Theater of Memory against a Background of Stars:
A Generation Starship Concept between Fiction and Reality

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Abstract. The concept of the generation starship constitutes a feasible response to the serious travel-time restrictions that the light-speed limit imposes upon human exploration of deep space – "feasible" in the sense that it could be realized within a reasonably short time span, given our present state of technological advancement. It was Tsiolkovsky, the Russian pioneer of space flight, who first conceptualized the generation starship. In his 1928 paper, *The Future of Earth and Mankind*, Tsiolkovsky imagines the creation of a fleet of "Noah's Arks," self-sufficient, man-made worldlets that would travel to a distant star system over a period of hundreds or thousands of years, while the crew onboard simply live out their lives maintaining and piloting the ships, and have children whom they teach the necessary skills to do the same once they are gone. Their distant descendants, tens or hundreds of generations in the future, will complete the voyage when the ships finally arrive at their appointed destination. Since Tsiolkovsky's time, science and science fiction have leapfrogged each other in an attempt to imagine what the conditions and consequences of such a venture could be. For example: how could one maintain a stable society throughout such a long period of time – and what sort of governing body should operate during the voyage? How would the composition and number of the crew influence the danger of genetic drift or decay? How might the ship-born generations retain their commitment to the goals of the culture(s) that first built and then equipped the ship back on Earth, when Earth itself has become less than a memory to them? How will space change them, both biologically and psychologically? Is it possible to imaginatively explore the impact of imponderable, unexpected factors – a shipboard emergency, a previously unobserved physical phenomenon, a paradigm-changing discovery? This paper explores the evolution of the generation starship concept between 1940 and 1970, and the lessons that future planners of long-term space missions might glean from these imaginative efforts.

Keywords: Interstellar Travel, Slower-Than-Light Speed, Generations, Sociological Problems, Science Fiction
PACS: 87.23.Ge; 89.65._s; 89.65.Ef

INTRODUCTION

The writing of this paper was motivated by a desire to use literature, specifically science fiction (SF), to contribute something to the ongoing debate on the exploration of space. The literary approach to this aspect of human endeavor, while often difficult to employ as a straight source of information, can prove useful not so much for the scenarios it creates, but rather for what these scenarios reveal of our attitude towards the endeavor itself. When we finally go into space to stay, when the dream of a permanent human presence outside the Earth will have become a reality, we will create a literature – as well as other forms of artistic expression – like nothing we have ever seen down here. It will not be science fiction, not space opera – it will be the past fictions of space as straight realism. We should all be looking forward to reading it. In the meantime, we are left with science fiction, the literature the Earth bound use to dream about going into space. It is a form of planning for the future, and can be revealing not only of potential technologies and scientific approaches, but also and more importantly, of the possible ways in which people will come to terms with such a fundamental change in their environment. If literature is the distorted mirror humans use to imaginatively wear the lives of others, then SF is the literary form that allows us to dress ourselves in the garb of potential futures, and to speculate about how these futures might look like. Some of these possibilities are presented below.

TWO BASIC APPROACHES TO LONG-TERM SPACE TRAVEL

It is perhaps ironic to think that, while the technological and scientific challenges inherent in the "slow boat to the stars" approach are substantially less daunting than those involved in inventing a faster-than-light propulsion system, the sociological and cultural problems, on the other hand, promise to be far more serious in the former case than they would be in the latter. For all its theoretical improbability and practical impossibility (so the consensus seems to be, at least), the development of the warp drive would enable a pattern of human expansion in space similar in nature to the European colonization of Africa, America, and Australasia between the sixteenth and nineteenth centuries.

Such a pattern, made famous in fiction by, for example, the various *Star Trek* series, would involve no more than weeks or months of travel time for any ship, constantly supported by a technological, logistical, and social infrastructure arranged around the presence of inhabited planets, star bases, and communication relays spread more or less homogeneously throughout the expanse of human-inhabited space. If such a scenario were ever to become real, there would conceivably be little or no risk of cultural discontinuity within a given ship. That is, (1) the chances of the crew starting to develop a stronger sense of affiliation towards the vessel itself than towards their culture of origin would be negligible; and (2) the superluminal speeds at which both information and matter could travel would ensure a constantly renewed sense of continuity between the crew and the social nexus that sent it out into space. Communications involving mission parameters and operational orders, news from home, entertainment programs, cultural and political events, election results and so on could all reach the men and women aboard the ship in real time, or close enough to real time to allow them to keep thinking of themselves as identical to, continuous with, and interacting in their world of origin.

