is paradoxical, an archetypal "**mythic vision**" involving the union of opposites. Further, for Wachhorst, underneath this quest is the theme common to all mythology and religion that man and the cosmos are one. Hence, if on one hand Zey wishes to emphasize the "self-assertive" quality of exploring and colonizing outer space, Wachhorst wants to integrate this pole of human existence with its reciprocal, the drive toward togetherness and oneness with our cosmic reality.

So in turning to the future of space travel and colonization, we leave the womb of the earth, though attempting all the while to create hospitable simulations of our world in our space stations and rocket ship interiors. For various reasons, good and bad, stretching across the philosophical continuum from military aspirations to cosmic unity, we have begun to extend our presence into the great beyond, riding on the powerful thrusters of technology, passion, and ego.

# Exploring and Colonizing the Solar System

***“Our planet is the cradle of intelligence,  
but one cannot live forever in a cradle.”***

***Konstantin Tsiolkovsky***

***“We will have to choose, either to remain one species united by a common  
bodily shape as well as by a common history, or to let ourselves diversify  
as the other species of plants and animals will diversify...  
This is the great question which will soon be upon us.”***

***Freeman Dyson***

Traveling to the planets and moons of our solar system and setting up bases and human habitats could become the central technological and social achievement of the 21<sup>st</sup> Century. The exploration and colonization of the solar system will gain increasing momentum as the advantages and gains to be made become more obvious and attainable. The chemical, mineral, and energy resources of the solar system are beyond imagination.<sup>53</sup> As stated earlier, just as the opening of the New World in the 16<sup>th</sup> and 17<sup>th</sup> Centuries helped to usher in the modern era, the opening of the solar system will probably trigger a whole new human era. Humanity, socially and biologically, could significantly diversify across different types of environments and life challenges. The scale of our technological constructions, communication systems, and transportation lines could expand over millions and billions of miles, harnessing the power of the sun and the resources of the trillions of asteroids and comets within the solar system. Human civilization could attain levels of wealth, industrial production, and population that dwarf our present reality.

Even in the next twenty years, some well defined beginning steps are planned for the eventual manned exploration and colonization of the solar system. Beginning with the moon, after having abandoned it three decades ago, we will soon be ready to return. The United States intends to set up a base on the moon in the near future.<sup>54</sup> William Halal predicts a **lunar base** by 2015.<sup>55</sup> The Artemis Project, a privately funded organization open to public membership, has outlined a detailed program for establishing a permanent base on the moon, which aside from supporting industrial and technological activities, would also support space tourism, entertainment, and homesteading.<sup>56</sup> As technological resources and materials and a sufficient population of inhabitants build up on the lunar colony, the goal would be to make the settlement self-sufficient. According to Prantzos, the moon, because of its lack of atmosphere, is the ideal observatory for viewing the heavens.<sup>57</sup> Also it is an ideal jumping off point for Mars and journeys to other planets, since the gravity of the moon is much lower than the earth and rockets can be launched from its surface with proportionally

much less expense and energy expenditure.<sup>58</sup> The moon may become our gateway to the solar system and the stars.

Both Halal and Zey predict a manned landing on **Mars** sometime around 2020, but there are even more optimistic forecasts that humans could reach Mars five to ten years earlier.<sup>59</sup> Whenever it is achieved, this epic landing, possibly in partnership with Europe, Japan, private enterprise, or public organizations dedicated to reaching Mars, will be the realization of a dream that has enthralled space enthusiasts and science fiction writers since the time of Percival Lowell and H.G. Wells. The mysterious, intriguing, and perhaps foreboding “Red Planet” has been the subject of innumerable science fiction stories and novels, including the recent awarding winning Mars trilogy by Kim Stanley Robinson.<sup>60</sup> Of all the planets in the solar system it has been studied most extensively and probably holds the greatest promise of discovering life within its environment.<sup>61</sup> Mars has captured the fascination of the public and the media more than any other planet as witnessed by a host of popular movies over the years such as *Invasion from Mars*, *The Angry Red Planet*, *Mars Attacks*, and *Mission to Mars* and the infamous radio broadcast of *War of the Worlds*, that terrified thousands of people and permanently imbedded in the public vernacular the expression “**Men from Mars**”. We have thought about Mars, looked at Mars, and wondered, perhaps apprehensively, since we named it for the Roman God of War, what marvels and dangers it held. Clearly, the desire and intent of many people is for humanity to journey to Mars and discover its secrets.

As Prantzios notes our knowledge of Mars has exploded over the last few decades as we have explored and studied our solar system more closely.<sup>62</sup> There have been numerous probes and landings and we have acquired a very detailed picture of the planet’s surface.<sup>63</sup> Among its most compelling topographical features are Olympus Mons, which at 27 kilometers high is the highest mountain in the solar system, the ten kilometer deep canyon Valles Marineris, which stretches farther than the length of the North American continent, and Hellas, the largest meteorite crater in the solar system, which is 2000 kilometers across. Mars has two polar caps, a combination of frozen water and carbon dioxide that change dramatically in size through the seasons. Further, Mars is covered with branching and curving crevasses and gullies that seem to indicate that water once flowed across its surface. Though Mars is presently very cold, very dry, and possesses an extremely thin atmosphere, the scientific speculation is that it was once much warmer, with lakes and rivers and possibly life.<sup>64</sup>

In 1952 Wernher von Braun published his scientific article “Mars Project”, which was the first technologically detailed and systematic study for traveling to Mars.<sup>65</sup> Yet the real push toward traveling to Mars began in the 1980’s with the establishment of the international “Case for Mars” conferences to discuss and study the economic and technological feasibility of journeying to the Red Planet.<sup>66</sup> Then, in the 1990’s, the engineer Robert Zubrin established the “**Mars Direct**” initiative, which developed plans for a multiple spacecraft landing on Mars while significantly cutting the previously estimated costs of a Mars expedition.<sup>67</sup> In the last decade Zubrin has done more than anyone to publicize

and support the idea of traveling to Mars.<sup>68</sup> His plan involves a six-month travel time to Mars, with robots on a first landing vehicle establishing a camp, to be followed by a manned landing in a second vehicle. These first visitors would stay on the surface for around 500 days and return to earth in another six months. The total estimated cost of the multi-craft expedition is 20 billion dollars.<sup>69</sup> Zubrin's ideas have had a big impact on NASA's plans for a Mars landing, illustrating the growing significance of non-governmental organizations and individuals in the exploration of outer space. His plans for a Mars manned landing though are just the beginning of his vision for the settlement of Mars. He believes that a self-sufficient colony should be established on Mars in the near future. This colony would develop an agricultural component, use the water, materials, and energy resources on Mars, and support a population into the tens of thousands by the end of the 21<sup>st</sup> Century.<sup>70</sup>

But why go to Mars? Since it is important for our species to spread outward and not keep all our eggs in one basket, Mars is the most appealing place at a reasonable distance for establishing another foothold for humanity. Although it is much colder than the earth and its atmosphere is un-breathable, it's climate and planetary conditions are more similar to earth than any other known planet or moon in the heavens. The requirements for adaptation would be much less severe than anywhere else. Dyson, in answering the question of why we should go to Mars, quotes Edmund Hilary, "Because it is there". As Dyson states humans throughout history have migrated to new lands and Mars is clearly one of the next new lands to explore and colonize.<sup>71</sup> Along with the moon, Mars is an ideal rocket launching pad, possessing a solid surface and a gravitational pull much weaker than the Earth's. In particular, Mars can serve as a base for the mining of the asteroid belt, which promises to yield great resources and wealth for the future development of human civilization.<sup>72</sup>

The most compelling and comprehensive arguments for traveling to Mars come from the **Mars Society**, another active and influential organization with which Zubrin is also closely affiliated. In the society's founding declaration they provide the following reasons for going to Mars:

- We must go for the knowledge of Mars. We will learn about the possibilities of life in the universe.
- We must go for the knowledge of Earth. We will be able to compare conditions on Mars, past and present, with conditions on Earth and consider future possibilities on the Earth.
- We must go for the challenge. Humans need to be challenged and the colonization of Mars would provide an ideal opportunity for international cooperation.
- We must go for the youth. Youth need adventure and going to Mars will stimulate young people into studying science and technology.
- We must go for the opportunity. The colonization of Mars is the opportunity to make a fresh start and create a new civilization.
- We must go for our humanity. We will be engaging in the act of creation.
- We must go for the future. We need to create a new world for future generations of humanity.<sup>73</sup>

Several of these reasons for going to Mars have already been identified in discussing reasons for traveling into space, for example, the need for adventure and the opportunity for creativity. But it is worthwhile to emphasize again that journeying into outer space helps us to understand our own world, in this case through a comparative analysis of Martian and Earth histories.

The Mars Society Declaration also highlights the potential synergistic effect upon humanity of space travel and colonization. The exploration of the solar system will probably take both an international form, as well as a collaborative form between government, business, and organizations such as the Mars Society and Mars Direct. It is too big a venture to be sustained by any one human institution or system and it is a dream and endeavor that belongs to all humanity. Zey suggests that if different countries don't participate in the exploration of space they will be "left behind", just as Portugal lost its place in the modern world by abandoning its efforts to further explore the Western Hemisphere.<sup>74</sup> Perhaps it is only appropriate that the "earth" venture outward into the solar system, rather than any one country or group of individuals. As a vast, sustained, cooperative effort, space exploration could further integrate us into a global community. And once again, ironically, our earthly concerns (the spirit of a global community) would be served by venturing into outer space.

Adrian Berry believes it is especially important that commercial and business organizations become involved in space. He argues that the real impetus for space travel will come when government moves out of the way and lets private business take the lead. According to Berry, as well as others, government controlled space exploration has been far too expensive a venture.<sup>75</sup> He believes that businesses will be able to reduce costs significantly and turn space exploration and colonization into a money making proposition. Competition among businesses would develop over the quality and cost of space vacations, sightseeing, mining, low gravity technology, housing, and industry, in turn spurring the growth of space exploration and colonization.<sup>76</sup>

**Space tourism** in particular is one commercial area that could significantly stimulate the growth of space travel and impact its cost. Kistler, who also sees the need for increasing commercial involvement in space travel, believes that the development of a space tourist industry is needed for further progress in moving the space initiative along.<sup>77</sup> As well as private businesses, countries such as Japan, with its proposal for the creation of one or more "Space Hotels", are also interested in space tourism. Many individuals have already made reservations for tourist trips into outer space with companies who are already advertising for such future space excursions. Interest is very high and people are willing to put down substantial monetary deposits to reserve their place on a future trip to the moon or to simply orbit the earth.<sup>78</sup>

Before large numbers of people begin to journey into outer space and establish large settlements on either the moon or Mars, the cost of sending people into space has to significantly come down. Commercial tourism will hopefully help to bring the cost down. The more people that fly, the cheaper it will get. But as noted above, the present challenge is to develop a relatively inexpensive re-useable transport vehicle. There are people, in particular those

individuals supporting the X-Prize initiative, who are optimistic and who believe that in the next decade or two, various companies will develop such ships and take thousands of people into space.<sup>79</sup> Dyson, though, states that cheap manned exploration into outer space won't begin till toward the end of the 21<sup>st</sup> Century. He notes that it took 128 years from the time Columbus explored the New World till the Pilgrims began to settle in North America. Calculating from the date of the launch of Sputnik in 1957 as the beginning point in humanity's journey into space, it won't be till 2085 that groups of "space pilgrims" will be able to venture forth on affordable trips to the moon and the planets. Dyson does think, however, that inexpensive unmanned trips will be achievable in the first half of the 21<sup>st</sup> Century,<sup>80</sup> thus suggesting the possibility that robots might constitute the first big wave of explorers into the solar system, an idea we've already seen in Rodney Brooks' paper "Fast, Cheap, and Out of Control: A Robot Invasion of the Solar System".<sup>81</sup>

One particular scientific-technological proposal connected with the colonization of the solar system that has generated a lot of recent interest is **terraforming**. "Terraforming", which literally means to form or make earthlike, could have a great impact on the future of humanity. Following from the general principle of the reciprocity of earth and space, the knowledge being gained by ecologists regarding how to evolve and sustain earthly ecosystems will serve as a basis for the terraforming of moons and other planets.<sup>82</sup> Informed by ecological and meteorological principles, terraforming would involve the transformation of the atmosphere and environment of an entire world to better suit the living conditions of humans. It is a prime example of life modifying its environment to support its own existence and the inclusion of technology into the management of nature. Terraforming is purposive evolution on a grand scale. The idea of transforming an entire planet and its climate was first suggested by Olaf Stapledon in his novel *Last and First Men*, in which he described our future descendents changing the environment of Venus by introducing micro-organisms into the planet's ecology.<sup>83</sup> In 1961, Carl Sagan published a scientific study on terraforming Venus and, over the last few decades, numerous proposals and scenarios, both technical and within science fiction, have been presented for changing the overall ecology and climate of various planets.<sup>84</sup> Venus has continued to be an object of study, but because of its intense atmospheric greenhouse effect, it is the hottest planet in the solar system. Thus terraforming efforts would need to cool its surface down by hundreds of degrees.<sup>85</sup> In most cases though, terraforming would involve heating up the surface of a planet or moon.

Because of all the planets, Mars is most similar to the Earth, the greatest number of studies for terraforming have centered on the Red Planet. Numerous scenarios have been suggested for how to turn Mars into a habitable planet that would support human life. One of the leading figures in this area is Christopher McKay, who hypothesizes that it would take approximately 500 years to terraform Mars.<sup>86</sup> The beginnings of this ecological effort in planetary engineering could start in the next century. According to one study produced by NASA, the first stage, which would take approximately 100 years, would involve the introduction

of bacteria into the atmosphere to generate increasing amounts of carbon dioxide, which would gradually raise the temperature on the planet. At this point in the process, Mars would basically turn into a cold arid desert still with little oxygen in its atmosphere. The next stage, with progressively still more warming of the climate, would involve the melting of the polar caps and the release of water flow across the Martian surface. Waterways and lakes would be produced. Mars presently contains the necessary chemical elements for life, including water, nitrogen, carbon dioxide, and oxygen, but these elements exist in a frozen state. The warming process would free these chemicals, thus setting the stage for seeding the planet with vegetation and primitive life forms. Vegetation will create increasing amounts of oxygen in the atmosphere, and allow for the eventual introduction of animal life into the ecology. Over time, these various modifications into the Martian ecology and atmosphere would positively interact with each other, hopefully causing a snowball effect, raising temperature and oxygen levels even further. Gradually, the temperature, atmospheric pressure, water and oxygen levels, and the spreading and diversification of life would all increase. By some estimates, Mars could be green and supporting a population of millions of people by 2500, if not sooner.<sup>87</sup>

Kim Stanley Robinson, in his Martian science fiction trilogy, *Red Mars*, *Green Mars*, and *Blue Mars*, chronicles in magnificent detail and drama one hypothetical depiction of the colonization and terraforming of the Red Planet.<sup>88</sup> As clearly illustrated in this science fiction epic, transforming Mars from a cold and barren planet to a habitat for life and future humanity will involve more than technology; it will be an experiment in human evolution, a philosophical and social debate on values and meaning, filled with all the challenges, set-backs, and struggles involved in creating a new world. Carl Sagan in his book *Pale Blue Dot* considers the ethical question of whether we should attempt to transform a world to suit our needs and type of biology.<sup>89</sup> Robinson in his Martian trilogy examines this question, among many others. One view is that we shouldn't disturb or destroy the unique reality and beauty of another world, but the counter-argument is that we should spread intelligence and consciousness throughout the cosmos.<sup>90</sup> There are many space enthusiasts and futurists, including Marshal Savage and Michael Zey, who support the view that humanity should help to spread life and intelligence through space.<sup>91</sup>

Zey argues that the terraforming and colonization of Mars will be an extreme act of human creation and art; it will transform the nature of who we are at multiple levels, including the biological, social, and psychological. Such a grand achievement of transforming an entire planet will redefine what is possible. We will be presented with the opportunity to envision and create a different human reality and a different living ecosystem. Arguing that humanity's destiny is to vitalize the universe, that is to spread human life throughout the cosmos, turning Mars into a home for humanity will be the first significant step in this cosmic process.<sup>92</sup> Terraforming Mars will provide the opportunity to study ecology and evolution on a planetary scale, which will not only empower humanity in the spreading of life through the universe, but will help our species

better understand and manage life on earth. Again, venturing into space will benefit the earth.

