SCI FI-ARIZONA
A Virtual Science Fiction Bookstore And Writer's Workshop

Writer's Workshop Series
The Art of Science Fiction
No. 20

World Building For Fun And Profit, Part II

By
Michael McCollum

You've all seen pictures of Earth taken from space. Our beautiful blue-white world hangs there against the black backdrop of the star-filled universe, its girdling swirl of clouds contrasting sharply with the blue of the oceans and the brown-green of the continents. A layer of haze that seems too thin to be our lifesaving blanket of atmosphere softens the planet's limb. At each pole the icecaps glare with enough brightness to make an observer squint, and pairs of contra-rotating hurricanes frequently straddle the equator as they wend their way toward landfall on some distant shore.

Astronauts tell us that the view of Earth from low orbit is one of the most beautiful imaginable. In fact, the sight of the planet seems to trigger a special response in the human psyche. It is almost as though Earth is transmitting a siren song on a wavelength that we can sense, but never hear. It is a song beckoning our species back to its place of birth.

Isn't it lucky that we humans just happen to be living in the one place in the universe that so perfectly matches our physical and psychological needs that we can run naked beneath the warm sun and not fear for our lives? Where else in the Solar System can we make that claim? Not on overheated Mercury, or pressure cooker Venus, or frigid carbon dioxide enshrouded Mars, nor crushing Jupiter, nor frigid Pluto. Only on Earth will the human machine operate for long periods of time without the use of artificial aids. Only on Earth do we walk naturally under a pull of one standard gravity, are our circadian rhythms perfectly synchronized, and our lungs filled with the pure mixture of 80% nitrogen and 20% oxygen that we crave so. My mother, who is a very religious woman, maintains that the correlation between Earth's environment and humanity's requirements is proof of God's handiwork. And while I agree with her in the most abstract sense, I don't place the same emphasis on the facts that she does.

I blame evolution.

If you think about how it is we came to be on this blue-white marble in space, I think you will agree that it is less surprising that we fit our niche than it would be if we didn't. Earth is our cradle, the world that shaped our evolution long before there were such organisms as human beings. We look upon our world and see beauty because it is perfectly suited to us — or rather; we are perfectly suited to it. Our distant ancestors, the amoebas, swam in its oceans, as did all of the fishlike animals that went before us. The first amphibians that ventured out of the water and onto dry land did so onto continents that were shaped differently, but which were otherwise very like the ones we live on

today. The first small mammals hid among the same trees that we now relax beneath, and the first hominids sweated beneath the same yellow-white sun that heats us.

Earth is our mother and evolution has seen to it that we are perfectly suited to her conditions. We are comfortable in temperatures found in the temperate regions of our world in spring and summer, and we require minimal environmental protection even under the most extreme conditions of winter and fall. Our eyes see best in the wavelengths of light from a spectral class G2 star, especially after that light filters through the chlorophyll tinted leaves of a forest. Our hearing is optimized to detect directional sound waves as they pass through the air at pressures of 760 millibars and speeds of 330 meters/sec (1100 feet/second). Our epidermis is covered with tiny hairs that allow us to sense the merest puff of breeze on naked skin, and our cooling system allows us to run all day in the hot sun without keeling over from heat exhaustion. One of the most common substances on the surface of our world is di-hydrogen oxide (water); which is lucky for us since we happen to be big, walking sacks of the stuff. Small wonder that human beings find the Earth to be beautiful from space.

What if the Earth hadn't turned out to be seven-tenths covered with water? What if it had been born a dry, desert world with vegetation of crimson and a sky of deep purple? What if the atmosphere was thick with the green haze of chlorine? Would we find the planet so beautiful then?

The answer to that question is "yes." We would find it just as beautiful because we would have evolved to breathe chlorine and bask in the hot sun among the crimson-leafed trees. We find beautiful those things that evolution has programmed us to find beautiful. Anthropologists have long noted that our various standards of beauty among human cultures have at their root an evolutionary purpose. The basic female shape to which most men are strongly attracted (wide hips and large breasts) are caused by physical attributes that maximize the probability of successful child bearing. The large, strong male archetype to which women are attracted once denoted someone who would likely be a good provider of food. Now, of course, the archetype of a good provider is someone who is scrawny and wears glasses – the Bill Gates, computer nerd type. I doubt, however, that the computer revolution will last long enough to give evolution the time to change the basic female programming.