The generation ship, on the other hand, presents socio-cultural challenges of an altogether higher order. The concept was fully developed for the first time in 1928, when Tsiolkovsky (1993), the Russian pioneer of space flight, wrote a paper entitled *The Future of the Earth and Mankind*. In it, Tsiolkovsky envisioned the construction of "space arks," man-made biospheres (one could conceivably call them technospheres) that could travel to the stars at a small fraction of the speed of light, reaching their destination after centuries or millennia of travel time through previously uncharted space. Advanced life-support systems would keep the societies on these ships alive during the voyage, while they would navigate, repair, and tend to the vessel for the duration of their lives. Several generations would succeed one another over the centuries until, at the end of the trip, the last generation could complete the mission, whatever its nature: landing on a new Earth, establishing a forward base, etc. Tsiolkovsky's formulation represented as much a practical proposal for an entry point into space as a declaration of faith in human resourcefulness, because after 1905 we truly needed such faith to keep ourselves from despairing that we would ever reach the stars.

Before Einstein's theory of special relativity imposed an absolute limit on the maximum speed achievable by conventionally powered spacecraft, scientists and writers of speculative fiction operated under the assumption that, however great the distances between star systems and galaxies, all we needed was to develop a powerful enough energy source. Once such a source became available, it could be properly harnessed and channeled by the right kind of engine, and made to produce the thrust necessary to reach distant places in the cosmos within a matter of days, weeks, or months. The venture into deep space, so we thought back then, only waited for the right technological circumstances to prevail, and then it would become true in much the same way as transatlantic ships, trains, and cars had. And then 1905 happened, and suddenly we found the fundamental physical principles of the universe blocking our path to the stars. Short of bringing about a paradigm shift in our understanding of post-Einsteinian physics comparable in magnitude to the one Einstein himself initiated, we will remain destined to crawl across the skin of space-time at less than relativistic speeds.

And so the generation ship concept came to be. Tsiolkovsky was the first to fully and comprehensively illustrate the only available scenario for interstellar travel that, while not violating Einsteinian physics, could give us the stars: a multi-generational mission through space, carried out by a shipboard society with a cultural structure optimized for the task at hand. It is at this point that the real challenges of such an endeavor start becoming evident in all their magnitude:

> … it is hard to think of what could justify the expenditure of energy required for interstellar voyaging. In a recent paper Frank Drake has calculated that the energy needed to send a colony of 100 people over a 3 parsec distance over 100 years is equivalent to 'the total energy necessary to meet all the energy requirements of a major country, such as the

United States, for a period of time of hundreds of years.' He adds: 'It is very difficult to believe that any intelligent group of people, or any major government, would ever consider this a cost-effective approach to any problem.' (Regis 1985)

Even allowing for a decrease in costs due to the development of new technologies in the near future, present-day assessments of the economic and political returns attending the sponsoring and financing of a generation ship remain uncertain. Moreover, these problems are compounded by some relevant sociological and psychological issues: who would take part in such a venture, knowing that they would either never see Earth again or, should the trip be feasible within one's lifetime due to relativistic time dilation, return to an essentially unknown world, aliens in their own land? What sense of commitment to the mission could one expect to generate in a group of people who would eventually find themselves cut off from any meaningful exchange with Earth? What attachment to Earth could one hope to foster in successive generations of humans who, born on the ship and ignorant of any other environment, would only know of their elders' planet of origin through, at best, second-hand experience? These are only some of the serious variables involved in thinking about – or planning for – a multi-generational voyage through space. Since Tsiolkovsky's time, science and science fiction have endeavored to "wargame" a variety of scenarios that could provide some tentative answers to the problem. This paper presents a brief overview of these efforts during the so-called "golden age" of science fiction, when the birth of the first space age stimulated SF writers to provide plausible answers to the questions raised by the possibility of a permanent human presence in the solar system and beyond – something that, many thought at the time, could become real within the lifetime of the generation that was then endeavoring to send men to the moon.