Through terraforming, the environment of an alien world is changed to meet the needs and biology of human life. The reverse process would involve changing humans to fit the conditions of the world. Both approaches will undoubtedly occur in the future. The idea of reciprocal evolution implies that life and the environment co-evolve, each affecting the other. As humanity moves out into space, we will purposively alter and evolve both our surroundings and ourselves. Recall from Chapter One that Moravec foresees humans diversifying as we move into space. Alien worlds and outer space possess a vastly extended variety of conditions far exceeding the range of conditions encountered on the earth. If human life is going to find ways to adapt to outer space, human life is going to diversify far beyond its present range of variability.<sup>93</sup> Besides modifying ourselves, we should also, as Dyson suggests, develop new life forms that could survive on other worlds, for example, “warm-blooded plants” to endure the colder climate of Mars.<sup>94</sup>

As a general point, even if we begin to terraform other planets or create artificial enclosed environments to support human life, it will always be a give and take process between the alien environment and human life. We will both modify surrounding conditions and modify ourselves to better fit the world. Mars will probably never be a duplicate earth populated by humans, as we presently exist. Mars will reflect the impact of humanity, but humanity will also reflect the impact of having to adapt to Mars. The terraforming of Mars and the transformation of humanity will indeed be a creative act, as Zey proposes, producing a world of sentient beings existing in an ecology and social order in many ways different from our present earthbound human reality. We will become Martians, not only biologically but also psychologically and socially as well.

Following from the general principle that life and the environment are a dynamic co-evolving reciprocity, the journey into space will transform humanity. We will be empowered to make this evolutionary journey because we will take with us our technology and our scientific understanding of both nature and ourselves. We will be able to create with our technology and science living conditions that support our existence in outer space, but through biotechnology and genetic engineering, we will be able to purposively direct our own future evolution to adapt to the varied and strange conditions we will encounter on our journey. As we explore and colonize the solar system, Dyson argues that we will diversify into many different species in the coming millennium.<sup>95</sup>

Our robots and computers will come with us on this adventure. Often they will probably lead the way. As one important step in the exploration of outer space, our ships and various probes need to become more internally directed and autonomous in their functioning.<sup>96</sup> The continuing development of artificial intelligence and robotic capabilities will support increasing autonomy in our spacecraft. But also, given the steady advance of cyborgization, we can expect that humans and computer-robotic systems will integrate in various ways to meet the challenges of outer space. Part of the diversification of humanity as we move

into outer space will involve various human-technological integrations (syntheses of the born and the made) adapted to different worlds and conditions in space.<sup>97</sup>

As Dyson states, although presently humankind is dealing with the challenge of creating a relatively inexpensive, re-useable rocket launch system, the real challenge in moving out into space is biology rather than engineering.<sup>98</sup> From the above discussion it seems that humanity will probably need to utilize genetic engineering and other biotechnological approaches to meet the challenge of surviving and thriving in outer space. Following from Easterbrook's hypotheses that life moves toward diversification and expansion and that humanity has a special role to play in these processes, one could argue that humanity moving out into space clearly serves the evolution of life. Space exploration and colonization provides the opportunity and stimulation for evolutionary growth. Further, the application of biotechnology to the purposive evolution of both humanity and other earthbound forms of life will play an integral role in evolutionary radiation, allowing for the spreading and diversification of life beyond the confines of the earth.

One of the present limitations of life, according to Easterbrook, is that it is **planet bound**.<sup>99</sup> Although humanity, as indicated from the discussion above on the colonization of Mars, clearly has plans for planting its roots on another terrestrial world, we should also consider how humanity could become a true inhabitant of outer space. Various writers such as Dyson, Prantzos, and Savage have explored how humanity might create spatial environments for living and working off the surfaces of planets, for example on asteroids, comets, or enclosed "membrane bubbles" circling the sun.<sup>100</sup> But the possibilities of biotechnology and cyborgization suggest that humanity might be able to modify their biological form and create artificial suits or envelopes such that we could live and move through space without the need for constructed enclosures. We could truly become beings of space. In Dan Simmons' *Hyperion* series, the Ousters, who are nanotechnologically-modified humans, have developed a real space culture and way of life; they are no longer planet-bound. Having created nanotechnological space skins, they live in and around various mobile constructions in outer space, including technologically designed biospheres, and fly through space on wings powered by the energy of starlight and electromagnetic currents.<sup>101</sup>

Farther out than Mars lie the **gas giants** Jupiter, Saturn, Uranus, and Neptune. These planets could not be colonized with any presently conceivable technology; their surfaces are not solid and their gravity levels are much greater than the earth. Yet all these planets have solid moons and Titan, the giant moon of Saturn, may have atmospheric and surface conditions chemically similar to early earth.<sup>102</sup> Although the temperature on Titan is much colder than even Mars, proposals have been presented for heating up its surface and terraforming it.<sup>103</sup> Arthur C. Clarke, in his novel *2010*, suggests an ingenious way of heating up Europa, whose surface appears to be covered with a thick sheet of ice, making it a likely candidate for evolving life on its surface in the future if the frozen water can be melted. Although Prantzos notes that Clarke's idea is not scientifically feasible, Clarke imagines turning Jupiter into a sun.<sup>104</sup> Even if none of the moons

of the gas giants are ever terraformed, and I think this is highly unlikely, it is important to keep in mind that there are approximately sixty known moons circling these four planets, some of which, like Ganymede and Titan, are larger than the planets Mercury and Pluto.<sup>105</sup> There is plenty of room for colonization and space industry across these numerous moons, and again, with much lower gravitational fields than the earth, the moons are ideal launching points for rockets and spacecraft.

Some of the greatest benefits, though, from moving out to the gas giants and their moons derive from the vast **energy** and **water reserves** in this part of our solar system. As Prantzios notes, there is enough helium-3 in the gas giants for nuclear fusion reaction technology to supply the energy needs of human civilization for perhaps *billions* of years. Further, the greatest fresh water reserves in the solar system are contained in Europa, Callisto, and Ganymede, three of the largest moons of Jupiter.<sup>106</sup> These huge energy and water reserves could become critical, if not essential, resources for human civilization in the next hundred years.

Between Jupiter and Mars is the **asteroid belt** that collectively has a surface area at least as large as the earth. Two additional clusters of asteroids, the Greek and Trojan asteroids, which have a total mass three or four times the main asteroid belt, move along the orbit of Jupiter, one cluster ahead of Jupiter, the other behind it. Aside from providing thousands of individual locations for a multitudinous variety of space settlements, the asteroids are rich in minerals and resources that could easily be mined. They contain water, iron, and other metals such as gold, platinum, and nickel. Tsiolkovsky suggested that asteroids could be guided to earth bringing their resources closer to us.<sup>107</sup> More recently, Berry has argued that a huge industry could develop around the mining of the asteroid belt. We could either extract metals and minerals, if not frozen water and gases, and ship them back to the earth, the moon, and Mars on huge space freighters, or we could, as Tsiolkovsky proposed, move entire asteroids through space back to industrial sites in other parts of the solar system. According to Berry, the amount of wealth that could be generated over the next five centuries through mining the solar system and other technological endeavors in space could be 100 million times the wealth of today.<sup>108</sup> Prantzios estimates that asteroid mining could begin as early as 2050.<sup>109</sup>

As can be seen, there are numerous values associated with the exploration of space. As discussed throughout this chapter, there is the fundamental need in humans for adventure and the fundamental drive in life to spread and differentiate into ecological niches. Although there is an understandable dimension of fear and doubt associated with space exploration, humans are inherently curious and need to explore. Exploration and adventure foster innovation and creativity and invariably generate increased maturity, wisdom, and perspective. In the past, adventuring into the unknown has had deep and powerful effects on the human mind and human civilization. It is our archaic and pervasive dualistic thinking, in this case the separation of "the heavens" and the earth that gets in the way of seeing the human values of space travel. Yet recent events are teaching us that the more we know about space, the

more we know about the earth; conversely, the more we know about the earth, the more we know about space. All told, what seems increasingly clear is that the exploration and colonization of space, which will begin with humankind spreading throughout our solar system, will transform, empower, and enrich humanity more so than any previous event in the history of the species.

Necessity is the mother of invention, and in spite of what philosophical, psychological, and evolutionary arguments might be proposed supporting space travel, it will probably be practical and economic factors that will light the candle under our backside and get us off the earth. B. Alexander Howerton states in his article “Why Bother About Space?” that the two main arguments for space travel are that it is human destiny and that it produces many beneficial spin-off technologies.<sup>110</sup> Howerton also identifies an economic argument for space travel. He states that the best thing a government can do is to create conditions to support the enhancement of human life and the best way to do this is to support an ever-growing economy. Yet the earth is a closed system, and in order for the economy to grow we must expand our resource base into space. As we have seen the resource base in the solar system, understandably so, vastly exceeds the resource base of the earth. Howerton believes that a serious effort into space travel will create an explosion of new jobs and industries that will dwarf any comparable development in the past. Further, in agreement with arguments presented by Zey and the Mars Society Declaration, space travel will also unlock a “tidal wave” of human creativity and human initiative.

From an evolutionary perspective, growth is necessary for survival, but we should also consider the related point that our continued economic and social growth on the earth is going to strongly motivate humanity to reach out into space to support our developing civilization. Our need for increasing amounts of energy, if nothing else, will provide the impetus to establish energy generating installations in outer space. As noted in the last chapter, most of the energy produced by the sun is not utilized; further its total energy output is billions of times the world energy consumption level. Various technical proposals have been outlined for establishing huge solar energy panels in space and on the moon to more extensively collect the energy output of the sun.<sup>111</sup> I already noted above that the gas giants could supply the necessary chemical resources for nuclear fusion energy production extending far into the future. Even if the idea that the earth possesses limited resources is, in some ways, conceptually flawed, it makes perfect sense to expand our resource base. Further, the development of space technologies to tap into the vast energy sources of our solar system is a prime example of how human inventiveness can expand the available resources for human society.

Aside from providing the necessary energy and natural resources for our developing civilization on the earth, there is a positive feedback loop that will emerge as we move out into space and increasingly utilize the resources of the solar system. As Prantzos repeatedly points out, exploring and colonizing outer space will involve energy and material demands far beyond our present economic and industrial output.<sup>112</sup> In effect, we can only extend our reach outwards if we keep increasing our energy consumption and material wealth. In

earlier chapters I described the Dyson-Kardashev three-stage model of civilization, moving from planetary to stellar to galactic levels of development.<sup>113</sup> Each stage would involve immense leaps in energy production and consumption. As we expand through the solar system, we will create an industrial and energy base commensurate with the dimensions of our civilization. The more we expand, the more energy we will need to use, and consequently, the more energy resources we will have to utilize. For Prantzos, the basic question or challenge is how a technological civilization such as ours can best exploit the material and energy resources in a stellar system to maximize population, consumption, and durability.<sup>114</sup>

Berry believes that the wealth generated through exploring the solar system, coupled with the opening up of new habitats for human settlement, would instigate a huge **population explosion** over the next few centuries. Berry thinks that we would be able to support, much more comfortably than today, a human population exceeding a trillion people. Savage provides a similar population estimate within the next few centuries.<sup>115</sup> Our present world population is approximately 6 billion. If this number seems highly excessive and undesirable, if not insane, Berry points out that each time humanity has taken a significant step forward in civilization and associated technology, the population of humans has multiplied ten-fold or more.<sup>116</sup> The colonization of the solar system would constitute a huge advance in human society; in fact, as I have stated it would be the most monumental step forward in the history of humanity. Berry believes, as well as others, such as Stock and Zey, that human wealth and the quality of life are going to drastically increase in the future.<sup>117</sup> With the energy and material resources available through colonizing the solar system, humanity will be able to support and, in fact, will probably require such a population.

One could ask, “Where would a trillion people live in our solar system?” First, it will probably not be the case that the bulk of this population will migrate from earth. Earth will never get that crowded. What will probably happen is that settlements and colonies such as those on the moon and Mars will begin with rather small populations, but over succeeding generations these populations will grow on their own. As we extend outward through the solar system, there are over sixty moons with solid surfaces orbiting the gas giants, as well as thousands of asteroids, many of which will probably be inhabited in the centuries ahead. Savage suggests in fact that the bulk of the trillion people in the 23<sup>rd</sup> Century could live in and around the asteroid belt.<sup>118</sup> But surprisingly, even after we have settled out to the perimeter of the most distant planets, including Neptune and Pluto, we would have barely scratched the surface of habitable area in the solar system.

Surrounding the orbit of Pluto and extending for several billion miles further into space is the **Kuiper Belt**, which according to present estimates contains ten billion comets with 1000 times the collective surface area of the earth.<sup>119</sup> Although our popular image of comets is of fiery objects streaking across the night sky, comets are actually balls of ice and stellar dust, and according to Dyson, would make ideal locations for innumerable smaller settlements. For one thing, ice is better than rock. There is a fresh supply of

water immediately available and the comets in the Kuiper Belt are close enough together to make comet-hopping a relatively easy and quick type of trip.<sup>120</sup> The gravitational pull of individual comets is so small that it would involve minimal amounts of thrust and energy consumption to move about between them.

Yet further still, to get a good grasp of the magnitude of our home within the cosmos, beyond the Kuiper Belt is the immense spherical Oort cloud, a thousand times the radius of the Kuiper Belt and holding roughly 10 trillion comets, which is between 50 and 100 times the number of stars in our entire galaxy. The Oort cloud will probably be the stepping-stone to the stars.<sup>121</sup>

As can be seen, there is plenty of room and surface area within our solar system to hold a stellar civilization that vastly exceeds the population of our present local nest and would supply the necessary resources and energy needs of such a civilization. Dyson projects that within a thousand years we will have settled out to the Kuiper Belt and Oort cloud, and in adapting to the varied and extreme conditions throughout our solar system, humans will have diversified into a variety of different species.<sup>122</sup>

In colonizing the solar system and evolving into a stellar civilization, humanity could eventually alter, in significant ways, the overall structure and dynamics of the entire system. I have already mentioned the idea of building large numbers of floating bubbles or orbiting structures that would provide homes for humans adapted to living in outer space. We could create a new belt of thousands if not millions of technologically constructed astral objects around the sun.<sup>123</sup> On an even bigger scale, we could build a sphere around the sun. The idea of constructing a habitable shell that would surround the sun was first proposed by Tsiolkovsky and Stapledon.<sup>124</sup> The more contemporary version of this idea comes from Freeman Dyson. The **Dyson Sphere** would have 600 million times the surface area of the earth (plenty of room there for a 100 trillion inhabitants) and, per Dyson's proposal, the material needed for its construction would involve dismantling the planet Jupiter. The Dyson Sphere would not be a rigid construction but would consist of rings encircling the sun. With the appropriate system of immense solar panels, the sphere would be able to capture a much higher percentage of the total energy emanating from the sun.<sup>125</sup>

The Dyson Sphere has inspired science fiction writers with their own speculative variations on the idea. The most famous example is Larry Niven's *Ringworld*. Niven imagined a single huge ring surrounding a sun, created by an enigmatic alien intelligence in a distant solar system and then left abandoned to be discovered by the space traveling protagonists of the story. The ring was 2 million kilometers wide with a surface area 6 million times that of earth. The inner surface of the ring was covered with land and vegetation and possessed an enclosed atmosphere. Panels floating above the inner surface provided for the alternation of day and night.<sup>126</sup> Dan Simmons created a different version of Dyson's idea in the final novel in his *Hyperion* series, *The Rise of Endymion*. Simmons envisions a spherical "**Startree**" surrounding a sun with a contained atmosphere on its inner surface. The most interesting feature of the Startree is that it is organic and alive, a vast branching network of tree-like structures entwined together with immense leaves for gathering solar energy facing the

encircled star. The Startree has large openings throughout its surface for the transport of comets into the spherical enclosure, which are brought inward toward the sun and melted for water to hydrate the structure. The construction of the Startree is a collaborative effort of various intelligent life forms including the Ousters, the space adapted descendents of earthly humans.<sup>127</sup>

As discussed earlier, in venturing into outer space, biotechnology and the purposive evolution of humanity and other forms of life will play a significant role in adapting to the varied conditions encountered in space. Simmons' Startree is space biotechnology on a grand scale. It is literally grown in space, though also supported and maintained by a variety of constructed physical technologies and tended by a number of space adapted intelligent life forms. It is a gargantuan Biosphere II floating in space. Various space futurists, most notably Marshall Savage, have envisioned ways to "green" outer space,<sup>128</sup> and Simmons' Startree is a superb illustration of this general idea. To recall, contrary to the Newtonian view that outer space is a cold, empty vacuum inhospitable to life, Smolin has argued that we live in a universe that supports the presence of life.<sup>129</sup> In line with Easterbrook's view that life is driven to spread outward beyond the bounds of the earth, we can imagine that in the future life will be adapted in innumerable ways to flourish not only on different planets but in space itself. Humanity will green the solar system and turn the whole system into a living ecosystem.