Even the variation in standards of beauty between cultures can be attributed to evolutionary roots. Several years ago there was a hilarious German film called *The Gods Must Be Crazy*. The movie follows the adventures of a Kalahari bushman who is trying to rid his world of an alien artifact, namely a Coca-Cola bottle some careless tourist dropped out the window of an airplane. During his quest to throw the offending bottle off the edge of the world (actually, into a wide river gorge), the bushman encounters the heroine of the movie, a beautiful German blonde whose attributes made me instantly attentive. The bushman's reaction to her is different from mine. He takes one look at her pale skin and wonders whether she was something that crawled out from under a rock, proving that beauty to a Kalahari bushman is a Kalahari bushwoman!

Nor is this merely a human reaction. Most of the higher animals have some analogous sense. We humans consider warthogs to be so ugly that some of us wonder how they ever manage to procreate. This is a decidedly parochial viewpoint. There is little doubt that a male warthog finds a female warthog to be beautiful and probably

wonders what human males see in human females. Why, those two-legged pigs don't even have musk glands with which to attract the ladies!

One of the interesting things about being a science fiction writer is that we are required to step out of ourselves and look at things from a wider perspective than that of our local village, country, or planet. What, precisely, did those Bug-Eyed-Monsters plan to do with the scantily clad women they held in their clutches on all of those pulp magazine covers? Surely they couldn't have had amorous intentions. Assassination with intent to ingest would be understandable, but rape would just be weird, even when viewed through alien eyes. And just why were those chlorine-breathing, frigid slugs trying to take over a godawful hell of a planet like Earth in the first place?

When we finally go out to the stars, we will look for worlds that bear a striking resemblance to our own. Optimally, they will all be blue-white marbles framed against the blackness of space, and to whatever extent they are not; it will be because a paucity of terrestrial worlds will force us to settle for something not quite up to our standards. The same can be said for any other species that invents interstellar travel. The inhabitants of a Jupiter-class gas giant will visit all of the gas giants in their stellar neighborhood, ignoring the small, wet worlds that have too much liquid water on them. The inhabitants of a Venus-class hell will check out other cloud enshrouded worlds with sulfuric acid atmospheres. The beings with superconductors for arteries will confine their searches to the cold, dark worlds at the very edge of a star system and never venture deep into the furnace-like heat of the inner systems.

Thus, if we are to write interstellar adventures with starships dueling like the Roman and Phoenician galleys of old, we will have to crew our enemy ships with creatures who inhabit a world more or less like our own. Only those species that crave the same real estate as humans are likely to come into conflict with us. Both Poul Anderson and Larry Niven have made this point in their novels. Each have whole interstellar empires interpenetrating one another, with different species colonizing the planets that best suit them, while leaving the worlds of fundamentally different species unmolested.

Last month we learned something about how planets are situated around stars. We learned to choose a suitable star for the fictional home of our alien villains or colonist heroes, and then to place a planet in orbit at a distance where human beings would be neither cooked nor frozen. We will now look at what it takes to actually build a terrestrial world from scratch, or at least, to imagine one. There are a number of factors to take into consideration when you set out to construct an entire planet.

Newton's Law of Gravity

Several years ago I was somewhat surprised when a friend of mine, a graduate engineer with more than twenty years experience, asked me to explain the difference between a planet and a star. I doubt that anyone reading *The Art of Science Fiction* would be confused about the distinction, but just in case, I will explain anyway. A planet is an intermediate size mass floating in space. Larger than an asteroid, a planet tends to be roughly spherical in shape and smaller than a star. Planets shine by reflected starlight, not through internal illumination caused by a thermonuclear reaction. They may or may not have smaller collections of mass (called moons) circling about them.

One thing all planets have in common is a gravity field that attracts objects to them. In fact, that is how planets are formed. Large masses of stellar gas and dust tend to coalesce under their mutual gravitational attraction. Over time, the large central mass becomes a star and multiple smaller masses become planets to orbit the central star. Nor is this behavior unique to stars and planets. *All* mass in the universe is attracted to all other mass via a phenomenon we don't understand well, but which we call gravity.