GENERATION STARSHIPS IN SCIENCE FICTION, 1940 TO 1970

The first couple of "true" generation-starship stories, Wilcox's (1940) book, *The Voyage that Lasted 600 Years,* and Heinlein's (1941) book, *Universe* [followed a few months later by the second part, *Common Sense*], established a long-standing pattern for this kind of narrative: both are tales of struggle with social and cultural decay against a backdrop of degrading generations and failing memories.

The Voyage that Lasted 600 Years

Wilcox's (1940) story features a narrator/protagonist who serves onboard the S. S. Flashaway as "Keeper of the Traditions." Going into hibernation at the beginning of the trip, the character Gregory Grimstone wakes up once every one hundred years to make sure everything is fine with the ship – that is, he acts as a constant link to the memory of Earth, and therefore to the crew's sense of cultural and historical continuity with it. However, a series of unforeseen events – a surge in birth-rates, strife among the crew, the development of a family-based power structure strongly reminiscent of some areas of feudal Europe – conspire to gradually worsen the situation until, towards the end of the trip, the inhabitants of the ship have burned all books and instruments of learning, forgotten how to operate or repair complex machinery, lost any memory of Earth as a real place, and instituted a process of cultural myth-making that explains the "Keeper of Traditions" regular reappearances in terms of a fable, or a cautionary tale.

In the absence of learning tools and schooling procedures, science became magic, the Keeper a monster, and his tools and weapons objects of arcane power. The area of the ship where he hibernates is now a shunned place, and his cold-sleep chamber has turned into the archetypical fairy-tale cave, the place of darkness where evil dwells. At the end, Wilcox solves his character's dilemma with a rather pulpish twist: Grimstone storms the control room of the S. S. Flashaway, puts the captains in hibernation, and flies the ship himself until they reach their destination – where they find an already well-established human colony! It turns out that the warp drive was not that far into the future from the day the S. S. Flashaway left; new, fast ships completed the trip in a mere six years, and the settlement that the original colonists were supposed to found was established fifty years before.

Discussion of Issues

From a purely practical point of view, Wilcox's (1940) book, *The Voyage That Lasted 600 Years,* raises as many questions as it answers. For example: why is the Keeper the only one that goes into cold-sleep? If the technology is already available and reliable, why not hibernate everybody and be rid of all the trouble before it even starts? There

are plausible answers to that (even the best automation fails, you never know what could be out there, there is nothing like human instinct and spirit of improvisation, etc.), but the story does not address the issue. Also, why hibernate for such protracted periods? Given the average life of a human being, and allowing for improvements in medical science in the near future, the Keeper would easily have been able to stay awake for one year out of every fifteen or twenty, and still have had a good amount of time left once the ship reached its destination. The much shorter intervals between waking periods would have done a lot to help keep the vessel's society from decaying the way it did.

Universe and Common Sense

Heinlein's (1941) books, *Universe* and *Common Sense* [reprinted in 1963 as a single novel, with the title *Orphans of the Sky*], present an altogether sharper, more detailed picture of social and cultural degradation – in fact, the narrative takes the idea to its conceptual extreme. In this case, the events that trigger social decay are a mutiny and its attending conflict, during which the ship is damaged and crucial information is lost – again, books and tapes are burnt, specialist crewmembers are killed before they can pass on their knowledge, and so on. As a result, during the course of the decades and centuries after the mutiny, the people onboard the vessel do not simply forget how to operate it, they actually forget they are in a ship. Their descent into barbarism and ignorance is so pervasive that they come to see the ship as their entire universe, use the term "Crew" to mean the entire human race, and employ a complex mythological system to explain their voyage in allegorical terms. When the character Hugh Hoyland, the protagonist of the story, is inducted among the ranks of the so-called "Custodians," he starts reading the holy tomes of his religion. One of the most important of them is called "Basic Modern Physics," and when Hugh gets to the section detailing the "Law of Gravitation," he and his mentor have an interesting discussion concerning its interpretation:

> "Well, (…) it didn't seem to mean anything. It just sounded silly, if you will pardon me, sir."
> "That illustrates my point. You were thinking of it in literal terms, like the laws governing electrical devices found elsewhere in this same book. 'Two bodies attract each other directly as the product of their masses and inversely as the square of their distance.' It sounds like a rule for simple physical facts, does it not? Yet it is nothing of the sort; it was the poetical way the old ones had of expressing the rule of propinquity which governs the emotion of love. The bodies referred to are human bodies, mass is their capacity for love. (…) when they are thrown together, they fall in love, yet when they are separated they soon get over it. "Out of sight, out of mind." It's as simple as that. But you were seeking some deep meaning for it. (Heinlein, 1963)

In the end, Hugh ends up clinging to his strongly Galilean skepticism, and just like his illustrious real-life predecessor, he must confront his society's hostility towards heretical ideas. His task is made even more difficult by the utter absence of viewing ports in the section of the vessel his people occupy, which robs him of any evidence to back up his claim that he and his peers are on a ship traveling through space, headed for a certain destination nobody even remembers anymore, and launched from a world called "Earth" centuries before – no evidence, that is, until he finds the starship's control room, lavishly provided with a large window from which can be seen both the rest of the universe and the hull of the ship itself. The revelation triggers yet another power struggle, this time between Hugh's followers and the adherents of the old ways, the latter group being constituted by those who have not yet seen the control room window and refuse doing so out of piety.

Discussion of Issues

As in Wilcox's (1940) tale, Heinlein's (1941) employs a standard pulp fiction solution to the crisis onboard the ship: after their faction is defeated by the orthodox part of the crew, Hugh simply hijacks a shuttle and, with his only follower and their respective spouses, lands on their planet of destination, leaving the vessel to keep drifting forever, along with its ignorant cargo. The story presents us with no solution to the problems of a multi-generational flight. How was the original crew chosen, and in what structure was it arranged? Would this arrangement have worked if not for the mutiny? Or was the mutiny inevitable, and in this case, what solutions could conceivably have restored a meaningful social structure to the people onboard? Heinlein does not address these problems, except to say that something went wrong so as to be able to present a case for the importance of scientific learning and education.

Social Commentary and Power Structures in the Post-Heinlein Era

Together, Heinlein's (1941) and Wilcox's (1940) stories inaugurated a trend in generation starship writing that would last until the early 1970s – and has actually been revived in more recent times, under slightly modified conditions. Such an approach to the variables of long-term interstellar flight can yield interesting insights to researchers in the field, at the cost of careful sifting of useful practical suggestions from the rest – for science fiction is a literary genre constantly teetering on the cusp between the two worlds encapsulated in its definition, the sciences and the humanities, and its themes and tropes always constitute a compromise between the exigencies of effective dramatic tension and the desire to present a plausible interpretation of future trends. Be that as it may, the amount of information extracted from the collective of stories treated below can be distilled to provide insight into several areas of interest. For this section of the paper is limited to an analysis of the governing body that should operate onboard the generation ship: would a democracy work best, or would it be more expedient to put the entire mission under the command of a "beneficent dictatorship" designed along the lines of, say, the government of the Greek city-states during the age of Pericles? Would a theocracy provide the necessary cultural cohesiveness, or would it degenerate into dogma and social sclerosis? Could different governments within the same vessel function as a generator of political and cultural energy?