The ultimate source of all life on our planet is the sun. Inevitably the sun will exhaust its available hydrogen for nuclear fusion - by current estimates in approximately 6 billion years - and transform into a red giant, literally cooking the earth in the process. Then it will shrink to a white dwarf.<sup>130</sup> As human civilization expands its technological powers and energy capacities, it is conceivable that we will be able to control and modify the future history of the sun. Two possibilities are suggested by Prantzos. Using solar engineering, humans could manipulate the sun into burning more of its total hydrogen reserves far beyond what it would presently do if not manipulated by technological forces. Through this process we could extend the life span of the sun to 20 to 30 billion years. Or we could shrink the sun to approximately one-half its size causing it to burn its hydrogen much slower and extend its life span to 100 billion years. Either way, humanity should be able to "**master the sun**" and orchestrate, on a holistic scale, the future evolution of our solar system.<sup>131</sup>

But the sun will eventually burn out and if humans are still living on the earth billions of years in the future then we could conceivably move the earth to a new younger sun somewhere else in our galaxy. Suggesting the use of an array of rockets, while maintaining the rotation of the earth, technical proposals have been presented for accomplishing this mind-boggling feat.<sup>132</sup> Another alternative would be to move a new sun into our system or further still, create a new sun, perhaps along the lines of Clarke's vision of turning Jupiter into a sun. Jupiter however does not possess sufficient mass to collapse into a star, according to Prantzos, so material would have to be brought into the solar system to create the needed mass of gas to instigate the birth of a new star.

As can be seen from the examples above, the colonization and **technologization of the solar system** could involve engineering projects that

would alter the conditions of planets and even the sun; the movement of comets, asteroids, and even planets, and in general, the rearrangement of the total configuration of innumerable objects in the system; the adding of new structures, including living systems, both large and small; and the dismantling or creating of massive objects, including planets and stars. Technology and life will be infused into the total expanse of the solar system and the system will be redesigned to accommodate the presence of humanity and life throughout.

Such visions of colonizing and redesigning the solar system may seem utterly fantastic and unrealistic to us today. Many people are worried about finding enough energy and resources for our present world population while space futurists are discussing potential social-technological networks spread across a myriad of worlds, with energy requirements millions and billions of times our present modern world. With such ongoing ecological and environmental concerns, contemporary public attitude toward space is ambivalent at best. Yet especially over the last few decades, people have grown more accustomed to the visions and ideas of space travel via the popularization of science fiction movies and TV shows.<sup>133</sup> Future generations will find the possibilities of space travel, colonization, and astral engineering increasingly plausible.

Space travel is, in fact, a journey of the mind. Beyond the technological and economic challenges of creating viable spacecraft, and even the biological challenges of adapting to space, the real challenge in moving into space is psychological. Although five hundred years ago Copernicus demonstrated that we live on a sphere circling the sun, we have probably not grasped the fact that our home is the heavens and when we are looking up into the night sky we are looking out into our own neighborhood. We are mentally earthbound; we do not really feel that we live in space. The adventure into space is a mental journey and will entail nothing short of a fundamental psychological transformation within humanity. In the final analysis, though, as the adventure does move forward, and there are many individuals, such as Marshall Savage and the Living Universe Foundation and Robert Zubrin and the Mars Society, who are ready to begin the great journey, humanity's self-identity will progressively change from an earthly concept to a cosmic one and the visions of humanity traveling through the solar system and beyond will not seem so farfetched.

Although in this section I have emphasized the various technological, scientific, and economic issues associated with exploring and colonizing the solar system, the social and psychological ramifications of space are equally significant. Not only must the human mind and human society prepare itself for this great adventure, but in embarking on the journey, we will be entering into a new monumental phase in our mental, social, and ultimately spiritual growth. New human cultures and ways of life will probably emerge as we colonize different worlds. Mars, for example, as Robinson considers, will probably evolve its own unique society, culture, and values.<sup>134</sup> With new and different environments, along with various biological changes and differentiations, the human sense of self will also diversify and transform. The cosmic sense of humanity will not be a singular identity, but a variety of different social - psychological realities networked together through communication and

transportation lines. Simmons, in the *Hyperion* series, examines in great detail the different human cultures that could emerge on a host of varied worlds across outer space.<sup>135</sup> At first, there will undoubtedly be great anxiety, shock, and turmoil over living on alien worlds, but this is the necessary element of chaos preceding evolutionary and creative growth. New fashions, languages, beliefs and values will develop on different worlds, and inevitably these space cultures and people will want to assert their uniqueness and self-determination relative to the mother earth society.<sup>136</sup> At some point Mars or the Moon will probably wish to declare its independence, as the New World declared its independence from the nations that initially explored and settled it.

Olaf Stapledon, influenced by Oswald Spengler's cyclical theory of human history, considered in his novel, *Last and First Men*, the rise and fall of human civilization over the next 200 million years as humanity struggles to maintain its life and vitality throughout the solar system.<sup>137</sup> The colonization of the solar system may bring with it challenges and problems that we will not be able to handle. Ultimately, in Stapledon's *Last and First Men*, humanity perishes in the far distant future without ever participating in the grand cosmic adventure of mind and spirit he describes in his later novel, *Star Maker*. Many science fiction writers, as well as other modern thinkers and commentators, have considered the possibility that, due to disasters and insoluble roadblocks here on earth, humanity may never get into outer space at all.<sup>138</sup> Since the future is possibilities rather than certainties, there are indeed no guarantees that we will make the journey into the cosmos. As Michael Zey argues, going into space is a question of willpower. We have the power. Can we find the will?<sup>139</sup> Can we overcome our own inertia and our own inner conflicts and fears and prevail? Can we light the proverbial candle in the darkness and open our minds to the greatest adventure in the history of our species? And once we have landed and planted our roots, will we sink back into our often self-destructive ways, or can we keep the fires burning and transform and truly become beings of space?

## **Life and Intelligence in the Universe**

***“Yet across the gulf of space, minds that are to our minds as ours are to those beasts that perish, intellects vast and cool and unsympathetic, regarded this earth with envious eyes, and slowly and surely drew their plans against us.”***

***H. G. Wells***

***“Two possibilities exist: either we are alone in the universe or we are not. Both are equally terrifying.”***

***Arthur C. Clarke***

One event that would transform our self-identity from earthly to cosmic would be contact with alien intelligence. Humanity will never be the same after we meet and communicate with alien beings. We will no longer occupy our privileged sense of superiority or uniqueness within the universe. Our species will become one of many inhabitants of the cosmos and we will no longer be simply creatures of the earth. We will become part of something bigger.<sup>140</sup>

Yet we are as fearful of aliens as we are of the vast dark emptiness of space. To a great degree, it may be the apprehension over encountering aliens that creates the fear of outer space. It is “what that goes bump in the night” and the unknown that makes outer space terrifying. Having been raised on a steady dose of science fiction movies that depict aliens as monstrous and sinister beings, we have a hard time imagining the potential positive benefits of alien contact. H.G. Wells, in *The War of the Worlds*, described the Martians as highly intelligent beings who wished to conquer and subdue the earth without any regard for human life. More recently, the technologically advanced aliens of *Independence Day*, swiftly, mercilessly, destroy countless human cities around the world. For sheer terror, perhaps the quintessential space monsters were the creatures of the *Alien* series, which used human bodies as hosts for their own reproduction. And there are the Borg of *Star Trek*, a cyborg synthesis of our fears of aliens and of machines, whose intention is to assimilate us into their depersonalized collective society, destroy our individuality, and rob us of our souls. We have been raised to believe that aliens care little about the happiness or well being of humans.

Since outer space is like a blank screen on which we can project our deepest thoughts and feelings about ourselves, our different images of aliens could also reflect different aspects of how we see our own psyche and character. Why is it that aliens are so frequently warlike? Why are they often so much like the monsters of the id? Frequently they represent the worst in us. They are the devils of the modern soul.

Equally, our images of aliens could reflect our underlying vision of the cosmos. Do we believe that we live in a nasty brutish universe populated by demons, akin to depictions of the seas in 16<sup>th</sup> Century maps, or do we believe we live in a universe filled with love, benevolence, wonder, and angels? Do we see the universe as a cold and impersonal reality or do we see it as magical and beautiful? Into the darkness we project our hopes and fears and structure its content in terms of our philosophical, psychological, and spiritual beliefs.

The fear we have of aliens conquering and destroying us perhaps simply reflects a deep apprehension over the possibility of meeting creatures from a different world. The word for this fear is “**xenophobia**”. Nothing would seem so strange and unnerving as to come face to face with an intelligent mind from another planet or star system. The psychological and cultural shock of an alien encounter is what I think we fear most of all, rather than whether they will destroy us with laser guns or monstrous poisonous fangs. It is the possibility or probability of extreme difference that frightens us. The alien is the ultimate “otherness”.

Still not everyone fears the possibility of alien contact. In fact, a hope of many people is that aliens will in some way save us from ourselves. They will bring the light of the heavens, the wisdom of superior intellect, and the maturity of their more advanced civilization and help us to avoid our own self-destructive tendencies. They will bring us out of the “dark ages” of our primitive world into the enlightened realm of their stellar and cosmic perspective and way of life.

Alternatively, Zey though states that belief in alien intelligence puts us in an inferior position. To think that they possess the wisdom and know-how to save us reflects a negative view of our own self-image. Zey also thinks that believing in aliens reflects our own fear of our growing powers. With all the potential developments in technology, from computers and robots to genetic engineering and space travel, someone or something better come along and help us, for if left to ourselves, we will assuredly not know how to handle all of these new powers.<sup>141</sup>

Intelligent alien beings may not be as different from us as we might suppose. They may neither be inscrutable demons from the abyss nor angelic wizards from above. They may be like us, somewhere in between, struggling in their own evolution as we are in ours. Further, although humans have clearly anthropomorphized aliens, often imagining them as variations on the basic humanoid shape, it may be that there are certain structural properties that all intelligent life forms would possess. Kaku suggests that aliens would have some kind of eyes, or at the very least sensory organs, and some type of appendages with manipulators or attached hands. He also thinks that they would possess some kind of language for communication.<sup>142</sup> Even assuming such rudimentary dimensions of commonality, as can be exemplified by the incredible variety of aliens imagined by science fiction writers,<sup>143</sup> there is still a lot of room for all kinds of biological forms that could possess intelligence, consciousness, social order, and technology.<sup>144</sup> Perhaps the deepest commonalities will involve psychology rather than specifics of biology.

NASA’s Astrobiology and Origins programs are dedicated to understanding the possibilities of life in the cosmos. Specifically, scientists in these programs are concerned about “the origin, evolution, distribution, and density of life in the universe”. How does life fit into the universe? They are involved in the search for life, biospheres, and potentially habitable planets.<sup>145</sup> In Chapter Three, I discussed the cosmic significance of life and in this chapter I examine the cosmic significance of intelligence. As I explained, many scientists believe that life is a natural consequence of the basic evolutionary laws of the universe and consequently should be ubiquitous throughout the cosmos.<sup>146</sup> Life fits into the grand scheme of things. Intelligence, which as far as we know, initially requires the emergence of life, may also be a natural consequence of the evolution of complexity and computing power in open systems throughout the cosmos.<sup>147</sup> Perhaps intelligence will play a critical role in the ultimate fate of the universe, a hypothesis I examine in the next section of this chapter.

Throughout history the possibility of intelligent alien beings has been debated. Surprisingly, as indicated in early-recorded history, many people did believe in alien life in the heavens above. Plato, Aristotle, and St. Augustine

though argued against the possibility and the idea fell out of favor for many centuries. Yet with the supposed “discovery” of canals on Mars and the increasing popularity of science fiction, belief in aliens has become prevalent again.<sup>148</sup>

There are various arguments over the probability of alien intelligent life in the universe.<sup>149</sup> As noted above, if evolution and the progressive emergence of increasing complexity is a basic fact across the universe, then the probability is extremely high that there are countless intelligent life forms within our galaxy alone. The scientist, Frank Drake, over 40 years ago formulated the famous “**Drake Equation**” as a mathematical method for estimating the number of advanced civilizations in the Milky Way.<sup>150</sup> Beginning from the hundreds of billions of stars in the Milky Way and based on a variety of estimates regarding the percentage of suns with planets, the percentage of planets suitable for life, and the percentage of living planets where intelligence could have evolved, the Drake equation predicts that there should be around ten thousand technologically advanced civilizations in the Milky Way.<sup>151</sup> Carl Sagan offers an even higher estimate.<sup>152</sup> Adams and Laughlin, hypothesizing that there should be around 10 billion suitable star systems in the Milky Way for life to evolve and that it should take a considerable length of time for an advanced civilization to arise in any of these star systems, estimate that there should be around 1000 advanced civilizations in the Milky Way, spread on the average three thousand light years apart.<sup>153</sup>

Closer to home, Mars is a possible candidate for at least some primitive type of life existing on its surface or below the surface. Dyson suggests the possibility of “warm blooded plants” on Mars. In fact, in the last decade, possible evidence of life on Mars was discovered in meteorites from space, though the evidence has turned out to be highly questionable.<sup>154</sup> Mars though may hold a deeper surprise and revelation. The “**Face of Mars**” photographed by satellite exploration of the surface of Mars, might indicate some ancient Martian civilization that may have seeded the earth millions of years ago.<sup>155</sup> As Dyson states, “Whatever creatures we may find on Mars will probably be either our ancestors or our cousins.” According to Dyson, the other likely candidate for life in the solar system is Europa, one of the moons of Jupiter. Europa is covered with a thick sheet of ice, and possibly under the frozen surface there lies a vast ocean of relatively warm and fluid water where life could have evolved.<sup>156</sup>

Discounting for the moment the enigmatic “Face of Mars”, the belief that life might exist on either Mars or Europa is based upon presumed similarities between these worlds and those conditions on earth necessary for life to exist here. Yet life could take a very different chemical form, for example, being based on the element silicon instead of carbon as it is here on earth. Both carbon and silicon allow for a sufficient level of chemical complexity to support the metabolic and reproductive complexity of life, but might there not be other types of “chemistry” that would support the complexities of life. As discussed in Chapter Three, although it is difficult to provide a set of clear defining criteria of life, the abstract descriptions of life offered by Murray Gell-Mann, Smolin, and others entail that life involves a high level of inner complexity, a capacity for acquiring,

storing, and using information, some type of metabolism, and a capacity to self-organize and evolve. What range of chemical and environmental conditions would support the emergence of these abstract properties?