Since the Earth is a planet, it also possesses a gravity field, a fact that is understood intuitively by every child who has ever fallen out of a tree. The first person to take this innate knowledge and quantify it was Sir Isaac Newton. Legend has it that he was sitting under an apple tree one day when an apple fell down and conked him on the head. Whether true or not, somehow Newton became interested in why it is that things fall down, and after inventing the mathematics of calculus to prove his point, postulated his Universal Law Of Gravitation:

Equation 1: $$F = G\frac{M_1 M_2}{r^2}$$

What Newton's Law of Universal Gravitation says is that the force weighing you down is equal to the Earth's mass, multiplied by your mass, divided by the square of the distance between yourself and the center of the Earth. To make the units come out correctly, the result of that calculation is then multiplied by a number called the Universal Gravitation Constant, G. To acclimate you to how Newton's Law of Gravitation works, consider that G = 6.672 X 10^{-11} Nm^2/Kg^2, that M_{earth} is 5.9763 x 10^{24} Kg, and that the radius of the Earth is 6370 Km. If you plug these numbers into Equation 1, along with your own mass (measured in kilograms, not pounds), you will come up with the force with which Earth is attracting you, measured in Newtons. (To get pounds, multiply by 9.8.) Since the Earth is so much larger than you are, we give the force of mutual attraction between the planet and ourselves a special name: We call it our "weight."

But what if the planet you are standing on is different from Earth? Will it have a different gravitational pull? Almost surely. How, then do you calculate the gravitational pull for a world other than Earth?

The easy way is to merely say, "The gravity was 1.05 of standard." That way you don't have to do any calculating, especially if you don't specify exactly how large the planet is. However, your writing will have more verisimilitude and your horizons will be wider if you know the various factors that affect the gravitational pull of a world.

Gravity on Other Worlds

To calculate the gravitational pull of another world than Earth, all that you need know is the diameter of the planet and its mass. And while you can calculate the gravitational pull using Newton's Law of Universal Gravitation (Equation 1), this can be a procedure that is prone to errors in decimal place. To make it easier, you can calculate the gravity field of a planet based on its relative size and density with respect to Earth. The equation for this is as follows:

Equation 2: $$A_{Gravity} = r_{rel}\rho_{rel}$$

Where $A_{gravity}$ = Acceleration due to gravity, measured in "Standard Gravities, i.e., multiples of Earth's gravitational pull of 980 cm/sec^2).

r_{rel} = the planet's radius, relative to Earth's 6370 Km.

ρ_{rel} = the planet's density, relative to Earth's 5.5 grams/cm^3.

If the foregoing seems a little esoteric to you, it really isn't. Consider a world that has a mean radius very much larger than Earth, but a much lower density. The world has a radius of 60,000 km (9.4 times that of Earth), but a density of only 0.7 grams/cm^3 (0.127 that of Earth). A planet with such a low density is obviously a gas giant composed primarily of hydrogen and helium. Earth's density of 5.5 grams/cm^3 is the result of our planet's heavy iron core.

Plugging the above values into the formula yields the surprising fact that a world nearly 10 times the size of the Earth only has a gravitational pull of 1.19 standard gravities, a mere 19% greater! This illustrates the point that both the size and density are required when calculating a planet's gravity. (If you are wondering if this is accurate, there is no need to take my word for it. The numbers used in the calculation are the vital statistics for Saturn, a big world, but one with a low density. In fact, if you could dunk Saturn into some really big ocean, it would float!)

So, depending on whether you want to make the gravity on your planet heavier or lighter, Equation 2 gives you a tool for adjusting your fictional planet's size (relative to the Earth) in order to obtain the value you require for the purposes of plot.

Does Your Planet Have Any Moons?

The Earth is unique in that we have the largest satellite (with respect to the size of the Earth) of any planet in the Solar System. Jupiter has moons that are larger than Luna (and nearly the size of Mercury), but these have little effect on the planet because Jupiter itself is so immense. Earth's mass is only 81 times that of Luna, where Jupiter is 12,000 times as massive as Ganymede, and Saturn is 4,200 times as massive as Titan.

Having such a large moon means more to us than the fact that lovers can lie out in the damp grass at night and look up at this big, silver ball in the sky. A big moon also means big tides. The Earth is covered with water over 70% of its surface. These oceans are subjected to the alternating pull of the Moon as our globe rotates beneath it. Twice each day the level of the water rises and falls due to influence of the Moon's gravitational pull on the Earth. Tides rise when the moon is directly overhead and again when it is directly on the opposite side of the planet.