An interesting feature of the "barbarism" approach is the deft sleight-of-hand with which most of the stories tend to dodge the issue of government. At the beginning of the voyage, the command structure of the generation ship is based on a hierarchy identical in every aspect to the power structures operating aboard any conventional vessel; there is a captain, a series of senior officers, specialists in various crucial disciplines, the crew – and their families, who often play the role of x-factor in the ship's social mix. Then order breaks down, usually through a freak accident [overpopulation in Wilcox (1940), a mutiny in Heinlein (1963), an epidemic in Aldiss (2000)], and the collective degrades into various kinds (and degrees) of pre-industrial societies, ruled by the kind of governing body that their Earth counterparts are known to have employed in ancient times: tribal and family-based collectives in Aldiss and Wilcox, an Aztec-type theocracy in Harrison, a quasi-feudal system in Heinlein, an oligarchy in Tubb (1976), and so on. The whole point of these power structures is that they work (or do not) precisely because something went wrong; they make sense to the reader because he/she knows that the striking similarities with ancient Earth societies are the product of a reversal, of a turning away from the future and into the past. By the time order and knowledge are restored the ship has reached its destination, so that the colonists can finally land and the issue of shipboard power structures is bypassed entirely – scant pickings for researchers seeking plausible answers to conceivable scenarios, and answering that there actually is a command structure operating onboard the ship before things go badly only dodges the issue. It is not beyond the realm of the possible to imagine that the kind of power structure that applies to Earth-based ships (an oil tanker, a cruise ship, a carrier battle group) would not work in the case of a multi-generational space voyage, essentially because such a structure is precisely designed not to be permanent – otherwise, the crew of a ship might end up thinking of their vessel as their country, and that could prompt them to set their own goals, in all likelihood at variance with the interests of the society that trained, paid, and equipped them. Earth-bound vessels are created to not be home. However, such a choice would be impractical in the case of a generation ship, possibly to the point of being destructive, and one could argue that, instead of dodging the problem of shipboard governments, the collective of the reversal-to-barbarism stories provide a repeated commentary on the dangers of setting out on a generational trip without the proper social arrangement. Some tales in the group, however, do grapple with the issue directly.

The Oceans Are Wide

Robinson's (1953) book, *The Oceans Are Wide*, at first glance, does not seem to actually change the game, because it presents the reader with a shipboard society whose governing body is essentially identical to Earth-bound, family-based power structures. When the old captain dies at the beginning of the tale, the position automatically passes to his son, who must exercise that power within the setting of a rather Machiavellian power struggle between himself and a number of greedy uncles, aunts, and cousins. Robinson, however, inserts a new level of political agency by having the society on the ship observed and ultimately manipulated by one single man, an overseer who, thanks to an unspecified immortality drug, has remained alive since the day the ship left Earth. The new captain, who knows enough but not everything, is aware that the power struggle in which he is engaged represents only part of a game played on an altogether larger chessboard than anybody knows, and learns the true nature of the situation as the story progresses: the generation ship in which he lives is the last of a fleet of identical vessels, launched from Earth

in the planet's last days after a nuclear war. Every other ship has come to grief in one way or another, and they are the last remnants of mankind. If they die, the human race will vanish from the universe. As a result, from the overseer's point of view everything is subordinated to the imperative of survival: people, resources, governments, values, private life. Like Grimstone in Wilcox's (1940) story, the overseer represents Earth's living memory, but unlike Grimstone, his extended lifespan does not come at the price of prolonged periods of absence from the world. He is always there, always awake, always aware, and his functional immortality allows him to hatch plans of far greater depth and scope than anything the remaining inhabitants, with their mayfly lives, can bring to fruition. The ultimate form of governance that Robinson (1983) proposes in his generation ship story is essentially a dictatorship of supreme competence, enabled by medical technology and supported by historical awareness.

Captive Universe

Harrison's (1669) solution for the governance issue is, if possible, even more radical. That is, the forgetfulness pattern in Harrison's book, *Captive Universe*, it turns out, did not just happen – it was arranged to spare the crew the psychological strain of being cooped up inside a ship over a period of centuries. Before the vessel left Earth, the original participants were carefully selected and genetically engineered to produce two populations. The first are the so-called "Observers;" designed to possess low intelligence and a dogged deference to authority, they are the keepers of the ship and the guardians of the second population, the Aztecs, chosen for the trip because of their ancestral culture, with its love of order, strong faith in a thoroughly hierarchical power base, and rather vengeful deities who will reward those who trespass their admittedly strict set of laws with terminal punishment. Divided into two villages within a closed valley, complete with a fake sun and a painted sky, the Aztecs are not allowed to marry between the two communities. They can only marry within their own village – until the day the ship reaches its destination, at which point the genetic traits causing lack of intelligence, placidity, deference to authority, and fear of exploration will no longer be needed. At that time, the Aztecs will be allowed to intermarry, and those unions will set off the elimination of the recessive genes and the birth of a new generation of planetary settlers – curious, intelligent, self-reliant people, able to tame the newly discovered wilderness and adapt to its environment. As in Robinson's (1983) book, *The Oceans Are Wide*, the local power structures in Harrison's book, *Captive Universe,* have been put in place as a palliative, but without the presence of an actual *deus ex machina*. In this instance, machinery and genetics represent the blind guardians of the status quo.