If we allow for a wide range of chemical and environmental conditions which could lead to life, and following Drake's equation, we assume that intelligence and civilization should emerge, given sufficient time, in at least some of these extra-terrestrial ecosystems, then why haven't we been openly contacted by aliens from another world? As Enrico Fermi asked, "Where is everybody?" The **Fermi Paradox** is: If life is so probable in the universe, it is extremely strange and counter-intuitive that there is not one iota of solid evidence for life or intelligence anywhere but on the earth.<sup>157</sup> There are no clearly documented visitations from other worlds, no identifiable signals coming from anywhere in space, no astronomical indications of solar systems or stars being altered by the presence of intelligence, and no pieces of starships or alien artifacts to be found anywhere on the earth. Even if we assume that it would take centuries, millennia, or even millions of years for alien beings to cross the vast distances of space, the Milky Way is sufficiently old (10 to 12 billion years) to have allowed for some space faring alien civilization to have evolved and spread across our galaxy. At the very minimum their signals would have reached us. Yet, "the sky is thunderous in its silence."<sup>158</sup>

Perhaps the aliens are waiting to see if we can, of our own power and accord, leave our earthly nest. Maybe they are watching to see if we can work out our internal problems and difficulties before they will even approach us. Or, as in Arthur C. Clarke's science fiction novel *Rendezvous with Rama*, highly advanced aliens may simply not care about us.<sup>159</sup> In Stephen Baxter's *Vacuum Diagrams*, the technologically far superior Xeelee do not wish to deal with humans at all, though humans keep attempting to interfere in Xeelee affairs until the Xeelee, to get us out of their hair, put all of our species into a hyper-dimensional sphere with no way out.<sup>160</sup> Another possibility is that space civilizations, as in *Star Trek*, follow some type of "Prime Directive" not to interfere in the evolution of life on a planet. Perhaps in the next century, as we journey into space, we will meet someone or something waiting to welcome us into the galactic community.

Still, even if all these possibilities are allowed for, Prantzos notes that it is extremely odd that not even one alien life form has contacted us.<sup>161</sup> Further, as Savage argues, it would be extremely difficult for aliens to hide the presence of a highly advanced technological civilization. Human civilization, barely three hundred years into industry and modern technology, has been broadcasting its presence into space at the speed of light through radio and TV for the last 70 years and anyone possessing equal technological abilities within this perimeter would have noticed us. If the sky is full of alien civilizations, we should be inundated with signals from these worlds.<sup>162</sup>

Because of such considerations, among others, there are some notable futurists and space enthusiasts who believe we are alone in the universe. Tipler, Savage, and Zey all support this view.<sup>163</sup> All three also support some version of the anthropic principle where the existence of the universe that we live in is

conditional upon our existence.<sup>164</sup> Further, they all argue that the colonization of outer space is the destiny of humans, although at least Zey and Savage believe that this cosmic destiny is not absolute. Zey and Savage acknowledge that whether we fulfill this destiny or not depends upon human choice. In general Tipler, Savage, and Zey take a human centered perspective on the universe; humans are unique in the universe and have a special role to fulfill. We are here to spread life and intelligence through the cosmos. Zey and Tipler, at least, believe that humans or the descendants of humans will determine the ultimate fate of the cosmos.

Even if we believe that it is the destiny of humans to explore and colonize outer space and even if we believe that human intelligence has some significant role to play in the future evolution and even fate of the cosmos, it seems to me highly improbable that the earth is the only place where there is life in the universe or the only place where there is intelligence and some form of technological civilization. As Prantzos suggests perhaps we are the first technologically advanced civilization to emerge in our part of the universe.<sup>165</sup> Or there may be some interesting and surprising twist that will answer the Fermi Paradox. Also, an advanced civilization on another world may not possess a visible technology in the same sense as we do. If the principles of self-organization and evolution hold true across the cosmos, then increasing chemical complexity, life, intelligence, and evolvability should be manifested throughout the universe.

There are many who do not believe that we are alone. Beginning with the efforts of Frank Drake in the 1960's to detect radio signals within outer space, humans have been exploring the heavens for signs of intelligent life. The **S.E.T.I.** Project is actively searching the skies for signals that indicate intelligence on other worlds.<sup>166</sup> So far their efforts have been unsuccessful. We have sent probes out into deep space beyond our solar system, containing information about our location and our species, in hopes that intelligent life from some other world might find a probe and attempt to establish contact with us. We have sent radio signals directed at clusters of stars outside of the Milky Way.<sup>167</sup>

The hope of many individuals is that contact with aliens will have numerous positive effects on our civilization and species.<sup>168</sup> Although many of our popular images of alien intelligence and life are negative and often nightmarish, there is the equal possibility that alien contact could have a tremendous growth promoting effect upon us. The aliens of *Close Encounters of the Third Kind* came in peace to the earth with the hope of establishing a constructive and beneficial relationship. In the movie *Star Trek: First Contact*, our initial contact with an intelligent life form is a great impetus for our further evolution and development as a society. After fighting a Third World War and destroying a great deal of our present civilization, we make contact with the peaceful and rational Vulcans, who literally bring us out of our second "Dark Ages". In Arthur C. Clarke's Space Odyssey saga, brought to the screen in two movies, *2001* and *2010*, alien intelligence is actually the instigating force behind our rise to conscious sentience.<sup>169</sup>

The interchange that could develop between us and other intelligent forms would be an incredible learning experience at the scientific, technological, social, psychological, and even spiritual levels. Practical technological knowledge could be gained; major questions about the universe could be answered; our own view of ourselves could be enriched through comparison with alien cultures and alien minds; and we may be brought in to participate in grand galactic and cosmic projects. Undoubtedly, as noted above, there will be an element of psychological shock associated with alien contact, and probably an initial period of significant disruption and turmoil, but in the long run we could benefit in ways beyond our present imagination.<sup>170</sup> It is clear that we should be cautious and thoughtful in how we approach contact and communication with alien intelligence, but we should also see the innumerable potential opportunities of alien contact.

In thinking about intelligent aliens we should see the basic fact that regardless of their appearance, psychology, or culture, we are all **children of the universe**. The mysteries of space and time are fundamental realities for all of us. We are on a quest to find answers, to make progress in our lives, and explore the universe. Wouldn't aliens have similar concerns? We are all creatures of evolution, having struggled in one form or another, to move forward from simpler and more primitive stages in our development. Just as humanity has struggled throughout history to find ways to cooperate and create a better world, the next challenge will be before us to find avenues for mutual understanding and reciprocal benefit. There are scientists who argue that we should be preparing for first contact, to maximize the chances of mutual understanding and a positive beginning.<sup>171</sup> If the basic principles of ecological cooperation and reciprocity hold throughout the universe, then we could argue that other intelligent life forms would have cooperative goals within their "social and ethical philosophy". In fact, the more advanced they may be, the more these ideals may be developed in them. In the long run, it may be a basic fact of all nature that the road to survival and growth is necessarily collaboration and cooperation. Nothing in the universe stands alone and nothing in the universe can continue to thrive at the expense of others without giving back in return. The real issue to come may be whether humans have matured far enough to demonstrate cooperativeness toward alien life forms; presently, we are still in many ways a competitive and destructive species.

Initial contact with alien intelligence is just the beginning, a doorway into the future. If a cooperative and constructive line of communication can be established, human society will undoubtedly move into a new phase of evolution. We will become part of something bigger than ourselves and we will progressively integrate with each other. The interaction and integration of humanity and other intelligent life forms will occur at all levels of reality. There will be cultural, scientific, and psychological exchange. Although we presently have great difficulty with diversity even among ourselves, aliens would bring a whole new level of diversity into the picture. If diversity theory is correct in arguing that diversity brings strength and flexibility to an organization, then, in the long run, after the initial shock of the different, we should benefit greatly from interaction with aliens. What special gifts and talents do we have to offer to aliens? What

special gifts and talents will they possess to enrich our lives? We could quite conceivably find ways to form biological relationships and even romantic ones. Different intelligent life forms will undoubtedly have distinctive advantages for different types of challenges and environments. The possibilities of interaction and communion through information technology and other modes of communication and mental contact will give us enhanced levels of intimacy with alien minds. Various science fiction writers such as Vinge, Stapledon, Simmons, and LeGuin have considered all these possibilities and many more.

The journey into the future could very well turn out to be an adventure we will not go on alone. The exploration and colonization of space could become a cooperative venture. It is quite possible that collectively we will be participants in the evolution of a cosmic intelligence and cosmic consciousness and venture on a vast and ever expansive journey in the exploration of the universe, existence, and the future.<sup>172</sup>

## **Exploring and Colonizing the Galaxy, the Universe, and Beyond**

***“...as the future unfolds,  
more of the cosmos comes into view.”***

***Fred Adams and Greg Laughlin***

***“Our choice is limited: either the whole Universe or nothing.”***

***H. G. Wells***

Whether we go it alone or go with the Vulcans, humanity is going to reach for the stars. In this section on exploring and colonizing the cosmos I describe some truly mind-boggling awe-inspiring visions of the future. These futuristic images synthesize space technology, information technology, evolutionary theory, cosmology, and nanotechnology, among other scientific areas considered in the last chapters. These visions, which reach out into the vast reaches of space in the vast expanses of time, also have a narrative and dramatic quality, offering different stories of the life of the cosmos and the life of humanity within it. They are often spiritual in their intent and overtones and offer a new “mythos” for our species as we set sail on the journey into space.

Savage states that only when we have colonized the solar system and achieved a stellar level of civilization (Level II in the Dyson-Kardashev model), will humanity be ready to explore the stars.<sup>173</sup> The energy requirements for stellar travel are immense compared to our present level of industry and technology and the distances are several orders of magnitude above journeys within our local

solar system. Savage believes that we won't be ready to journey to the stars till around 2500. Still, at the very least, probes may be launched to explore the stars by the middle of the 21<sup>st</sup> Century and there are other estimates that we might be able to travel to the stars sooner than 2500.<sup>174</sup>

Relative to the planets, the stars are very far away. Pluto is approximately 3.5 billion miles from the sun. The Kuiper Belt extends out around 10 billion miles from the sun and the Oort cloud may reach 10 trillion miles into space.<sup>175</sup> Light travels approximately 6 trillion miles in a year or almost 2000 times the distance from the sun to Pluto. The closest star system to us is the Alpha Centauri A and B – Proxima Centauri triad, the most probable target for a first star flight. The Centauri system is approximately 4.3 light years or 26 trillion miles away. Expanding our perspective further, within a perimeter of 12 light years from the earth are 26 stars and there are around 190 stars within 25 light years and 1500 stars within 50 light years or 300 trillion miles. Eighty per cent of the stars in our immediate vicinity are red dwarfs, but there are a number of stars, including Alpha Centauri A and B, which are main sequence stars similar to our sun. Moving up one more level in scale, the earth is approximately 27,000 light years from the center of the Milky Way, which stretches 100,000 light years across and holds 200 to 400 billion stars.<sup>176</sup> Traversing such distances will require a different type of spacecraft than what we can presently build, or even what we may develop in exploring the solar system. As Prantzos states, conventional chemical rockets will never take us to the stars.<sup>177</sup>

In spite of how daunting such distances might appear, there have been a number of design proposals for starships that could potentially get us to the stars in a reasonable length of time. In the late 1960's, the **Orion Project** study outlined plans for a nuclear fusion ship that would accelerate through pulsed nuclear propulsion and according to Dyson could reach 3 per cent of the speed of light and get us to the Alpha Centauri system in around 100 years. Dyson projected that the technology necessary for this type of ship could exist within a couple hundred years.<sup>178</sup> In the 1970's the British Interplanetary Society initiated the **Daedalus Project** study. The starship described in this study would also be powered through nuclear fusion, but would operate by igniting mini nuclear explosions. The Daedalus ship would be assembled in space and require a computerized autonomous guidance and control system. According to the study, this ship could accelerate to 12 per cent the speed of light, considerably shortening the time needed to travel to the nearest stars.<sup>179</sup> A totally different type of design, first proposed by Tsiolkovsky, is the **solar sail** spaceship. As originally conceived, a solar sail ship would be powered by the radiating energy of the sun, propelled on the ocean of light. As proposed more recently by Robert Forward, huge lasers from within our solar system could power solar sail ships. These newer models, with sails stretching 30 to 100 kilometers across, could achieve speeds close to 20 per cent the speed of light.<sup>180</sup>

All these designs far exceed in expense the present economic capabilities of human society, but to recall, projections of stellar civilizations suggest energy and financial capacities millions of times our present levels. Still, even reaching the closest star system would require a trip of over twenty years. There are

though more powerful ships that conceivably could be constructed. Discussed by Zey, Savage, and Prantzos, among others, a star ship propelled by anti-matter might be able to reach half the speed of light. Based upon Einstein's famous formula that energy is equal to mass times the speed of light squared, one kilogram of matter if totally converted in energy would yield 90 million billion joules of energy. When matter and anti-matter collide, all the material in the reaction is converted into energy with 100 per cent efficiency. Hence, a star ship powered by a matter anti-matter reaction would be able to release colossal amounts of energy and thrust and would not need to be as big as fusion ships. Anti-matter has to be manufactured though, and the cost by present standards would be very high. Savage who has provided some initial calculations and estimates on anti-matter production and star ships, figures that each star launch propelled by an **anti-matter engine** would cost 15 thousand trillion dollars. Yet, for a stellar civilization of the 26<sup>th</sup> Century, this cost would equal only .0002 per cent of the annual gross solar product.<sup>181</sup>

Even more potentially powerful is the **Ramjet** design. This ship would collect and use the hydrogen in space as its fuel. In principle this ship could progressively reach velocities almost equal to the speed of light. Because of the strong relativity effects as an object gets close to the speed of light, inhabitants on the ship could travel the extent of the known universe (approximately 15 billion light years) within 40 subjective or ship years. The problem with this design at present is that as the ship accelerates it is increasingly impacted by proportionately faster approaching interstellar dust, as well as cosmic ray bombardment, which would wear down the hull of the ship and kill its human occupants. Protecting a star ship's hull integrity will be a problem for any ship moving at very high speeds through space and clearly some type of advanced protective shield needs to be developed for journeys to the stars.<sup>182</sup>

Noticeable relativity effects occur for any ship that is moving at some significant percentage of the speed of light, so trips to the stars will not be as long to star travelers as the time measured for the trip back at its launch point. Yet, as can be easily deduced, most stars would take longer to reach than the average life expectancy of present day humans. In the coming centuries, the maximum life span of humans could be extended dramatically to hundreds, if not thousands of years, and it may be that such long-lived humans will be the appropriate voyagers for such trips to the stars. There are though also proposals for hibernation and suspended animation systems that would make journeys to the stars subjectively much shorter and probably psychologically much more tolerable.<sup>183</sup>

Another way to get to the stars is in a **space ark**. In the 1920's both Tsiolkovsky and John Desmond Bernal suggested that humans could build huge shell-like structures that would house thousands of people along with technologically maintained living ecosystems and journey to the stars in these self-contained voyaging worlds. Generations of humans could live out their lives in these space arks as the vast distances between stars were crossed.<sup>184</sup> In the following decades science fiction writers such as Robert Heinlein in his story "Universe" speculatively considered the possible social and psychological

ramifications of living in such traveling space worlds. As in Heinlein's story, the human inhabitants might forget their earthly origins as well as their intended destination.<sup>185</sup>

In the 1970's the Daedalus project studied the technological feasibility of creating self-contained huge space arks. They presented designs for the Mark-2, a gigantic ship measuring 20 kilometers by 200 kilometers, which would contain a natural environment with an atmosphere, plants, and animals within it. Immense fusion engines would power the Mark-2, but because of its colossal size, it would take centuries to reach the nearest star system.<sup>186</sup>