Tides have several benefits. They keep the oceans stirred up and aid in wave action. They promote upwelling, which allows detritus to be brought to the surface where microorganisms can break it down in the presence of sunlight. A world without a large moon wouldn't have any tides and its oceans are liable to become stagnant over time. Think of a planet-wide swamp where billions of years of dead things just sit there and decay. Think of the smell! Do you really want to write a 100,000-word novel about such a stinky place?

What if your planet has more than one moon and they are all relatively large? What do the tides look like on such a world, and what effect would the moons' pull have on the social structure of the beings that live beneath them. What could the tides have to do

with social structure? Perhaps a great deal. Humanity has invested a great deal of effort into predicting when the tides will roll in. In fact, it is one of the primary reasons why we have naval observatories. Perhaps civilization on your fictional world began because the high priests figured out how to predict their much more complicated tidal patterns and used that knowledge to gain control of their societies.

Don't laugh. Something similar happened here on Earth in ancient Egypt. Both civilization and trigonometry were invented because of the need to enforce property rights following the spring floods every year. In fact, the word "pharaoh" can be loosely translated "irrigation supervisor."

Is Your World A Moon?

Nowhere is it written in the guild rules for science fiction writers that you have to plant your fictional civilization on a planet. You can just as easily use a moon, that is, a celestial body in orbit about a larger celestial body. In the last battle of the original *Star Wars*, the Death Star is attacking a moon on which the Rebels have taken refuge, not the planet itself. One advantage to making your planet a satellite of a much larger planet is that you have spectacular sky views for your hero and heroine to admire during the love scenes. However, based on our sampling of one planetary system to study, you may want to use caution planting your colony on a terrestrial-like moon.

As noted above, some of the moons of Jupiter are as large as small planets. In fact, interplanetary adventures involving Jupiter almost always focus on the Jovian system of moons rather than the big world itself. However, the thing that makes Jupiter a gas giant is that it orbits in the outer Solar System, far enough out that the heat hasn't had a chance to boil off the light hydrogen and helium atoms that make up the bulk of the planet's mass. In other words, the planet is frigid! So, too, are the Jovian moons.

So, you are writing along, working on your magnum opus, when your heroes stop off on a terrestrial world that it nearly the twin of Earth, and that world is a moon of a gas giant planet. Suddenly you realize to your horror that Jupiter is an outer system planet, and cold; while Earth is an inner system planet. How does your moon stay so hot while its planet remains cold, especially when considering that both orbit at the same distance from the central star?

There is one other problem. Large worlds like Jupiter, especially ones that rotate very quickly, have a much stronger magnetic field than does Earth. These strong magnetic fields have a tendency to collect charged particles from the solar wind and trap them. The result is radiation belts that accompany Jupiter around in its orbit, and through which the Jovian moons pass periodically. In fact, Jupiter's moon, Io, suffers so much from these heavy radiation storms that Io's surface may well be the most hostile environment in the Solar System. Not too good for your colonists if they have to wear lead underwear all the time.

Does Your World Have Seasons?

Seasons are so much a part of our existence that we take them for granted and often assume that any world we visit out in space will also have them. This is not

necessarily true. Many people naturally assume that summer is hotter than winter because the Earth is closer to the sun during the summer. This theory doesn't take into account the fact that when it is summer in the Northern Hemisphere, it's winter in the southern, and vice versa.

No, the Earth goes through its endless march from summer to fall to winter to spring because it is tilted 23.45 degrees on its axis. That means that as the Earth orbits about the sun, it tends to point first one hemisphere, and then the other more directly toward the sun. We who live on the Earth see this effect as having the sun climb higher in our sky during summer and then lower in the sky during winter. This translates into longer summer days and shorter winter ones, along with an increase in solar radiation during the summer and a decrease during the winter. In other words, we have seasons.

This steady march of the sun about the sky has a number of interesting effects. One of these is to define what we mean when we say "tropical." The tropics are those lands where the sun is directly overhead during some time during the year. The tropics are defined as those latitudes that lie between the Tropic of Cancer and the Tropic of Capricorn, and it isn't surprising that these two imaginary lines occur at precisely 23.45 north and south latitude.

Your fictional world need not have seasons. Any world that rides around its star with its north and south poles oriented at right angles to the plane of its orbit has 0 degrees inclination, and will not have any seasonal variations. This could have profound effects on those who live on these worlds. Many of our philosophies relate to our belief that life is a constant cycle of birth, growth, and death. A people who evolved under a world with 0 axial inclination might have a much different philosophy because life would not seem cyclic to them.