Lungfish

Brunner's (1957) book, *Lungfish,* constitutes something of an oddity compared to the patterns of social analysis we have seen so far. Instead of framing the collapse of the mission's original power structure in terms of an accident, or making its continued existence part of a larger plan, the story portrays its failure as the inevitable result of evolutionary developments within the generation starship's population. With the passing of the years and the birth of two generations of crewmembers who have never seen Earth, the relationship between them and the remaining members of the original crew becomes increasingly more strained, a result of the radically different environment within which the former – who call themselves "Tripborn" – were raised. Never having known seasons, weather, oceans, or even the simple sound of a breeze rustling the leaves of a tree, the Tripborn soon start exhibiting psychological traits which seem distinctly disturbing to the "Earthborn," who hold the reins of power in their capacity as guardians and guides to the new generations, but fail to recognize the changed behavioral parameters of their situation. When the ship finally arrives at its destination, and one of the Tripborn is sent down to the planet to investigate, the real magnitude of the generation gap becomes violently evident when the unlucky crewmember suffers a massive attack of agoraphobia. After that, the Tripborn refuse to land, and arrange for the Earthborn to populate the new planet in their stead, while they will simply continue to exist within the environment most congenial to them: deep space, and the ship they call home. Brunner's story is a tale of human evolution outside the biosphere that gave it birth – the title an open reference to the first amphibian creature which could exists on land without needing to periodically return to the ocean to reproduce. The end of the story places this new evolutionary phase in perspective:

> "This isn't the end of mankind; there are still snakes and birds and dogs on Earth, still amphibians, even, which have to return to a pond and lay their eggs. That's what I think the Tripborn have become: amphibians, who will have to return to their rock pools, their planetary bases, when they want to reproduce. But that need only be a temporary phase. The

ship we are going to build here will teach the Tripborn how to breed. And after the amphibian, there will be a snake, and a bird, and a dog – "The certainty was growing. He could *feel* it."

"And in the end," Franz said slowly, "there will be a man." (Brunner, 1972)

The end result of the human venture into space, Brunner suggests in his story, might well be the beginning of a new phase in human evolution, one that could usher into the interstellar stage a sub-strain of the human race one might call, conceivably, *homo sapiens spatialis*.

LESSONS LEARNED FROM SCIENCE FICTION

The April, 1953 issue of the short-lived magazine *Science Fiction Plus* featured, among other things, a four-page article by Shepherd (1953), then-technical director of the British Interplanetary Society, who discussed the problems and variables involved in conceiving a generational voyage to the stars. Shepherd was writing in his capacity as an expert in the technological aspects of the issue, and accordingly he openly demurred giving more than a passing hint of the sociological ones, largely confining himself to a discussion of possible propulsion systems. However, it is interesting to note what he did have to say about human life onboard the generation ship:

> The passage of perhaps thirty generations would pose major problems of a sociological nature. The control of population would be only one of many. Children could only be born according to some prearranged plan, since overpopulation or under population would be disastrous. The community would be subjected to a degree of discipline not maintained in any existing community. This isolated group would need to preserve its isolated civilization, and hand on precious knowledge and culture from generation to generation and even add to the store of science and art, since stagnation would probably be the first step to degradation. (Shepherd, 1953)

By and large, Shepherd's (1953) passage encapsulates the basic parameters that informed science-fictional reflections on the generation ship concept, and especially relevant among them is the attitude towards the role that technology is expected to play. The hard science fiction of the time predominantly operated on the assumption that scientific and technological advancement would be limited to the outside of our body – computers, machinery, robots, weapons, all would exist as an adjunct to the untouched sanctity of the human frame. Even the postulation of biological enhancement technologies – the immortality serum in Robinson's (1983) book, *The Oceans Are Wide*, for example – did nothing more than provide the body with one or more super-human abilities, without bothering to speculate on the inevitable psychological and sociological consequences attending such relevant alterations. This attitude engenders a set of perspectives whose advantages can prove useful in advancing our speculations.