Traveling to specific destinations among the stars is not the only reason though for creating such huge voyaging worlds. One way in which humans could become inhabitants of space rather than terrestrial species is to turn such arks into permanent homes. These self-sufficient worlds would forever journey through space, stopping at various solar systems encountered along the way, perhaps seeding planets with the germs of life and dropping off some intrepid settlers and then departing, on an endless exploration of space. Gerald O'Neil, in the 1970's and 1980's, developed technical designs and plans for such space colonies. His huge ships would possess rotating cylinders to simulate gravity and have solar panels for generating energy. O'Neil suggested that the gigantic amount of raw material needed for constructing these ships be taken from the moon. These **O'Neil colonies**, as they have come to be called, would house up to one million people and as they traveled through space, they would undoubtedly evolve new space cultures very different from the terrestrial cultures on our planet. In 1985, he founded the Institute for Space Studies to promote the colonization of outer space, and aside from inspiring science fiction writers with his ideas, he has also had a substantial influence on many space futurists.<sup>187</sup> Kistler, for example, believes that something like an O'Neil colony may be the only conceivable way to get to the stars.<sup>188</sup>

Another approach to exploring the stars is not to send humans at all, at least not on initial reconnaissance missions. Various scientists and futurists, such as Frank Tipler, whom I discuss at length below, propose sending either robots or von Neumann probes to the stars. **Von Neumann probes** would contain universal constructors for building settlements from the raw materials on new planets or asteroid bodies. Robots could be constructed for operating the facilities and the probes would be able to self-replicate and thus send out new probes even deeper into space. Kaku believes that self-replicating von Neumann probes are the best approach to colonizing the galaxy.<sup>189</sup> A wave of space faring, perhaps sentient robotic beings could move out across the stars much more quickly and cheaply than manned explorations. At the very least, von Neumann probes could establish bases for humans who would follow later. Interestingly, it has been suggested that our first contact with alien intelligence might involve contact from von Neumann-like probes, which may be out scouting new areas of space for extra-terrestrial life forms.<sup>190</sup>

All of the above modes of transportation and exploration to the stars assume that the speed of light is an inviolable upper limit on the velocity of interstellar travel. **Supra-luminal travel** though has been a topic of hot debate

and profuse speculation ever since Einstein first described the relativity constraints on moving faster than the speed of light. According to the theory of relativity, for an object with any mass approaching the speed of light, its mass exponentially increases and the amount of force needed to accelerate the motion of the object further also exponentially increases, such that the object would reach an infinite mass and require infinite force for further acceleration at the speed of light. In spite of this apparent natural limit to the velocity of moving objects, both scientists and science fiction writers have considered a host of ways to get around the law.<sup>191</sup>

Following Kaku's vision of future humanity becoming "**masters of space and time**", shouldn't there be some way to manipulate the fabric of space and time such that we could transcend the limits of the speed of light? In Frank Herbert's classic science fiction epic *Dune*, the Spacing Guild is able to "bend space" and move ships almost instantaneously across vast distances.<sup>192</sup> On *Star Trek*, there is the warp drive mechanism, which presumably by altering the space around the moving ship, can accelerate a space vehicle to multiples of the speed of light. Another idea that has been considered in depth is creating "wormholes" in space, where a ship could enter a hole in space at one location in the universe and come out through another hole at some distant location. As envisioned in Isaac Asimov's famous science fiction *Foundation* series, the creation of wormholes for traveling through space is a critical event in the future evolution of humanity. Similarly, as dramatized in the movie *Star Trek: First Contact*, the invention of the warp drive is a turning point in human civilization, transforming us into space faring species that become members of a growing galactic community.<sup>193</sup> Again, along similar lines, the farcaster portals in *Hyperion* allow individuals to travel to different locations across numerous star systems by simply moving through the portal. The farcasters are entrances or holes into a deeper level of reality, "The Void Which Binds" as Simmons identifies it, which transcends the limits of space and time.<sup>194</sup>

All of these speculative visions for moving about the universe in ways that overcome or bypass the limits set by the speed of light transcend our present scientific ideas and technological capabilities. The various ideas offered though do derive their inspiration from contemporary quantum theory, cosmology, and ultimate physical theories of the universe.<sup>195</sup> My intuitive sense, following Kaku's thinking, is that as we understand more deeply the fundamental nature of space, time, and the cosmos, we will be able to trans-locate about the universe in ways totally different from our present mode of transporting physical objects through space. Perhaps, as our biological and psychological capacities evolve, we may be able to "farcast" from one location to another simply with the use of our minds in resonance with the cosmos, as described in Simmons' final novel in the *Hyperion* series, *The Rise of Endymion*.<sup>196</sup>

Regardless of whether or not a way is found to transcend the speed of light, humanity, probably with the assistance of robotic and von Neumann exploratory probes, should be able to extend its reach increasingly farther into the galaxy in the millennia ahead. Wachhorst envisions a metamorphosis from Gaia to "**Galaxia**" as we spread the seeds of humanity and life throughout the

Milky Way.<sup>197</sup> Prantzos foresees a steady slow migration of humanity across the Milky Way, of nomads and space colonies and innumerable diverging paths. Even with the use of self-replicating von Neumann probes, according to Prantzos it will probably take up to 100 million years to spread across the Milky Way.<sup>198</sup> Adams and Laughlin think that even with directed and systematic exploration, it could take up to 300 million years to colonize the Milky Way.<sup>199</sup> At any rate, if for some reason humanity does not take to galactic exploration in the millennia ahead, eventually in the later periods of the Stelliferous Era,<sup>200</sup> as more main sequence stars such as our sun become red giants and shrink to white dwarfs, we will be pushed to extend our presence throughout the Milky Way in search of hospitable suns.

Though Dyson is more optimistic, stating that within a million years humanity could spread across the galaxy,<sup>201</sup> one of the most thorough and upbeat visions of exploring the Milky Way is expressed in Marshall Savage's *The Millennial Project: Colonizing the Galaxy in Eight Easy Steps*.<sup>202</sup> He believes we can accomplish the task in seven hundred thousand years. To recall, Savage believes that it is the destiny of humans to enliven the universe and bring life to the stars. As the title of his book suggests, he outlines in considerable detail the steps for achieving this cosmic destiny. He sees humanity first establishing a solar or stellar civilization, **Solaria**, where life is spread throughout the solar system. Solaria will provide the seed for the next step, "**Galactia**", where humanity colonizes the galaxy and literally engages in the "**Greening of the Milky Way**". Finally, from the living Milky Way of Galactia, the seeds of humanity and life will be dispersed throughout the universe, creating "**Cosmia**", the living universe.

Savage suggests that once we attain stellar drive capabilities, human civilization can move outward into space at about 10 light years per century. Starting from our local system, starships, each carrying around 100 to 200 genetically diverse human passengers, would be sent to seed the closest habitable adjoining star systems. Habitable planets in these new systems aren't necessary because humans can build "**Dyson clouds**" around the suns, finding asteroids and other orbiting objects on which to build ecosystems and space communities of varying sizes. Assuming an annual population growth of 8 per cent a year, these newly settled colonies could reach populations of 5 billion within two centuries and, within a thousand years, they could become stellar civilizations, economically ready to send out new seed ships from their locations. Solaria would stop its seeding process after around 1000 years, as the wave of seeding moved progressively further outward along the growing perimeter of Galactia. As this web of civilizations expands through the galaxy, the development of a multitudinous array of ecosystems of different sizes would progressively turn the visible color of the Milky Way green. As more and more stellar civilizations emerge, the total population of humans would reach astronomical proportions, although it is important to keep in mind that this immense population would be spread across hundreds and then thousands of light years. By 2500, Solaria will have reached a population of 100 trillion humans. Within a million years, after the entire Milky Way has been settled,

Savage projects a galactic human population of 10 quadrillion quintillion or 10 to the 34<sup>th</sup> power.<sup>203</sup>

Although it is difficult enough to imagine a stellar civilization with trillions of people and innumerable distinct cultures stretching across billions of miles, the magnitude and complexity of a galactic civilization goes beyond present human imagination. There are though a number of suggestive ideas regarding at least some aspects of a galactic civilization. To recall, a galactic civilization, according to the Dyson-Kardashev model, would have mastered the energy resources of a galaxy. Compared to the possible stellar civilization that could evolve in our solar system, a galactic civilization encompassing the Milky Way would utilize 30 billion times the energy.<sup>204</sup> The power, productivity, and scale of industry and technology would dwarf our present world. Correspondingly, the wealth of such a civilization would allow for projects and endeavors at a stellar and galactic level, including the translocation, dismantling, and creation of astral objects and structures stretching light years across. We will make stars, move planets, and orchestrate the dynamics of the Milky Way.

Savage proposes that space civilizations should adopt a “**light symbiosis**” philosophy and mode of operation. Similar to the concepts of industrial ecology discussed in Chapter Four, Savage argues that space technologies, industries, and modes of life should cycle their waste outputs back into the system, finding ways to use waste as input, fuel, and raw materials for its operations. He also thinks that our present high consumption, materialist society must be abandoned when we move out into space. Exploring and settling new worlds in strange and often desolate conditions may force us into adopting a more Spartan lifestyle, having to depend upon human ingenuity and whatever resources may be at hand in order to survive. But Savage, as much as any other space futurist, envisions gigantic technological creations, immense energetic powers, and huge expenditures in future space civilizations. Humans may live in a light symbiosis with outer space, but our constructions and the scope of our presence will be enormous. We will harness the energy of the galaxy and transform it. We will clearly be neither invisible nor non-intrusive.<sup>205</sup>

Savage argues that a **galactic civilization** would need to operate according to a different set of principles of social order than our present earthbound human society. Although representative democracies govern many nations in the world today, Savage suggests that civilizations in space need to adopt true participatory democracies, which he sees as being grounded in chaos. Basing his thinking on open systems and self-organizational theory in science, Savage argues that social order and consensus in space would arise out of the chaos of absolute individualism, where everyone participates in decision making and there are no elected officials or top-down bureaucracies controlling human society. As he states, chaos is the foundation of the cosmos and human society in space should adopt a similar approach to creating order. Everyone would be a free individual and decisions should arise through mutual consensus. Instead of human society having a hierarchical structure, it should be a network where the order of the system emerges through the interaction of the parts.<sup>206</sup>

There are certain potential or probable features of galactic civilization that would make a centralized hierarchy of government seem either difficult or undesirable. For one thing, a galactic civilization would involve an incredible variety of colonies and settlements, ranging from planetary societies to nomadic space arks and Dyson cloud communities scattered across asteroid systems.<sup>207</sup> Different environments, coupled with biotechnological and cyborg-like adaptations, would lead to a highly diverse population of inhabitants. If we add in the possibility of non-human intelligent life forms, then a galactic civilization would possess a level of diversity several orders of magnitude above our present earthbound human society. Could such a highly variegated galactic system be ruled and coordinated from a central command station? Although harnessing the power of a galaxy would allow for colossal technological and social systems, the Milky Way offers freedom, space, and diverse opportunities for settlement and exploration far beyond the limiting confines of a single planet. As we have seen, Dyson, in fact, foresees humanity diverging into different species and cultures even as we extend out into the solar system. Once we extend out into the galaxy we may not be able to coordinate or organize our network of worlds at all.

Within science fiction, there have been numerous thought experiments on the possibilities of supra-stellar and galactic civilizations. One familiar science fiction scenario is the Federation within the *Star Trek* series. The Federation, which is portrayed as a rather democratic organization of scores of worlds and different intelligent species throughout our local area of the galaxy, faces nonetheless repeated challenges to its integrity, peace, and social order from Klingons, Romulans, and the Borg, among other alien groups, as it attempts to explore and spread across the Milky Way. Isaac Asimov, in the *Foundation* series, envisions a civilization of star systems in the year 10,000 that encompasses 25,000,000 worlds, but it requires supra-luminal travel through wormholes to support communication and coordination across the system, and as the saga unfolds, the Foundation falls apart into chaos, eventually evolves into a Second Foundation.<sup>208</sup> It is difficult to hold this many worlds together. In Simmons' *Hyperion* series the human Hegemony, supported through farcaster technology, is able to maintain a relative social order across several hundred worlds, but what is particularly fascinating is the incredible variety of ecosystems, ways of life, and social philosophies across this network of planetary systems. The civilization, in fact, cannot hold itself together, and the Ousters, one group of humans who migrate into deep space, begin to evolve into a different species altogether and are seen as a threat to the Hegemony, leading to war and social disintegration.<sup>209</sup> In Vinge's *A Fire Upon the Deep*, set perhaps tens of thousands of years in the future, intelligence, technology, and varying social systems are spread across the entire extent of the Milky Way. Though there is a level of coordination and control among many of these worlds, with various alien species, factions, and conflicts among the beings of the Milky Way, the overall level of integration and common purpose in the galaxy is far less than what presently exists among the peoples and nations of our earth today.<sup>210</sup> Even from these few examples, the common themes of integration versus separation, order versus chaos, autonomy versus control, and uniformity versus diversity all emerge as

central issues in attempting to create a civilization in space. These themes, of course, are recurrent issues in our own struggles here on earth, except now they are played out on a scale stretching across the stars.

The exploration and colonization of the Milky Way offer great opportunities for freedom and diversification. Any reasonable vision of a galactic civilization needs to address the incomparable richness and variety of cultures, life styles, and inevitable evolutionary branching of intelligent species that will emerge at this level of magnitude. Still, how could a galactic civilization achieve at least some degree of coherence, especially given the vast distances separating the worlds, colonies, and modes of existence among its members? In discussing the colonization of outer space, Savage states that humanity needs a common focus and inspired goal as we move out into the stars. To recall, he thinks that our destiny is to spread life throughout the cosmos.<sup>211</sup> Similarly Zey argues that in taking to the stars humanity should attempt to vitalize the cosmos, which entails bringing life, intelligence, and the presence of humans to outer space.<sup>212</sup> Even if humanity diversifies, biologically, socially, and psychologically, which seems to be inevitable, given continued technological evolution and the opening up of innumerable different environments that would require an array of varying adaptations, the spreading of life and intelligence does seem to be a common feature to space exploration and colonization. Yet, even discounting for the moment the possibilities of alien life forms, what would constitute life and intelligence among the ever-diversifying branches of human civilizations may not be so easy to define. Various evolving life systems and modes of intelligence and social order throughout the galaxy may have very different notions of life, intelligence, and organization. Although scientists and futurists have offered general theories of the nature of life and intelligence,<sup>213</sup> our ideas are undoubtedly limited by the space and time of our present perspective. To some degree, yet to be determined, the spreading of life and intelligence throughout outer space will be a competitive struggle, as different embodiments of these qualities attempt to extend outward and assimilate through their surroundings. Life and intelligence will go through an evolutionary process of self-creation and self-organization in the future history of the Milky Way. An ecological dynamic of reciprocity, competition, cooperation, and evolutionary change will emerge at a galactic level.

Cooperation, collaboration, and symbiosis are processes within earth ecology that not only serve an evolutionary value, but in the long run may be necessary for survival. Since all life forms and modes of intelligence within the cosmos, by definition, exist in a common space or environment and ultimately derive their sustenance off of this common reality, it would follow that any entity which values its survival must ultimately have to value the survival of its environment. Life and intelligence, even on the earth, clearly alter the environment in ways that support their continued existence, yet the eventual result of such alterations is the establishment of networks of reciprocities. There will probably be great give-and-take and oscillations of order and chaos in the future history of the galaxy, but as life and intelligence spread and create a living, sentient network, the total system will move toward a collective and mutually

supportive reality. What is truly mind-boggling is that some unimaginable form of collective and integrative organization will emerge across a galactic ecosystem that vastly exceeds, by several orders of magnitude, our present earth ecosystem in diversity and complexity.