How Long Is Your World's Day?

It may seem trite to ask this question, but how long is your planetary day? Obviously, this depends on how quickly your world rotates on its axis. Perhaps it is tidal locked, showing only one face to its star (as Luna only shows one face to Earth). Obviously, it is going to be hot on the side that faces the star and cold on the side that doesn't. Or your planet may be rotating very quickly, which means that the days will be much shorter than we are used to. How will your human colonists adapt to this fast rotation?

Oceans: How Many, How Big, and How Deep?

Of course, the blue in "blue-white marble" comes from Earth's oceans. On this world we have large, deep oceans. To be precise, we have 361 million km^2 of ocean, which equates to 70.8% of the Earth's surface area. The mean depth of the oceans is 3794 meters, and the total mass of water on the planet's surface is 2.5×10^{18} tonnes. That's a lot of water by any standard.

If you think about the Earth, our world would have been radically different had the amount of water on it been significantly different. What if the proportions were reversed, and we had 70% land and 30% water. For one thing, it is unlikely that there would have been any need for a Leif Erickson or Christopher Columbus. On a world that is mostly

landmass, you ought to be able to walk to just about everywhere, as indeed you could during the last ice age when there was a land bridge where the Bering Strait now exists. What would have been the effect on Earth's history had all of the continents remained attached to one another? Would we now have five different geographically oriented races (Negroid, Caucasoid, Mongoloid, proto-Caucasoid, proto-Mongoloid) or would we all be one homogenous racial type?

Apply this same reasoning to your fictional world. Is it a desert planet like Arrakis (*Dune*), with giant worms and mysterious people? Or is it a "Waterworld," totally covered by ocean like the Earth during that unlamented recent movie bomb of the same name? You will have to admit that these two extremes lead an author in dramatically different plot directions.

And even if your world has oceans, making them shallow or deep has a strikingly different effect on your scenery and the sort of boats that sail the oceans. In one of my favorite books, *King David's Spaceship*, by Jerry Pournelle, the author writes a battle scene between the heroes and a group of pirates in one of the shallow seas of Makassar. Because the seas are so shallow, there is considerable movement of water between neap tide and ebb tide, so much so that the ships run aground each day as the tide goes out, and must be refloated when it comes roaring in again. The battle scene takes place on the sand between two beached ships and ends when a wall of water comes roaring back in across the shallow sea floor to engulf the pirate ship and dash it onto the nearby rocks.

So why did Pournelle describe Makassar's seas the way he did? Obviously, to set up the scene where the heroes fight off the pirates on the dry seabed. It was necessary for purposes of plot. Lest we forget, that is the reason we authors do just about everything.

So, when designing a planet, consider the requirements of your plot. If you want scenes with beautiful, fairy-like landscapes and warm sunbeams arching down through the water, then make your oceans shallow and populate them with a porpoise-like race of aliens who glide effortlessly between underwater domes and through giant, waving seaweed plants. If, on the other hand, you have need for a dark, oppressive underwater scene, make your oceans deep and concentrate on the killing pressure outside the stricken submarine where your heroes are struggling to survive.

Other Environmental Factors

When it comes to whole worlds, there are any number of fictional choices an author can make in order to aid his writing. What sort of weather does your world have? Is the atmosphere calm and dry for much of the year, or are there storms that march continuously across the landscape? In either case, what causes the weather you have postulated? For instance, the American Midwest seems to be the most prone place on Earth for tornadoes. The reason for this is the placement of the Rocky Mountains and the Gulf of Mexico. Does your fictional world have an analogous problem? Perhaps your tornadoes are a lot bigger and more violent than the ones we see here on Earth.

How tall are your mountains, and how steep? On Earth there is a limit to how tall a mountain can be. The pull of gravity and the strength of the planetary crust beneath a mountain range combine to determine that limit. On a low gravity world, the mountains might be considerably higher than they are here at home.

How often do meteors from space bombard your fictional world? Does the world orbit amid a massive cloud of debris, making meteor strikes relatively common, or is it almost alone in its orbit, making them virtually nonexistent? And what would a society look like that evolved on a planet that was struck every few centuries by massive space rocks? Would they ever develop beyond the caveman stage, or would they build magnificent cities time after time, only to have them destroyed when the next rock fell from space?