Today, at the birth of the twenty-first century and possibly at the threshold of what Kurzweil (2000 and 2006) in his books *The Age of Spiritual Machines* and *The Singularity Is Near* calls the "post-human singularity," humans face the prospect of a radical change not only in our infrastructure, but in our bodies as well. Nanotechnology, stem cell research, genetic engineering, cloning, cybernetic interfaces – all these advances seem to be lying in wait immediately outside of our present reach, not yet obtained but very close to becoming real. In the meantime, however, we do what we can with what we have: ourselves, slightly improved and longer-lived than we were millennia ago, but basically still the same system, and it is here that the speculations of golden-age SF might yet become, fifty years after the fact, actual. When taken together as an interconnected, thirty-year-long dialogue on the subject, the group of stories featured in this paper essentially represent the attempt to find out what happens when whole generations of un-augmented, standard-lived human beings are asked to spend their entire lives in the service of a goal they will never reach. From the evidence gathered, we should probably conclude that exclusively placing our faith in self-denial and dedication to the cause to successfully see the mission through would be a mistake. Sociologically as well as psychologically, we will need a radically new social arrangement to make the prospect of a generation-ship voyage bearable for the people onboard, and in this respect the development of a shipboard ecological movement may well prove to be the most important legacy of the stories under examination. At a time during which those particular perspectives were still in their infancy, at least for the public at large, generation starship tales were talking about hydroponics, recycling systems, closed ecological loops, and effective birth control procedures. Irrespective of whether they had fallen into forgetfulness or not, the people living onboard the ship displayed an awareness of the necessity to carefully husband available resources that would do Al Gore proud. In actuality, indeed, the teaching and practice of ecological awareness would not simply constitute an essential survival trait for the crew; it would also provide future generations with the basic knowledge they need to:

a) Successfully survive once they have arrived at their planet of destination, and
b) Remain able to relate, at least in general terms, to the idea of a planet-bound existence after an unspecified number of centuries spent in deep space.

Another relevant point some of the generation starship tales have engaged is the question of a potential shift in the crew's priorities during the voyage, either because of unforeseeable changes in their situation or because the values of the new generations are too different from those of their predecessors. Here, Brunner's (1972) story is particularly relevant (also see; Cooper's (1959) book, *Seed of Light,* and McIntosh's book, (1961) book, *200 Years to Christmas*). The Tripborn are neither evil nor handicapped; they appear so from the perspective of the Earth-born crewmembers, whose values and morals, shaped as they were by decades spent in a planetary biosphere, prevent them from realizing the full extent of the influence that their changed environment exerts on the Tripborn's psychological makeup. These differences create two conflicting social realities, and it is only after the Tripborn crewmember's agoraphobic seizure that those realities start finding some sort of common ground, one that takes into account the now permanent changes between the planet-bound and the space-bound. Extrapolating fiction into a possible reality, we can certainly say that the few human beings who have been in outer space have often testified to a relevant shift in their view of the world, and of the role the human race should play in it – in the words of Ed Mitchell, a NASA astronaut, "you develop an instant global consciousness, a people orientation, an intense dissatisfaction with the state of the world and a compulsion to do something about it" (see; James, 1994).

And that is only for a comparatively short stay in near space. What would happen in the case of a permanent immersion in deep space? This question, in turn, leads us to another, even larger one: what lies out there exactly? To be sure, our space programs, coupled with spectral analysis and observational astronomy, have given us an acceptably good idea of the physical composition of the outer void, so that we can say with a degree of accuracy that nothing much seems to exist out there, far away from any solar system. However, saying that we do not see much in deep space is not the same as saying that there actually is nothing (there is dark matter, for example), and even if that were indeed the case, the mind has consistently proven capable of reacting to the absence of events with a force equal, if not greater, than that with which it would react to some actual occurrence. Outer space, ink-black and utterly alien to the human experience, elicits a response from our subconscious simply because it is there, and it is only because the Earth has so far been perfectly visible to every astronaut that this variable has not yet fully manifested itself. Things would certainly be different for a generation-long deep-space mission – indeed, we could conceivably speculate that, from the perspective of the crew's mental health, an eventful mission might be less stressful than an empty one, because the former would make them feel that, in some way, their responses to the outside matter. As silly as this sounds, let us not forget that human beings are still wired to respond to darkness with fear, and that the color black carries a set of associations which, in the long run, could easily have an adverse effect on the crew's morale, even on their sanity. There would be plenty of time for that in a generational flight. The obvious solution to the dangers inherent in contemplating the void would be to close all the viewing ports, but that would generate another problem, something with which the crews of today's submarines are fairly familiar: claustrophobia.