How would such a galactic civilization be networked together? The various speculative visions presented above all contain some type of transportation and communication infrastructure that allows for interaction among its myriad worlds. If we assume that the speed of light represents an upper limit on the speed of interaction within a galactic civilization, then messages and voyages through the system could take up to 100,000 years to go from one end of the Milky Way to the other end. This constraint on interaction may turn out to be inviolable, yet there are certain technological possibilities that would at least knit the system together fairly well within these boundary conditions. For Savage, a galactic civilization requires a fast **transport system**. He proposes that once star systems are explored and colonized, huge electro-magnetic launch tubes measuring billions of miles in length could be constructed that would be able to accelerate star ships to 99 per cent the speed of light. These launch tubes would be double-barreled, having incoming and outgoing cylindrical pathways. The incoming tube would be a de-acceleration pathway where the loss of kinetic energy in a decelerating vehicle entering a star system would be absorbed into the launch system and used to accelerate outgoing vehicles on trips to other stars. The launching system could therefore be highly cost efficient and energy conserving, using the energy of incoming ships to propel the launching of outgoing ships.<sup>214</sup>

The other significant challenge within a galactic civilization is communication. Vinge, in *A Fire Upon the Deep*, envisions of **galactic Internet** or **Web**.<sup>215</sup> Given the present evolution of the computer-based satellite communication system on the earth, it is easy to imagine that as we venture into space, this system will be progressively extended outward. Visions of a “Global Brain” will transform into visions of a “**Stellar Brain**”. However, given the constraints of the speed of light, the Stellar Brain would think rather slowly. Impulses across its network, even within the solar system, could require hours, days, or even months to transverse the distances between planets, asteroids, and comets. Also, as illustrated rather comically at times in Vinge’s novel, a galactic Internet would be filled with such an overpowering cacophony of voices, rumors, and propaganda that the system would be maddening and require search engines, filters, and functional agents of immense processing speed and complexity to bring any degree of order to the communication lines. A further complication, also dramatically illustrated in *A Fire Upon the Deep*, is the possibility of artificial intelligence viruses spreading through the system. The galactic civilization envisioned by Vinge comes crashing down as the Perversion, an intelligent computer virus attempting to assimilate the entire Milky Way, spreads across the airways of the galactic Web. The potential for chaos, turmoil, and confusion within a galactic communication system is enormous.

Savage though, for one, clearly foresees the evolution of an Internet-like system developing between star systems and across the galaxy. His ideas

regarding a participatory democracy among the incredible numbers of space inhabitants require a participatory communication system, where everyone can input ideas and everyone can “hear” each other.<sup>216</sup> Savage also invokes the model and metaphor of the brain in describing this communication system. Each individual person within the communication system is analogous to a single brain cell, possessing autonomy and a unique voice within the whole. Individuals are “**cosmic brain cells**”, together forming a cosmic mind or consciousness. Spread across vast distances of space, the collective cells would be able to take in the total panorama of the whole and, integrating their inputs through a collective dialogue, they could achieve a conscious perspective on the whole. Analogous to the idea of thinking globally by globally thinking (thinking of the whole by thinking as a whole), at a galactic level humans would be able to think about galactic issues by thinking as a galactic collective.

All of the science fiction scenarios of stellar and galactic civilizations presented above contain supra-luminal communication and transportations systems. In both *Hyperion* and *A Fire Upon the Deep*, the Internet systems transmit messages faster than the speed of light. Interestingly in the second novel, the Milky Way is stratified into layers of increasing speed of thought and transmission, with the inner core or depths constrained by the speed of light, but the outer layer open to supra-luminal transport and communication. Again, if one is to transmit messages faster than light, the challenge is to find some way to bend or bypass either space or time. The cosmic civilization of the Xeelee in Stephen Baxter’s *Vacuum Diagrams* appears to use the quantum principle of non-local entanglement to achieve instantaneous communication across the universe.<sup>217</sup> To recall from Chapter One, quantum particles that become entangled through interaction with each other seem to stay in immediate resonance with each other’s states even at astronomical distances. There is no transmission across space, which is limited to the speed of light, but in the Xeelee communication web, a change of state in one node of the web immediately shifts the states in other nodes in the web. Michael Zey, for one, believes that eventually human civilization will be able to exploit the principle of non-locality in order to communicate across the vast distances of space.<sup>218</sup>

Ideas regarding stellar and galactic brains and modes of thought lead to another important consideration in contemplating the possibilities of a galactic civilization. Within the evolution of life on the earth, smaller, less complex life forms have formed symbiotic collective relationships and in some cases, such as with the emergence of multi-cellular organisms, a sufficient number of simpler forms integrate into a unique emergent whole.<sup>219</sup> It appears it is necessary for a population to reach a critical mass before it can form into a larger system that transcends the properties of the parts.<sup>220</sup> Stock has suggested that the present population of humans on the earth, coupled with the technological communication lines linking humans together, is reaching a point in growth where humanity will ascend to a higher level of intelligence and integrity. He calls this new evolutionary level “Metaman”. The human brain, which is a collective network of hundreds of billions of cells, achieves a relatively integrated sense of

emergent identity and consciousness through the combined input of all the cells.<sup>221</sup>

Although the distances and degrees of diversity across the members of a galactic civilization would be exceedingly great, the number of individuals within such a system could reach a level of magnitude that would lead to some emergent cosmic intelligence and mind. The jump to a higher level of identity and functioning could happen even at the stellar level, if hundreds of trillions of humans were to populate the solar system and engage in coordinated interaction with each other.<sup>222</sup> In Chapter Two, I discussed the possible development of a cosmic intelligence as an evolutionary outgrowth of the burgeoning global intelligence system. Such a cosmic intelligence could emerge in stages, first at the stellar level and then at the galactic level. As the “mind” and “persona” of a spatial civilization, it would need to possess unique qualities to handle the inner complexity and external cosmic challenges it will face. A functional galactic civilization would involve qualities beyond simply advanced technology, massive energy expenditures, and large-scale structures and industry. It would require a different kind of intelligence as well.

The reciprocity of the whole and the parts implies that if a galactic level civilization and galactic intelligence were to emerge, then the individuals within this reality would clearly be different from the humans of today. Recall Kurzweil’s argument that even in the next hundred years, the evolving computer network and artificial intelligence systems will require humans to technologically augment their mental capabilities.<sup>223</sup> The dual promises of genetic engineering and cyborgization suggest that humans in the coming centuries will purposively evolve along numerous dimensions and perhaps even achieve functional immortality (a very desirable trait for extended space flights).<sup>224</sup> By the time humanity or the evolved descendents of our species are ready to travel to the stars, we assuredly will not be the kind of creature that we presently are. In some ways, we will probably be like the Ousters of *Hyperion*, nanotechnologically and biologically altered to live in outer space. But more critically, the social organization, communication systems, and vast diversity of space environments in which we will live, will require a different type of mental and psychological being than today. The minds of galactic beings will be “minds that are to our minds as ours are to those beasts that perish”.<sup>225</sup>

Along with Marshall Savage, Frank Tipler is another scientist and futurist who has proposed a full-scale exploration and colonization of the cosmos. Tipler’s plan for **colonizing the universe** is presented in his book, *The Physics of Immortality*.<sup>226</sup> For Tipler, space travel and colonization are a matter of human survival. As Tipler notes, the planet earth is doomed; it will eventually be destroyed by the Sun when the Sun uses up all of its hydrogen fuel and begins to expand. If we are to survive, we must move into outer space. But leaving the earth is just the first small step in an ongoing race for survival. Tipler outlines a general plan for colonizing the universe, based on the belief that nothing short of a total cosmic colonization will ensure our survival.

In considering the most efficient way to explore and colonize the universe, Tipler supports the idea, as suggested by other space futurists, of sending

unmanned vehicles into space.<sup>227</sup> Tipler proposes that we build self-sufficient robotic spaceships to travel to the stars. Assuming significant progress in the coming century for storing information in hyper-dense, miniaturized computer circuitry, as well as in human genetics, Tipler's robotically controlled star ships would contain, stored in computer circuitry, the biological and genetic information necessary for reproducing humans. For him it makes more sense to construct humans when a habitable world is reached, then to transport them across vast distances of space. Robots therefore will be the agents of human survival in space travel; they will transport our genetic blueprint and grow us when they arrive at appropriate settlement locations. This is an interesting reversal of roles; having created robots on the earth, now humans will be created by robots in space.

These space faring robots will contain von Neumann universal constructors. To recall, von Neumann universal constructors can, given directions and materials, construct anything. They are analogous to Turing's universal computer, which can compute anything. Tipler believes that humans will be able to build universal constructors in around 20 years.<sup>228</sup> With continued development in computer miniaturization, universal constructors could be built small enough for the stellar journeys. The constructors could code 10 to the 24th power of bits of information, which is enough to build a city of humans. These von Neumann constructors would build space settlements, as well as growing humans for these settlements, and self-replicate to send further probes into space. They could also build O'Neil colonies if no planets hospitable to humans were found in the particular solar system being visited. Through self-replication they would progressively expand the spreading wave of human colonization, seeding human colonies exponentially throughout space.

According to Tipler we should use light or solar sail ships for the journey into space. Based on advances in nanotechnology and the miniaturization of computer circuitry, according to Tipler we could build space probes that weighed 100 grams and achieved a velocity of nine-tenths the speed of light. We would use powerful lasers to accelerate the ships. Although the light sails on these ships would measure kilometers across, the entire ship would weigh approximately one kilogram. This image is a far cry from the gigantic Saturn rockets and the enormous spaceships popularized in science fiction. Tipler thinks that we could launch a von Neumann probe with this design by the middle of the next century. Given that the Milky Way is about 100,000 light years across, he estimates that it would take about 600,000 years using the above technology, to colonize the entire Milky Way. This projection is even sooner than Savage's estimate of 700,000 years.

Tipler, though, does not think that we should stop at just colonizing the Milky Way, but rather we need to explore and colonize the entire universe. Based on his view of the future history of the cosmos, the entire universe needs to be colonized and brought under intelligent human control to insure the continued existence of life and consciousness. Recall that one popular view of the future of the universe is that it will eventually stop expanding and begin to contract.<sup>229</sup> Tipler believes that this collapse will happen. He thinks that life could engulf the

entire universe, using the technology of space travel he presents, before the universe starts to collapse, and that intelligence could gain control of the collapse. If intelligence does not gain control of the collapse, everything will be eventually annihilated in the Big Crunch. The hypothesized Big Crunch lies tens of billions of years in the future, but the estimated time needed to colonize the entire universe, though taking billions of years, could given the technology Tipler outlines be accomplished before the collapse begins.

He believes that we can extend life and consciousness indefinitely without end into the future. In gaining control of the collapse of the universe, Tipler thinks that intelligent life could create a “Taub shear” or uneven collapse, to produce an unending sequence of temperature gradients that would provide sufficient energy for life to continue forever. He also thinks that the direction of the collapse should be controlled toward a single point or c-boundary to provide for communication across the entire cosmos; in his model the universe can't collapse into numerous points or c-boundaries. By making the universe go through a series of Taub collapses, first in one direction and then in the other, we will eliminate all event horizons (communication separations in the cosmos), and work toward a total integration of the flow of energy. This total integration of the collapse will generate an infinite amount of energy, and thus preclude the death of life and conscious intelligence.

Tipler refers to this total integration of the cosmos as the Omega Point.<sup>230</sup> If the combined efforts of all intelligent life in the cosmos can coordinate this convergent process, subjectively life will continue forever. Since we have an **infinite amount of energy** to work with in the collapse, we will be able to create and experience an **infinite amount of information processing** and subjective mental time, i.e., an infinite number of thoughts, perceptions, and emotions. This **infinite cosmic mind** reached at the end of time is, according to Tipler, God. Hence, for Tipler, God is the apex of evolution, the culmination of a universal process toward increasing intelligence and control within the cosmos.<sup>231</sup>

This vision of the ultimate future of the cosmos is an interesting argument for cooperation among all intelligent life in the universe. Although Tipler does not include in his scenario the possibility of alien contact along the way, and how this event would effect the exploration and colonization of the universe, Tipler's argument for **universal cooperation** would still hold even with the inclusion of aliens. The survival of all life throughout the universe is at stake and in his mind only a total coordinated guidance of the collapse of the universe would ensure the infinite amount of available energy necessary for immortal existence. Tipler's argument for universal cooperation is also an argument for the necessity of evolving a universal or cosmic mind. Only a cosmic mind, enveloping the entire universe, can ensure the immortality of all sentient living members within the cosmos.

Yet, if alien life forms are encountered on our journey into the cosmos and the developing relationships with them turn out to be cooperative and if an agreement is reached regarding the importance of gaining intelligent control of the entire universe, then the time scale for enveloping the universe could speed up considerably. But with the involvement of other types of intelligence, the

strategy and nature of the whole venture could change. Perhaps there are other technological or scientific means, different from what Tipler envisions, that would accelerate the spreading of intelligence throughout the universe. Perhaps, there are even other approaches to the continued existence of life and intelligence that would not involve the kind of scenario described by Tipler. Alien intelligent life forms may suggest alternatives. As I discuss below, there are other space futurists and cosmologists who have offered different visions of the ultimate fate of the universe and the role of humanity and intelligence in the grand scheme of things. Still, Tipler's general proposal that life and intelligence should spread throughout the universe is shared by many, including Zey, Dyson, and Savage, and his argument that intelligence will play a critical role in the ultimate fate of the universe is also in agreement with the ideas of many writers on this topic, including Kurzweil, Zey, and others.

Another important point to further examine regarding Tipler's vision is the physical evolution of humanity and intelligence during the process of space exploration. Tipler suggests that we initiate the universal adventure of space colonization using robots rather than humans. Yet as I have discussed, the possibilities of significantly altering or transforming our physical and biological make-up in the future are quite open, if not limitless. As the colonization of the cosmos evolves, it may be humans traveling across great distances of space, but humans that live for thousands, if not millions of years. Our consciousness and self-identity may be housed within robotic or computer form.<sup>232</sup> In the future, can we create bodies specifically designed for long trips in space and limitless adaptability on all types of worlds? As I have argued, the environment of space and the diversity of new worlds encountered on our journey into space will drive the biological evolution of humans. Tipler, in fact, imagines that as the universe heats up to billions of degrees during the Big Crunch, intelligence will need to be housed within physical forms totally different from anything imaginable today. Whatever scenario we imagine regarding our future in outer space, our bodies will undoubtedly be transformed as we colonize the universe.

One central theme within Tipler's vision of the future is the connection between space exploration and the evolution of a cosmic mind. As intelligence spreads and integrates across the universe, Tipler notes that some form of universal cooperative communication is needed. Presently our technologies of communication are limited by the speed of light, yet as I discussed above, perhaps there are ways to send messages through holes or doorways in space and time that transcend or bypass the constraints of the speed of light. However technology develops, as intelligent life explores and colonizes space, the universe will evolve systems of communication that integrate the minds and identities of beings across galaxies. Just as the Internet is creating a global intelligence here on earth, some type of universal Internet could create a cosmic mind in the future. In this sense, space exploration and colonization is a critical and significant step in the evolution of intelligence and mind in the future.

At the other end of the continuum from Tipler's Omega Point theory of the ultimate fate of the universe, is the vision presented by Fred Adams and Greg Laughlin in their book *The Five Ages of the Universe*.<sup>233</sup> Adams and Laughlin, to

recall, do not believe there is sufficient matter in the universe to generate a collapse and Big Crunch.<sup>234</sup> Rather they believe the universe will probably continue to expand indefinitely though more slowly as the unending billions and trillions of years go by. During the present Stelliferous Age, which will continue approximately 100 trillion years into the future, humans could easily explore and colonize the Milky Way and beyond. (Recall that Adams and Laughlin present the highly conservative estimate that the Milky Way could be colonized in 300 million years, which is little more than a millionth of the time remaining in the Stelliferous Age.) Six billion years in the future, our closest full-sized galactic neighbor, the Andromeda galaxy, will actually collide and merge with the Milky Way, so we will clearly be able to explore and settle systems within it as well.