Conclusion

From the foregoing, it is obvious that there is a lot to think about when you build your world. Still, going through the mental exercise can have major benefits to your writing. For one thing, having taken the time and effort to design a fictional world causes you to think about things and in turn makes you a more confident writer when you are plotting your book. If your newly created world seems real to you, if you can see it, and taste it, and smell it as you write, then writing will be easier for you.

If you are able to close your eyes and see your world floating amid a starry firmament, then you ought to be able to visualize the people and beings that live on that world. Knowing what the seas are like, be they azure or aquamarine; being able to predict the strength of the wind and the severity of the storms; looking up to see three gibbous moons hanging low over the horizon — all of these will make you a better, more realistic writer.

So get out a pencil and paper and start working on the central world of your Galactic Imperium. Who knows? While you're at it, you might even be able to think up a plot to go with it!

The End

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Michael McCollum, Proprietor
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1. Life Probe - ^{US}$5.00

The Makers searched for the secret to faster-than-light travel for 100,000 years. Their chosen instruments were the Life Probes, which they launched in every direction to seek out advanced civilizations among the stars. One such machine searching for intelligent life encounters 21st century Earth. It isn't sure that it has found any...

2. Procyon's Promise - ^{US}$5.00

Three hundred years after humanity made its deal with the Life Probe to search out the secret of faster-than-light travel, the descendants of the original expedition return to Earth in a starship. They find a world that has forgotten the ancient contract. No matter. The colonists have overcome far greater obstacles in their single-minded drive to redeem a promise made before any of them were born...

3. Antares Dawn - US$5.00

When the super giant star Antares exploded in 2512, the human colony on Alta found their pathway to the stars gone, isolating them from the rest of human space for more than a century. Then one day, a powerful warship materialized in the system without warning. Alarmed by the sudden appearance of such a behemoth, the commanders of the Altan Space Navy dispatched one of their most powerful ships to investigate. What ASNS Discovery finds when they finally catch the intruder is a battered hulk manned by a dead crew.

That is disturbing news for the Altans. For the dead battleship could easily have defeated the whole of the Altan navy. If it could find Alta, then so could whomever it was that beat it. Something must be done…

4. Antares Passage - US$5.00

After more than a century of isolation, the paths between stars are again open and the people of Alta in contact with their sister colony on Sandar. The opening of the foldlines has not been the unmixed blessing the Altans had supposed, however.

For the reestablishment of interstellar travel has brought with it news of the Ryall, an alien race whose goal is the extermination of humanity. If they are to avoid defeat at the hands of the aliens, Alta must seek out the military might of Earth. However, to reach Earth requires them to dive into the heart of a supernova.

5. Antares Victory – First Time in Print – US$7.00

After a century of warfare, humanity finally discovered the Achilles heel of the Ryall, their xenophobic reptilian foe. Spica – Alpha Virginis – is the key star system in enemy space. It is the hub through which all Ryall starships must pass, and if humanity can only capture and hold it, they will strangle the Ryall war machine and end their threat to humankind forever.

It all seemed so simple in the computer simulations: Advance by stealth, attack without warning, strike swiftly with overwhelming power. Unfortunately, conquering the Ryall proves the easy part. With the key to victory in hand, Richard and Bethany Drake discover that they must also conquer human nature if they are to bring down the alien foe …

6. Thunderstrike! - US$6.00

The new comet found near Jupiter was an incredible treasure trove of water ice and rock. Immediately, the water-starved Luna Republic and the Sierra Corporation, a leader in asteroid mining, were squabbling over rights to the new resource. However, all thoughts of profit and fame were abandoned when a scientific expedition discovered that the comet's trajectory placed it on a collision course with Earth!

As scientists struggled to find a way to alter the comet's course, world leaders tried desperately to restrain mass panic, and two lovers quarreled over the direction the comet was to take, all Earth waited to see if humanity had any future at all…

7. The Clouds of Saturn - US$5.00

When the sun flared out of control and boiled Earth's oceans, humanity took refuge in a place that few would have predicted. In the greatest migration in history, the entire human race took up residence among the towering clouds and deep clear-air canyons of Saturn's upper atmosphere. Having survived the traitor star, they returned to the all-too-human tradition of internecine strife. The new city-states of Saturn began to resemble those of ancient Greece, with one group of cities taking on the role of militaristic Sparta...