If fear and a sense of displacement represent problems that are likely to arise in a long-term space mission, an equally likely reaction to life in the void is the birth of a certain sense of wonder towards the utterly alien, usually the first step in a process of adaptation to the new conditions. This is certainly the possibility foreshadowed by Brunner (1972) in *Lungfish*. In the absence of hard data concerning the possible psychological configurations that could result from such a response, the only option left to us is speculation. However, we can provisionally say that curiosity towards the changed environment could become a solution to the overarching issues of governance, social stability, and crew happiness. In such a scenario, the shipboard government would consist of a democratically elected body of specialists in all areas relevant to the success of the mission. This group of people would set policies and priorities in the interest of achieving long-term scientific and cultural goals, and embracing the idea that the collective onboard the generation ship have become, and will increasingly become over the years, an astrosociological experiment designed to push forward the limits of the known while retaining a sense of their identity, not as a nation or a culture or a crew, but rather as a species. To this end, the ship should be equipped with:

a) State-of-the-art scientific equipment covering every known discipline, designed to easily receive upgrades or even radical redesigns as events warrant;
b) Manufacturing facilities able to create new artifacts and technologies resulting from scientific breakthroughs;
c) A complete summation of human knowledge in the fields of history, sociology, psychology, philosophy, politics, religion, literature, the performing arts, the visual arts, and so on; and

d) A library containing every book, poem, essay, treatise, movie, documentary, pamphlet, commercial – in other words, every scrap of information ever transmitted by human beings, irrespective of how trivial it looks to us today on Earth, because we would have no way of knowing what might become relevant, useful, or fundamental out there, three centuries from mission launch.

Given the magnitude of the database, this would be a virtual library. All this hardware and software would be used constantly inside permanent schools, and every human being onboard the ship would literally live out their life in the twin role of teachers and students – teachers in their discipline(s), students in the others. There would be no such thing as an officially sanctioned end to learning; everyone on board would need to constantly integrate new discoveries and changed perspectives as quickly as possible, because the continued existence of the ship could well depend on them. Also, these schools would provide the crew with the ability to generate artistic and cultural expressions of their own, thereby giving their society a truly original identity, unique to its conditions.

CONCLUSION

It is fairly evident that the thinking behind the scenario outlined above is utopian in nature. The idea of a democracy of knowledge can hardly be said to be original with this paper, and its previous incarnations have proven less than sturdy when confronted with the reality of current circumstances. However, it could be argued that, since one of the key variables in a generation ship voyage will be the crew's happiness with their situation, the future organizers of such a mission will find themselves in the position of having to literally plan for happiness. This cannot be the happiness of, say, an aircraft carrier's crew, who knows; they will be back home soon enough and can therefore bear the discomfort of their relative isolation for the time being. There is no "back home" for a generation starship. The awareness of the fact that they are, for all intents and purposes, a world of their own, humanity's first exterrestrial-planetary colony, must be met with curiosity, eagerness, even enthusiasm. The people onboard must necessarily embrace the idea that, far from venturing out into space to perpetuate Earth-bound realities on other planets, they are in fact letting the realities of deep space change them. Any other attitude will probably engender feelings of isolation in a hostile universe, feelings which will accumulate inside every individual on the ship over the years, and eventually find collective expression in the form of some kind of social collapse – possibly similar, or even identical, to the barbarism approach. If radical change is the way to successfully plan and execute a generational mission, then knowledge in all its aspects must be fostered, practiced, and constantly updated. The price of doing otherwise would be uncontrolled, undirected change that would rob the ship's population of choice and purpose, and would probably result in irreparable damage to the mission itself. Knowledge would give the shipboard society the ability to assess, extrapolate, and normalize change, to adapt to altered circumstances without losing too much of its constituent characteristics in a single stroke.

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