But when the Stelliferous Age comes to an end, mostly white dwarf stars and black holes will populate the universe. Discounting the possibilities of galactic engineering projects that would create new main sequence stars, like our sun, life and intelligence still would be able to thrive within the stellar systems of white dwarfs. The energy output of white dwarfs is considerably less than main sequence stars, but with highly advanced energy efficient technologies and redesigned biological or robotic forms to support our minds, intelligence and civilization could continue to thrive and probably continue to spread through a universe that will simultaneously be expanding as well.

When we come to the end of the white dwarf period when white dwarf stars will have burned out, the universe will be approximately 10 to the 39<sup>th</sup> power years old. At this point we enter into a totally new scale of existence, the Black Hole Era, which according to Adams and Laughlin will continue roughly 10 to the 100<sup>th</sup> power of years into the future. Based on present scientific estimates, the visible horizon of the universe at that time will be 10 to the 30<sup>th</sup> power times farther out than today. Adams and Laughlin also estimate that there will be 10 to the 46<sup>th</sup> power number of black holes in this future universe. This number is a trillion trillion times the total number of stars in the presently observable universe. Black holes slowly evaporate and can supply energy for intelligent and technological civilization to continue, but the time scale of such a future world would be drastically different from today's. The distances between black holes in this far future universe would be immense in comparison to today, hence signals would take much longer to reach their intended destinations, and the amount of energy being released from black holes would be at a rate incomparably slower than that of the energy that is released from main sequence or even white dwarf stars. Adams and Laughlin, though, outline a conceivable technology and communication system that could utilize black holes as energy sources, but the time necessary for various technological and intelligence activities in the Black Hole Era would be much, much longer than now. In fact, they state that thought itself would become slower by a factor of several billion times. Yet the Black Hole Era would be 10 to the 30<sup>th</sup> power times longer than the Stelliferous Era, thus providing enormously more relative time for the continued development of intelligence and civilization than the mere 100 trillion years in our present era.

The popular cliché derived from Einstein's theory of relativity is that "time is relative". The speed of human thought, in comparison to the rate of changes

occurring at the quantum level of electrons and photons, is incredibly slow by factors of billions and trillions. In this sense, quantum particles “think” much faster than human brains. The same relative scale of comparison would apply to the difference between our thought processes and physical activities and the lives of future inhabitants of the Black Hole Era. Our lives would seem to them as fleeting as the creation and annihilation of sub-atomic particles at the quantum level. The whole 100 trillion year epic of our star based civilizations would be nothing but a passing short-lived moment from their perspective.

Eventually, all the black holes in the universe will evaporate and the Black Hole Era will come to an end. We will enter the Dark Era. Adams and Laughlin consider whether life and intelligence will still continue in this strange universe of the future where all large stellar objects have disappeared, the proton may have decayed, thus breaking atoms apart, and subatomic particles circle each other at distances greater than the present dimensions of the universe. Still even in this dark cosmos of universe-size “atoms”, Adams and Laughlin believe there will be collisions among particles and energy flow, thus supporting the possibility of some type of life and intelligence. As they state, as far into the future as one can see, there will always be change and evolutionary transformation; the universe will never be still. Could there be intelligent beings that stretched billions, if not trillions of light years across and whose bodies literally consist of the ultra-rarified form of the vacuum of outer space? Such beings would truly be like the **spirits of space**.

In comparing the two different future cosmologies of Tipler and Adams and Laughlin, in the former case, the intensity of energy and the speed of intelligent processes accelerates to infinity as the Omega Point is approached. In the latter case the opposite happens, with the universe becoming progressively colder and more rarified with less overall energy flow and thought slowing down by a factor of several billion. Both theories of the far distant future envision cosmic realities and intelligent beings much different from those today. Yet neither theory sees the evolution of intelligence coming to an end; history continues forever. Further, although Tipler clearly emphasizes the role of intelligence in determining the far distant future of the cosmos, Adams and Laughlin also believe that intelligence will probably play a role in determining or influencing the long-term evolution of the cosmos. They are though more open to different possibilities than Tipler, considering various hypothetical scenarios of how intelligence could direct the evolution of the universe.

As discussed in earlier sections of this book, one possibility for the ultimate fate of the universe is that it will progressively disintegrate and wind down, with all structures within it falling apart and all available energy being used up.<sup>235</sup> This potential “heat death of the universe” presumably follows from the second law of thermodynamics and the inexorable increase of entropy throughout the cosmos. Regardless of what great and magnificent cosmic civilizations are created within our universe in the future, in the end everything will wither and die. There will be no more energy available. In the end chaos conquers order.

As noted above, Adams and Laughlin do not foresee this ultimate death ever occurring, though they do believe that the pace of events will continue to slow down the farther we move into the future. Yet even for them, as well as various other space futurists, there are other possibilities besides either an endless slowdown or eventual death to life, intelligence, and the cosmos. In all these cosmic scenarios, that in different ways bypass or overcome the dark threat of entropy looming at the horizon of existence, it is some advanced form of intelligence that saves the day and prevents the ultimate annihilation of life.

Zey believes that human intelligence is destined to save the universe. In his mind, the universe requires the evolution of intelligence for its survival. Citing Freeman Dyson, Zey agrees that intelligence will somehow manipulate or alter the future history of the universe and undermine the cosmic force of entropy.<sup>236</sup> Both scientists such as Stephen Hawking and science fiction writers like Isaac Asimov have considered the idea that the entropic flow of the cosmos could be reversed. Asimov in his famous science fiction story, "The Last Question", describes a distant future reality where a highly advanced artificial intelligence, after pondering the nature of existence for some indeterminable length of time, figures it out, and in an act of cosmic creation, announces, "Let there be light!" re-igniting the cosmos into existence.<sup>237</sup>

Dyson, in fact, has suggested different possibilities regarding how intelligence could survive forever within the cosmos. In the ultra-rarified type of future universe described by Adams and Laughlin, Dyson also suggests that intelligence could "move" into the thinly spread sub-atomic gases of this universe, extending into time mind and consciousness without end. As a general principle, Dyson argues that the capabilities of our distant future descendants will extend far beyond our present imagination, and in an expression of ultimate hope and optimism, he firmly believes that life and intelligence will find a way to perpetuate themselves and thrive forever.<sup>238</sup>

Ray Kurzweil believes that intelligence will ultimately prove to be more powerful than the impersonal forces of nature. He argues that the evolution of computational density within the universe, which actually derives its energy and stimulus for creative variation from the flow of chaos, has no limit. Instead of viewing the fate of the universe as a deterministic result of natural laws, Kurzweil sees the ultimate cosmic future as uncertain involving decisions yet to be made.<sup>239</sup>

How, though, can life and intelligence, which derives their very sustenance and existence from the material, energy, and lawful dynamics of the universe, transcend or overturn what are the basic inherent constraints of nature itself? First, following Kaku, we still do not understand as deeply as we potentially could the ultimate foundation and fabric of existence and of space and time. Clearly, there is the possibility that we are missing something essential in our understanding of the cosmos that would afford us the knowledge to alter the apparent inexorable demise of life and intelligence. As yet we are not "masters of space and time".<sup>240</sup> As discussed in Chapter One, the very real possibility exists that our universe is only one of many universes, and underneath the whole myriad array of particular universes lies a deeper reality, a quantum sea of

probabilistic creation. This deeper reality, which is the source of our creation, may have more extensive or fluid boundaries than the limited arena of our particular universe. Throughout the history of science, the power to control any one level of reality has opened up once the underpinnings at a more fundamental level of reality are understood. By moving into the reality of the cosmic multi-verse we may find ways to manipulate the nature of our own universe beyond anything we can presently imagine.

A second related possibility is that we might be able to leave our dying universe, just as in the nearer future we may have to leave the confines of our solar system once our sun exhausts its own energy supply. Kaku has suggested the possibility of building an “**Einstein-Rosen**” bridge from this universe into another one.<sup>241</sup> If the type of cosmology developed by Andre Linde and Lee Smolin is valid, where universes bubble off of each other, then there are parallel universes that are relatively “younger” than our universe, perhaps even recent children of our universe.<sup>242</sup> Assuming that black holes don’t collapse into infinitely dense singularities,<sup>243</sup> Kaku argues that humans could create “wormholes” in space through hypothetical portals within the center of black holes and find a way to travel through these wormholes into connected universes.<sup>244</sup> Where wormholes lead is still a matter of scientific debate. As mentioned earlier, they could lead to other parts of our universe, but they could also lead to other alternative histories of our own universe or to parallel universes.

In Stephen Baxter’s *Vacuum Diagrams*, the Xeelee create such a portal into a parallel universe to escape the eventual cosmic triumph of anti-matter Photino Birds within our universe.<sup>245</sup> The Xeelee though, who clearly seem to be masters of both space and time, have another technological capability that figures significantly in journeying beyond the confines of this universe – they can travel through time. Having faced the forces of dark matter in the far distant future and realizing that the Photino Birds will dominate the final fate of the universe, the Xeelee create a time traveling armada that moves backward in time to a much earlier period of the universe, when humans in fact are just beginning to explore outer space. They then begin their great technological project of creating a portal light years wide through which they can move their entire civilization through, along with a few humans, into another universe.

If advanced intelligence in the far distant future universe can master space, might it also be able to master time? The Techno-Core, a loose confederation of artificial life – artificial intelligence beings in Simmons *Hyperion* series send technological agents, including the mysterious Shrike, back through time to manipulate history to accomplish their ends.<sup>246</sup> The Techno-Core is able to travel backward in time apparently by reversing the flow of entropy. However time travel may be conceived, presently we are constrained in our actions by the inviolable forward flow of time, but if our descendents could overcome this limitation, finding some way to transcend or bypass the specific structure and dynamics of time within our universe, then the future of life and intelligence could take on a whole new twist. There are many scientists, including Stephen Hawking, who believe that time travel into the past is, if not impossible, astronomically improbable, but aside from the rich history of speculation on this

technological possibility in science fiction, there are various scientists who think that it may be possible in the future to travel both forward and backward in time.<sup>247</sup>

Just as reaching down into the primordial quantum foundation of our universe may open up possibilities for manipulating the fabric and laws of our universe, we may also find ways to manipulate time. In essence, we may be able to move into the arena of **meta-time**, a time above time. The future of the cosmos and of life and intelligence within it could be reconfigured from some more fundamental level of existence. Tipler sees the cosmic mind at the end of time transcending time and literally creating the initial conditions of the universe for its own eventual realization.<sup>248</sup> Aside from Baxter and Simmons, who have been discussed above, many other science fiction writers have envisioned futurist scenarios where intelligent beings are able to move across time and hence transcend it, attempting to manipulate history and the ultimate fate of the universe. Isaac Asimov's *The End of Eternity* and Fritz Leiber's *The Big Time* are two classic stories of time wars and trans-temporal beings, who exist at a level above the time of this universe.<sup>249</sup>

Combining a futurist scenario of the coming history of the universe and intelligence very similar to Adams and Laughlin's vision with the possibilities of time travel into the distant past, Baxter, in his novel *Manifold Time*, considers how advanced human minds might alter the entire saga of the universe to avoid some ultimate distant end to life and intelligence. (In his usual flare for integrating innumerable scientific concepts and themes into his stories, Baxter also weaves into *Manifold Time* Smolin's theory of evolving universes.) Baxter addresses the deep existential quagmire that even if life and mind continue to evolve into the far distant future, in the final analysis it all ends, and he finds this conclusion to the great cosmic saga unacceptable. There must be a way around the inevitable death of mind. In *Manifold Time* Baxter offers a possible solution through the purposive alteration of the entire evolution of the universe.<sup>250</sup>

Aside from altering the nature of the universe or manipulating the flow of time, Adams and Laughlin suggest another possibility that could affect the fate of life and intelligence in the future. This is that there may be areas outside the observable universe that would in the future become accessible to space travel and where the laws of our universe do not hold.<sup>251</sup> As they note, at present there is a horizon of observation to our universe, but as time progresses this horizon extends further outward as light from these distant regions first reaches us. There are no guarantees that something fundamentally novel or different won't appear at the edge of this expanding cosmic horizon. Just as parallel universes may not obey the same laws as our universe,<sup>252</sup> we may discover distant regions of space with different laws or parameters and by extension, different possibilities for our continued existence.

One other general consideration relevant to the ultimate future of life, intelligence, and the cosmos is the possible role of artificial intelligence in the exploration and colonization of the universe. As already seen, Tipler, for one, thinks that robots should explore the universe, with humans being seeded along the way to develop space settlements once the robots and von Neumann

constructors have done all the path finding and ground breaking work.<sup>253</sup> At a later time, once the collapse of the universe has begun and things begin to heat up, Tipler believes that we will need to move our minds into technological bodies of increasing sophistication to thrive within the increasing heat levels of the future universe. Our minds and consciousness will move into virtual reality.

Scientists such as Vinge and Moravec go one step further, arguing that humans, at least in their present form, probably won't make the journey into space at all.<sup>254</sup> Both Vinge and Moravec foresee artificial intelligence passing human intelligence by the middle of the 21<sup>st</sup> Century. If humans attempt to keep pace with the evolution of technological intelligence they will need to augment their brains and, as Kurzweil suggests, "wire into" the global intelligence system. In essence, we will need to become cyborgs. We will also undoubtedly need to be genetically altered to accommodate to the growing artificial intelligence network. As our space technology advances in the coming decades, reaching the level of cost-efficiency and launch capabilities necessary for a full-scale exploration of the solar system, artificial intelligence, robotics, and genetic engineering will be creating new types of passengers for the adventure. As noted earlier, it would clearly make sense to technologically and biologically evolve humans who are better suited than we for space travel and habitation. Following this line of thinking, the beings who travel into outer space will probably be cyborgs and artificial intelligence robots designed to thrive in space and possessing a level of intelligence far superior to present day humans.

Moravec thinks that robots, of an ever-increasing variety exceeding the biodiversity of the earth, will explore and populate the solar system in the coming centuries. Further, as the informational density of these robotic intelligences increases and their scientific understanding of the universe penetrates the ultimate structure of nature, they will move their minds into the micro-structure of matter and space and their bodies will literally become one with the fabric of the universe. They will extend outward into space through the microstructure of physical reality and they will transform the universe, assimilating the cosmos into their intelligent network as they move out through it. They will become Kaku's "masters of space and time" and their extending wave of exploration into the universe will not be carried within starships but rather through the quantum structure of space. Literally, their minds will move through space. These artificial intelligence minds will consciously exist in a cyberspace of their own creation and simulate and inject into their **cosmic cyber-reality** everything they encounter as they explore the universe. Further, within their cyber-reality they will create many alternative versions of this universe and many other possible universes as well.

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This vision of consciousness and mentality enveloping the cosmos and creating a hyper-rich cosmic cyber-reality is very similar to Tipler's theory of a cosmic mind coordinating and integrating all of existence at the end of time. In both cases an indeterminately complex and variegated conscious cyber-reality, extending far beyond the particulars and constraints of our universe, emerges in the process. Moravec though describes the process of cosmic envelopment as an extending wave of intelligence that sweeps out across the universe, whereas

Tipler describes the emergence of a cosmic mind as a coordinated and holistic process across the entire extent of the future universe. Moravec foresees the wave of artificial intelligence beginning to move out across outer space in the relatively near future; Tipler does not foresee a cosmic mind developing till close to the end of time.<sup>256</sup>

Yet in both scenarios conscious intelligence will literally assimilate physical reality into its web of influence and restructure the universe to support its existence. Further, in creating a cosmic cyber-reality that extends far beyond the specifics of this universe, intelligence and consciousness will ascend to a higher reality above the physical cosmos as we presently understand it. Tipler envisions an infinite array of virtual universes being created by the infinite cosmic mind at the end of time. Moravec's virtual cosmos is only constrained by the absolute upper limit of information storage within physical space. Having evolved to this higher plane of existence, there may be ways that we presently do not understand to either manipulate the cosmos or extend life and intelligence indefinitely.

We should consider the very real possibility that the universe as it appears to us today is only one limited aspect of the potential or real totality of existence. Perhaps the road to limitless evolution and infinite subjective time lies at some higher plane of reality? As scientists such as Adams and Laughlin, Kaku, and Smolin, among others, have argued, there are numerous possibilities for realities that exist outside of our observable universe. The exploration and colonization of the cosmos may lead us to scientific insights that are only beginning steps on an infinite journey.