8. The Sails of Tau Ceti – US$5.00

Starhopper was humanity's first interstellar probe. It was designed to search for intelligent life beyond the solar system. Before it could be launched, however, intelligent life found Earth. The discovery of an alien light sail inbound at the edge of the solar system generated considerable excitement in scientific circles. With the interstellar probe nearing completion, it gave scientists the opportunity to launch an expedition to meet the aliens while they were still in space. The second surprise came when *Starhopper's* crew boarded the alien craft. They found beings that, despite their alien physiques, were surprisingly compatible with humans. That two species so similar could have evolved a mere twelve light years from one another seemed too coincidental to be true.

One human being soon discovered that coincidence had nothing to do with it...

9. Gibraltar Earth – First Time in Print — $6.00

It is the 24th Century and humanity is just gaining a toehold out among the stars. Stellar Survey Starship *Magellan* is exploring the New Eden system when they encounter two alien spacecraft. When the encounter is over, the score is one human scout ship and one alien aggressor destroyed. In exploring the wreck of the second alien ship, spacers discover a survivor with a fantastic story.

The alien comes from a million-star Galactic Empire ruled over by a mysterious race known as the Broa. These overlords are the masters of this region of the galaxy and they allow no competitors. This news presents Earth's rulers with a problem. As yet, the Broa are ignorant of humanity's existence. Does the human race retreat to its one small world, quaking in fear that the Broa will eventually discover Earth? Or do they take a more aggressive approach?

Whatever they do, they must do it quickly! Time is running out for the human race…

10. Gibraltar Sun – First Time in Print — $7.00

The expedition to the Crab Nebula has returned to Earth and the news is not good. Out among the stars, a million systems have fallen under Broan domination, the fate awaiting Earth should the Broa ever learn of its existence. The problem would seem to allow but three responses: submit meekly to slavery, fight and risk extermination, or hide and pray the Broa remain ignorant of humankind for at least a few more generations. Are the hairless apes of Sol III finally faced with a problem for which there is no acceptable solution?

While politicians argue, Mark Rykand and Lisa Arden risk everything to spy on the all-powerful enemy that is beginning to wonder at the appearance of mysterious bipeds in their midst…

11. Gridlock and Other Stories - US$5.00

Where would you visit if you invented a time machine, but could not steer it? What if you went out for a six-pack of beer and never came back? If you think nuclear power is dangerous, you should try black holes as an energy source — or even scarier, solar energy! Visit the many worlds of Michael McCollum. I guarantee that you will be surprised!

Non-Fiction Books

12. The Art of Writing, Volume I - US$10.00

Have you missed any of the articles in the Art of Writing Series? No problem. The first sixteen articles (October, 1996-December, 1997) have been collected into a book-length work of more than 72,000 words. Now you can learn about character, conflict, plot, pacing, dialogue, and the business of writing, all in one document.

13. The Art of Writing, Volume II - US$10.00

This collection covers the Art of Writing articles published during 1998. The book is 62,000 words in length and builds on the foundation of knowledge provided by Volume I of this popular series.

14. The Art of Science Fiction, Volume I - US$10.00

Have you missed any of the articles in the Art of Science Fiction Series? No problem. The first sixteen articles (October, 1996-December, 1997) have been collected into a book-length work of more than 70,000 words. Learn about science fiction techniques and technologies, including starships, time machines, and rocket propulsion. Tour the Solar System and learn astronomy from the science fiction writer's viewpoint. We don't care where the stars appear in the terrestrial sky. We want to know their true positions in space. If you are planning to write an interstellar romance, brushing up on your astronomy may be just what you need.

15. The Art of Science Fiction, Volume II - US$10.00

This collection covers the *Art of Science Fiction* articles published during 1998. The book is 67,000 words in length and builds on the foundation of knowledge provided by Volume I of this popular series.

16. The Astrogator's Handbook – Expanded Edition and Deluxe Editions

The Astrogator's Handbook has been very popular on Sci Fi – Arizona. The handbook has star maps that show science fiction writers where the stars are located in space rather than where they are located in Earth's sky. Because of the popularity, we are expanding the handbook to show nine times as much space and more than ten times as many stars. The expanded handbook includes the positions of 3500 stars as viewed from Polaris on 63 maps. This handbook is a useful resource for every science fiction writer and will appeal to anyone with an interest in astronomy.