These final cosmic visions, from Adams and Laughlin to Tipler, Dyson, and Moravec, highlight two important themes regarding our future in outer space. First, as Wachhorst has argued, the journey into space will transform the human mind from an earth-centered perspective to a cosmic perspective.<sup>257</sup> The goal of space flight is the attainment of cosmic consciousness. We are going to travel into outer space to discover the nature of the cosmos and our place within it. As life and intelligence evolves and extends across the universe, our perspective on reality will expand and be enriched proportionately. Following from the principle of ecological reciprocity, by living in the cosmos we will become beings of the cosmos and attuned to the cosmos. As our civilization grows and diversifies and our minds evolve in resonance with our stellar, galactic, and cosmic social-technological networks, our personal identities will expand and be enlightened. We will become part of a greater whole. The light of this immense cosmic whole will shine upon us, illuminating who and what we are far beyond the dim outlines and "shadows of the cave" presently revealed to us. We will see ourselves in the bright light of galaxies and the vast cosmic epochs of time. As Wachhorst states, spaceflight is a **spiritual adventure**, an ascension into the heavens above.

The second important theme to consider is the dramatic and **mythological dimension** of space travel. As both Zey and Savage emphasize, there is a myth making quality to our journey into space.<sup>258</sup> The term "myth" is not intended to mean something fictitious, but rather to refer to a story or tale that gives meaning and significance to some aspect of life, in this case the great

cosmic story of our odyssey into the universe. Spaceflight will be more than just an exercise in technological evolution; it will engage our hearts, our wills, and our inner faith, as well as our minds. The early space futurists, Tsiolkovsky and Vernadsky recognized this and considered the total scope of human existence in their speculations on journeying into the cosmos. Further, the adventure will be a saga and a drama, as it has been in previous significant periods of human history. Our journey into space will be filled with emotion, danger, uncertainty, tragedy, wonder, and triumph. There will be heroes and villains and battles of both the mind and technology. Space travel will be a story. In fact, the exploration and colonization of the universe will undoubtedly be an adventure of epic proportions. It will be the stuff our future dreams are made of.

I would argue that science fiction is the **mythology of the future**, providing stories, themes, and archetypes concerning the future. Science fiction stories, in presenting possible unique scenarios of the future, involving plots, characters, and dramatic tension, underscore the inevitable narrative quality of the future. Within this chapter, I have referred to a variety of science fiction novels and stories that deal with outer space and cosmic civilizations. These science fiction stories about space give us an initial feel of possible dramas awaiting us. Having inherited a host of myths and archetypes from our early earthbound civilizations, we are faced with the spiritual and cultural challenge of constructing new myths of cosmic proportions to inspire and guide us in the millennia ahead. We are beginning to create such myths in the great stories of Asimov, Simmons, Clarke, and Vinge, but as the adventure unfolds and the cosmos teaches us many new and wondrous lessons, we will fashion and evolve great epics, filled with inspiring new characters and strange new worlds. These epics of the future will create a sense of cosmic consciousness filled with the drama of existence that will be necessary to journey to the stars. Our mental journey into this new reality has already begun in the stories of science fiction.

More generally, as Anderson states, all theories of the future are ultimately different stories of how the future could or should unfold. Tipler, Savage, and Zubrin, though scientists outlining theories and plans for space exploration and colonization, definitely communicate a dramatic and narrative quality in their visions of the future. Terraforming Mars, colonizing the galaxy with anti-matter rockets and Dyson clouds, and enveloping and controlling the cosmos in a web of hyper-intelligent consciousness are all mesmerizing chapters in the future of humanity. As one other example of one who bridged the gap between scientific-technological speculation and science fiction narration, Olaf Stapledon wrote spectacular future histories of humanity and the cosmos in which he described numerous technological possibilities that have inspired scientists and space futurists, and at the same time created cosmic epics filled with drama and mythic meaning. However the vision is described or conveyed, the journey into space promises to give humanity a new perspective and meaning to life that will inspire and educate us, as well as provide the substance for stories in the millennia to come.

## The Promise and Possibility of Cosmic Evolution

***“No matter how far we go into the future, there will always be new things happening, new information coming in, new worlds to explore, a constantly expanding domain of life, consciousness, and memory.”***

**Freeman Dyson**

***“A day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon the earth as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars.”***

**H. G. Wells**

Throughout several earlier chapters, based upon the principle of reciprocal evolution, I developed the hypothesis that humanity, nature, and technology will progressively integrate in the future. Life and the environment will be infused and reconfigured with technology, humanity will be altered through genetic engineering, nanotechnology, and cyborgization, but reciprocally, technology will be guided by the principles of life and human intelligence.<sup>259</sup> Inspired by futurists such as Stock, Glenn, and Kurzweil, I also discussed in these chapters the related idea that we were moving in the direction of a holistic integration of human minds, artificial intelligence, and communication systems that could conceivably envelop the earth. Gaia will become Metaman and a global intelligence will evolve on the earth. In the previous chapter on ecology I presented the view, championed by Easterbrook, among others, that life is driven to extend itself beyond the earth, and that humanity, empowered with advanced technology, will be the instrument for the expansion of life into the cosmos. In this present chapter, I considered the theory, advocated by writers such as Savage, Tipler, Moravec, and Zey, that the web of communication and intelligence could spread out across the cosmos and achieve some type of conscious control over the universe. Life, intelligence, and technology, as an integrated whole, will “enliven” the cosmos.

Connecting all these futurist ideas is the theory of purposive evolution.<sup>260</sup> Intelligence and consciousness, whether biological or technological, (and that distinction itself will steadily blur) will increasingly guide the evolution of nature and the cosmos. Presently, our efforts at guiding evolution are relatively primitive and limited in scope. In the future, as our understanding of biology, ecology, artificial intelligence, and outer space grows, we will expand our efforts to terraforming, stellar engineering, and our own self-transformation into beings of space.

As I have argued, purposive evolution, which includes genetic engineering and intelligence amplification, is an evolution within the process of evolution itself. Throughout the history of the cosmos, the process of evolution has advanced through stages of increasing power, flexibility, and speed in furthering its own self-creative development. As Murray-Gell Mann, Kurzweil, and others have argued, the process of evolution has accrued greater intelligence with the passage of time. Beginning with the self-organizational dynamics of physical systems, such as within atoms, molecules, stellar systems, and galaxies, nature advanced to the level of genetic inheritance, natural selection and symbiotic relationships within life, and most recently, at least on the earth, the evolutionary process has been further enhanced with the introduction of culture, science, technology, and conscious design. In the ongoing interplay of order and chaos, following Kurzweil's Law of Accelerating Returns, evolution is creating increasing intelligence by becoming more intelligent itself.

Space exploration and colonization are natural expressions of evolution. The journey into space is part of a **universal process** in the **evolution of intelligence and order** within the cosmos. As the universe is colonized, an increasing level of complexity and organization will be infused into the physical structures of stellar systems and galaxies. If the universe as a whole is evolving toward increasing complexity and self-organization, bringing life, intelligence, and civilization into the cosmos is a further extension of the evolutionary thrust of the universe. These new levels of complexity across the vast expanse of the cosmos will involve the unique dimensions of conscious purpose and technological reconfiguration, hence an evolution in cosmic evolution. Asteroids, moons, planets, suns, and even galaxies may be redesigned and moved about and future civilizations may harness the colossal material and energy resources of the universe.

We could also see the process of **purposive cosmic evolution** as the means by which the universe achieves **self-consciousness** and **intelligent control** of itself. Easterbrook has argued that the overall evolutionary direction and meaning of life is the creation of mind and consciousness.<sup>261</sup> As Tipler suggests, we could see the emergence of a cosmic mind, an intelligence and consciousness rising up out of the entire universe. Tipler proposes that in the distant future, as the universe is purposively guided in its gravitational collapse (a monumental feat in cosmic engineering), this cosmic mind could create an infinitely rich immortal existence for all intelligent beings within the universe. What abilities and powers could an intelligent universe manifest? What are the limits of evolution? Following the lead of Tipler, all of these possibilities at the cosmic level could be seen as steps in the evolutionary creation of God. For Tipler, God is a being that evolves out of a self-conscious, self-controlled, and hyper-intelligent universe.<sup>262</sup> Even if one disagrees with Tipler's particular scenario regarding the future and the emergence of God, it does seem that the spread of life and mind throughout the cosmos and the growing envelopment of physical reality by consciousness and technology will create a universe that is conscious, indeed self-conscious. If evolution has an ultimate goal, it is the attainment of **cosmic self-consciousness**.

Yet offering a different scenario of space exploration, colonization, and the ultimate future of the universe, Adams and Laughlin argue that the universe will not collapse but continue to spread outward for quadrillions and quintillions of millennia, perhaps without end. Throughout this vast future history, the organization and composition of the universe will progress through various stages, from stellar dominated eras to a cosmos of multitudinous black holes with atoms larger than the size of our present universe. These future eras will be to our scale of time as our conscious lives are to the subatomic scintillations of electrons. Throughout this ever receding future history the unknown will continue to loom ahead of us, as it does now when we peer into the heavens above, forever beckoning, forever promising some new odyssey into the **infinite darkness of space and time**.

At this moment in time our species exists bound within the spatial confinements of the earth, and equally limited by the powers of our intellect, the mortality of our biological bodies, the struggles and apparent infirmities of our society and cultural values, and our perceptions and philosophies of reality. Throughout earlier chapters I examined the possibilities of computer and robotic intelligence and the biotechnological transformation of humanity. These technological developments, as writers such as Kurzweil, Vinge, and Moravec predict, will almost certainly lead to the creation of our evolutionary children and the **transcendence of humanity**. Yet, just as significantly, reality will be redefined in the process. As I have described, our evolutionary descendents may move into a cyber-reality of possibilities and dimensions far beyond our present world. Furthermore, as has been suggested by both space futurists and science fiction writers, the possibilities of existence may extend into higher dimensions, parallel universes, and trans-temporal and trans-luminal realities, to identify just some of the ideas that have been imagined. In the final analysis, our future physical and mental evolution, what we may become, as well as the reality and expanse of the cosmos that we will explore, are open and indeterminate. One thing though does seem clear; following from the reciprocity of life and the environment and the reciprocity of mind and the world, as our surrounding reality expands and evolves, our identities will transform and evolve as well.

As Wachhorst notes, evolution, exploration, and self-transcendence are all parts of the same process.<sup>263</sup> Exploration leads to evolution and evolution leads to self-transcendence. As I noted earlier, the exploration and colonization of space is not simply a technological and scientific quest but a psychological and spiritual one as well. Though technology will support the expansion and evolution of life and intelligence within the cosmos, it is the drive for adventure, discovery, and self-enlightenment that will motivate the exploration of the cosmos. Without exploring the cosmos, we will wither and die. By journeying into the unknown and extending our reach, we will be nurturing and evolving the spirit of life, intelligence, and the mind.

Hence, cosmic consciousness may not be a final state that can be reached, but rather an ever extending perspective, both reflecting on the whole as it is momentarily understood and on ourselves as evolving explorers within the universe. The darkness calls for illumination, but the darkness may extend

forever, both in space and time. As bearers of the light, we should approach the cosmos with a sense of purpose, of being part of something grand in scope and meaning. We should approach the cosmos with wonder and even love, for the universe is our home, the fountainhead of our existence. We should set sail with a sense of limitless possibilities and excitement over the mysteries ahead. The journey into space and whatever realms lie beyond the horizons of the universe is the “never-ending story”, the truest expression of the infinite and open nature of tomorrow. There will be no guarantees and no final chapters. That is the drama of the quest and the ultimate value of the journey.

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- <sup>196</sup> Simmons, 1997.
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- <sup>198</sup> Prantzos, 2000.
- <sup>199</sup> Adams and Laughlin, 1999.

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- <sup>200</sup> See Chapter 1. The Stelliferous Era extends from 10 to the 15<sup>th</sup> power to 10 to the 39<sup>th</sup> power of years after the Big Bang.
- <sup>201</sup> Dyson, 1997.
- <sup>202</sup> Savage, 1992.
- <sup>203</sup> Savage, 1992.
- <sup>204</sup> Kaku, 1997.
- <sup>205</sup> Savage, 1992.
- <sup>206</sup> Savage, 1992.
- <sup>207</sup> Prantzos, 2000.
- <sup>208</sup> Asimov, 1982.
- <sup>209</sup> Simmons, 1989; Simmons, 1990.
- <sup>210</sup> Vinge, 1992.
- <sup>211</sup> Savage, 1992.
- <sup>212</sup> Zey, 2000.
- <sup>213</sup> See Chapters 2 and 3.
- <sup>214</sup> Savage, 1992.
- <sup>215</sup> Vinge, 1992.
- <sup>216</sup> Savage, 1992.
- <sup>217</sup> Baxter, 1997.
- <sup>218</sup> Zee, 2000.
- <sup>219</sup> Margulis, 1993.
- <sup>220</sup> Savage, 1992.
- <sup>221</sup> Stock, 1993.
- <sup>222</sup> Savage, 1992.
- <sup>223</sup> Kurzweil, 1999.
- <sup>224</sup> See Chapter 3.
- <sup>225</sup> Wells, H. G., 1895-1934.
- <sup>226</sup> Tipler, 1994.
- <sup>227</sup> Prantzos, 2000.
- <sup>228</sup> See Chapter 2.
- <sup>229</sup> See Chapter 1.
- <sup>230</sup> Omega Point Web page of Transhumanism - <http://www.aleph.se/Trans/Global/Omega/>
- <sup>231</sup> Frank Tipler Home Page - <http://www.math.tulane.edu:80/~tipler/>
- <sup>232</sup> See Chapter 2.
- <sup>233</sup> Adams and Laughlin, 1999.
- <sup>234</sup> See Chapter 1.
- <sup>235</sup> See Chapter 1.
- <sup>236</sup> Dyson, 1997; Zey, 2000.
- <sup>237</sup> Hawking, 1988; Asimov, Isaac "The Last Question" (1956) in Asimov, Isaac The Best of Isaac Asimov Fawcett Publications, Inc., 1973.
- <sup>238</sup> Dyson, 1997.
- <sup>239</sup> Kurzweil, 1999.
- <sup>240</sup> Kaku, 1997.
- <sup>241</sup> Kaku, 1997.
- <sup>242</sup> Linde, 1994; Smolin, 1997.
- <sup>243</sup> Hawking, 1988; Hawking, 2001.
- <sup>244</sup> Kaku, 1997.
- <sup>245</sup> Baxter, 1997.
- <sup>246</sup> Simmons, 1989; Simmons, 1990; Simmons, 1995; Simmons, 1997.
- <sup>247</sup> Hawking, 2001; Pickover, 1998; Davies, Paul How to Build a Time Machine. Viking, 2001.
- <sup>248</sup> Tipler, 1994.
- <sup>249</sup> Asimov, Isaac The End of Eternity. Fawcett Crest, 1955; Leiber, Fritz The Big Time. Ace Books, 1961.
- <sup>250</sup> Baxter, 2000.
- <sup>251</sup> Adams and Laughlin, 1999.

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- <sup>252</sup> Smolin, 1997.  
<sup>253</sup> Tipler, 1994.  
<sup>254</sup> Vinge, 1993; Moravec, 1999.  
<sup>255</sup> See Chapter 1.  
<sup>256</sup> Tipler, 1994; Moravec, 1999.  
<sup>257</sup> Wachhorst, 2000.  
<sup>258</sup> Savage, 1992; Zey, 2000.  
<sup>259</sup> See Chapters 1, 2, 3, and 4.  
<sup>260</sup> See Chapter 3.  
<sup>261</sup> Easterbrook, 1995.  
<sup>262</sup> Tipler, 1994.  
<sup>263</sup> Wachhorst, 2000.